FLORIDA DEPARTMENT OF TRANSPORTATION

Standard Specifications for Road and Bridge Construction

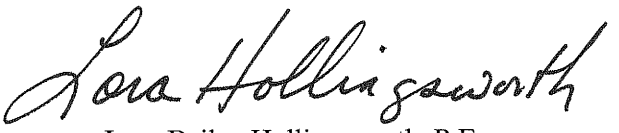
2010

COPIES OF THIS BOOK MAY BE OBTAINED FROM:
Florida Department of Transportation
Maps & Publications Sales
Mail Station 12
605 Suwannee Street
Tallahassee, Florida 32399-0450
Phone: (850) 414-4050
Fax: (850) 414-4915
E-Mail: co-mapsandpubs@dot.state.fl.us
http://www.dot.state.fl.us

All orders must be prepaid. We accept payment by check, US Postal Money Order, Discover, Visa, American Express or MasterCard. Orders may be mailed, faxed or placed on the Internet. No phone orders are accepted. A street address is requested for shipping, for tracking purposes.

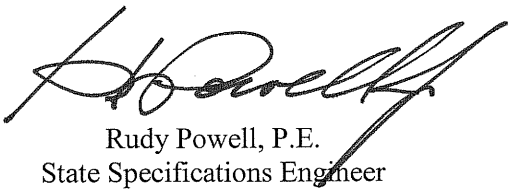
These Florida Department of Transportation Standard Specifications for Road and Bridge Construction, 2010, are hereby approved for application on highway and related construction contracts as referenced in the contract plans or specifications, and they shall apply as noted and amended by those documents.

Approved,



Lora Bailey Hollingsworth, P.E.
Director, Office of Design

I hereby certify that this Standard Specifications Book was prepared by me or under my responsible charge, compiled from specifications prepared, examined, adopted and implemented by the Florida Department of Transportation in accordance with established procedures, and as approved by the Federal Highway Administration.



Rudy Powell, P.E.
State Specifications Engineer

TABLE OF CONTENTS

DIVISION I GENERAL REQUIREMENTS & COVENANTS

DIVISION II CONSTRUCTION DETAILS

GENERAL CONSTRUCTION OPERATIONS

CLEARING CONSTRUCTION SITE

EARTHWORK AND RELATED OPERATIONS

BASE COURSES

BITUMINOUS TREATMENTS, SURFACE COURSES AND CONCRETE PAVEMENT

STRUCTURES

INCIDENTAL CONSTRUCTION

TRAFFIC CONTROL DEVICES

TRAFFIC CONTROL

DIVISION III MATERIALS

AGGREGATES

FLEXIBLE-PAVEMENT MATERIALS (INCLUDING MATERIALS FOR STABILIZING)

MATERIALS FOR PORTLAND CEMENT CONCRETE (STRUCTURAL PAVEMENT AND MISCELLANEOUS)

ACCESSORY MATERIALS FOR CONCRETE PAVEMENT AND CONCRETE STRUCTURES

DRAINAGE MATERIALS

TIMBER PRODUCTS AND MATERIALS

METAL MATERIALS AND FABRICATION DETAILS FOR METAL ITEMS

PAVEMENT MARKINGS, COATINGS AND RECYCLED MATERIAL (MISCELLANEOUS)

EROSION CONTROL MATERIALS

TRAFFIC CONTROL MATERIALS

DIVISION I
General Requirements and Covenants

SECTION 1
DEFINITIONS AND TERMS

1-1 General.

These Specifications are written to the bidder, prior to award of the Contract, and to the Contractor. Within Divisions I and II of the specifications, sentences that direct the Contractor to perform work are written in the active voice-imperative mood. These directions to the Contractor are written as commands. In the imperative mood, the subject "the bidder" or "the Contractor" is understood.

All other requirements to be performed by others, with the exception of the Method of Measurement and the Basis of Payment Articles, have been written in the active voice, but not in the imperative mood. Sentences written in the active voice identify the party responsible for performing the action. For example, "The Engineer will determine the density of the compacted material." Certain requirements of the Contractor may also be written in the active voice, rather than active voice-imperative mood.

Division III of the Specifications (Materials) is written in the passive voice writing style.

1-2 Abbreviations.

The following abbreviations, when used in the Contract Documents, represent the full text shown.

AAN	American Association of Nurserymen, Inc.
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AGC	The Associated General Contractors of America, Inc.
AGMA	American Gear Manufacturers Association
AIA	American Institute of Architects.
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute, Inc.
AREA	American Railway Engineering Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWPA	American Wood Preservers Association
AWS	American Welding Society
AWWA	American Water Works Association
CRSI	Concrete Reinforcing Steel Institute
EASA	Electrical Apparatus Service Association
EPA	Environmental Protection Agency of the United States Government
FDOT	Florida Department of Transportation

FHWA	Federal Highway Administration
FSS	Federal Specifications and Standards
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IPCEA	Insulated Power Cable Engineers Association
ISO	International Organization for Standards
MSTCSD	Minimum Specifications for Traffic Control Signals and Devices
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIST	National Institute for Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
OSHA	Occupational Safety and Health Administration
SAE	Society of Automotive Engineers
SI	International System of Units
SSPC	Society of Protective Coatings
UL	Underwriters' Laboratories

Each of the above abbreviations, when followed by a number or letter designation, or combination of numbers and letters, designates a specification, test method, or other code or recommendation of the particular authority or organization shown.

Use standards, specifications, test methods, or other codes as specified in the current edition at the time of the bid opening.

1-3 Definitions.

The following terms, when used in the Contract Documents, have the meaning described

Advertisement.

The public announcement, as required by law, inviting bids for work to be performed or materials to be furnished, usually issued as “Notice to Contractors,” or “Notice to Bidders.”

Article.

The numbered prime subdivision of a Section of these Specifications.

Bidder.

An individual, firm, or corporation submitting a proposal for the proposed work.

Bridge.

A structure, including supports, erected over a depression or over an obstruction such as water, highway or railway, or for elevated roadway, for carrying traffic or other moving loads, and having a length, measured along the center of the roadway, of more than 20 feet between the inside faces of end supports. A multiple-span box culvert is considered a bridge, where the length between the extreme ends of the openings exceeds 20 feet.

Calendar day.

Every day shown on the calendar, ending and beginning at midnight.

Change Order.

A written order issued by the Department and accepted by the Contractor, covering minor changes in the plans, specifications, or quantities of work, within the scope of the Contract, when prices for the items of work affected are previously established in the Contract.

Contract.

The term "Contract" means the entire and integrated agreement between the parties thereunder and supersedes all prior negotiations, representations, or agreements, either written or oral. The Contract Documents form the Contract between the Department and the Contractor setting forth the obligations of the parties thereunder, including, but not limited to, the performance of the Work and the basis of payment.

Contract Claim (Claim).

A written demand submitted to the Department by the Contractor in compliance with 5-12.3 seeking additional monetary compensation, time, or other adjustments to the Contract, the entitlement or impact of which is disputed by the Department.

Contract Documents.

The term "Contract Documents" includes: Advertisement for Proposal, Proposal, Certification as to Publication and Notice of Advertisement for Proposal, Appointment of Agent by Nonresident Contractors, Noncollusion Affidavit, Warranty Concerning Solicitation of the Contract by Others, Resolution of Award of Contract, Executed Form of Contract, Performance Bond and Payment Bond, Standard Specifications, Supplemental Specifications, Special Provisions, plans, Addenda, or other information mailed or otherwise transmitted to the prospective bidders prior to the receipt of bids, change orders, field orders, and supplemental agreements, all of which are to be treated as one instrument whether or not set forth at length in the form of contract.

Note: As used in Sections 2 and 3 only, Contract Documents do not include change orders, field orders, and supplementary agreements. As used in Section 2 only, Contract Documents also do not include Resolution of Award of Contract, Executed Form of Contract, and Performance and Payment Bond.

Contract Bond.

The security furnished by the Contractor and the surety as a guaranty that the Contractor shall fulfill the terms of the Contract and pay all legal debts pertaining to the construction of the project.

Contract Letting.

The date that the Department opened the bid proposals.

Contract Time.

The number of calendar days allowed for completion of the Contract work, including authorized time extensions.

Contractor.

The individual, firm, joint venture, or company contracting with the Department to perform the work.

Contractor's Engineer of Record.

A Professional Engineer registered in the State of Florida, other than the Engineer of Record or his subcontracted consultant, who undertakes the design and drawing of components of the permanent structure as part of a redesign or VECP, or for repair designs and details of the permanent work. The Contractor's Engineer of Record may also serve as the Specialty Engineer.

The Contractor's Engineer of Record must be an employee of a pre-qualified firm. The firm shall be pre-qualified in accordance with the Rules of the Department of Transportation, Chapter 14-75. Any Corporation or Partnership offering engineering services must hold a Certificate of Authorization from the Florida Department of Business and Professional Regulation.

As an alternate to being an employee of a pre-qualified firm, the Contractor's Engineer of Record may be a pre-qualified Specialty Engineer. For items of the permanent work declared by the State Construction Office to be "major" or "structural", the work performed by a pre-qualified Specialty Engineer must be checked by another pre-qualified Specialty Engineer. An individual Engineer may become pre-qualified in the work groups listed in the Rules of the Department of Transportation, Chapter 14-75, if the requirements for the Professional Engineer are met for the individual work groups. Pre-qualified Specialty Engineers are listed on the State Construction Website. Pre-qualified Specialty Engineers will not be authorized to perform redesigns or VECP designs of items fully detailed in the plans.

Controlling Work Items.

The activity or work item on the critical path having the least amount of total float. The controlling item of work will also be referred to as a Critical Activity.

Culverts.

Any structure not classified as a bridge that provides an opening under the roadway.

Delay.

Any unanticipated event, action, force or factor which extends the Contractor's time of performance of any controlling work item under the Contract. The term "delay" is intended to cover all such events, actions, forces or factors, whether styled "delay", "disruption", "interference", "impedance", "hindrance", or otherwise, which are beyond the control of and not caused by the Contractor, or the Contractor's subcontractors, materialmen, suppliers or other agents. This term does not include "extra work".

Department.
State of Florida Department of Transportation.

Developmental Specification.
See definition for Specifications.

Engineer.
The Director, Office of Construction, acting directly or through duly authorized representatives; such representatives acting within the scope of the duties and authority assigned to them.

Note: In order to avoid cumbersome and confusing repetition of expressions in these Specifications, it is provided that whenever anything is, or is to be done, if, as, or, when, or where "acceptable, accepted, approval, approved, authorized, condemned, considered necessary, contemplated, deemed necessary, designated, determined, directed, disapproved, established, given, indicated, insufficient, ordered, permitted, rejected, required, reserved, satisfactory, specified, sufficient, suitable, suspended, unacceptable, or unsatisfactory," it shall be understood as if the expression were followed by the words "by the Engineer," "to the Engineer," or "of the Engineer."

Engineer of Record.
The Professional Engineer or Engineering Firm registered in the State of Florida that develops the criteria and concept for the project, performs the analysis, and is responsible for the preparation of the Plans and Specifications. The Engineer of Record may be Departmental in-house staff or a consultant retained by the Department.

The Contractor shall not employ the Engineer of Record as the Contractor's Engineer of Record or as a Specialty Engineer.

Equipment.
The machinery and equipment, together with the necessary supplies for upkeep and maintenance thereof, and all other tools and apparatus necessary for the construction and acceptable completion of the work.

Extra Work.
Any "work" which is required by the Engineer to be performed and which is not otherwise covered or included in the project by the existing Contract Documents, whether it be in the nature of additional work, altered work, deleted work, work due to differing site conditions, or otherwise. This term does not include a "delay".

Highway, Street, or Road.
A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

Holidays.
Days designated by the State Legislature or Cabinet as holidays, which include, but are not limited to, New Year's Day, Martin Luther King's Birthday,

Memorial Day, Independence Day, Labor Day, Veterans' Day, Thanksgiving Day and the following Friday, and Christmas Day.

Inspector.
An authorized representative of the Engineer, assigned to make official inspections of the materials furnished and of the work performed by the Contractor.

Laboratory.
The official testing laboratory used by the Department.

Major Item of Work.
Any item of work having an original Contract value in excess of 5% of the original Contract amount.

Materials.
Any substances to be incorporated in the work under the Contract.

Median.
The portion of a divided highway or street separating the traveled ways for traffic moving in opposite directions.

Plans.
The approved plans, including reproductions thereof, showing the location, character, dimensions, and details of the work.

Proposal (Bid, Bid Proposal).
The offer of a bidder, on the prescribed form, to perform the work and to furnish the labor and materials at the prices quoted.

Proposal Form.
The official form or the expedite program generated bid item sheets on which the Department requires formal bids to be prepared and submitted for the work.

Proposal Guaranty.
The security furnished by the bidder as guaranty that the bidder will enter into the Contract for the work if the Department accepts the proposal.

Right-of-Way.
The land that the Department has title to, or right of use, for the road and its structures and appurtenances, and for material pits furnished by the Department.

Roadbed.
The portion of the roadway occupied by the subgrade and shoulders.

Roadway.
The portion of a highway within the limits of construction.

Secretary.

Secretary of Transportation, State of Florida Department of Transportation, acting directly or through an assistant or other representative authorized by him; the chief officer of the Department of Transportation.

Section.

A numbered prime division of these Specifications.

Special Provisions.

See definition for Specifications.

Specialty Engineer.

A Professional Engineer registered in the State of Florida, other than the Engineer of Record or his subcontracted consultant, who undertakes the design and drawing preparation of components, systems, or installation methods and equipment for specific temporary portions of the project work or for special items of the permanent works not fully detailed in the plans and required to be furnished by the Contractor such as but not limited to pot bearing designs, non-standard expansion joints, MSE wall designs and other specialty items. The Specialty Engineer may also provide designs and details for items of the permanent work declared by the State Construction Office to be "minor" or "non-structural". The Specialty Engineer may be an employee or officer of the Contractor or a fabricator, an employee or officer of an entity providing components to a fabricator, or an independent consultant.

For items of work not specifically covered by the Rules of the Department of Transportation, a Specialty Engineer is qualified if he has the following qualifications:

(1) Registration as a Professional Engineer in the State of Florida.

(2) The education and experience necessary to perform the submitted design as required by the Florida Department of Business and Professional Regulation.

Specifications.

The directions, provisions, and requirements contained herein, together with all stipulations contained in the Contract Documents, setting out or relating to the method and manner of performing the work, or to the quantities and qualities of materials and labor to be furnished under the Contract.

A. Standard Specifications: "Standard Specifications for Road and Bridge Construction" a bound book, applicable to all Department Contracts containing adopted requirements, setting out or relating to the method or manner of performing work, or to the quantities and qualities of materials and labor.

B. Supplemental Specifications: Approved additions and revisions to the Standard Specifications, applicable to all Department Contracts.

C. Special Provisions: Specific clauses adopted by the Department that add to or revise the Standard Specifications or supplemental specifications, setting forth conditions varying from or additional to the Standard Specifications applicable to a specific project.

D. Technical Special Provisions: Specifications, of a technical nature, prepared, signed, and sealed by an Engineer registered in the State of Florida other than the State Specifications Engineer or his designee, that are made part of the Contract as an attachment to the Contract Documents.

E. Developmental Specification: A specification developed around a new process, procedure, or material.

Standard Specifications.

See definition for Specifications.

State.

State of Florida.

Subarticle.

A headed and numbered subdivision of an Article of a Section of these Specifications.

Subgrade.

The portion of the roadbed immediately below the base course or pavement, including below the curb and gutter, valley gutter, shoulder and driveway pavement. The subgrade limits ordinarily include those portions of the roadbed shown in the plans to be constructed to a design bearing value or to be otherwise specially treated. Where no limits are shown in the plans, the subgrade section extends to a depth of 12 inches below the bottom of the base or pavement and outward to 6 inches beyond the base, pavement, or curb and gutter.

Substructure.

All of that part of a bridge structure below the bridge seats, including the parapets, backwalls, and wingwalls of abutments.

Superintendent.

The Contractor's authorized representative in responsible charge of the work.

Superstructure.

The entire bridge structure above the substructure, including anchorage and anchor bolts, but excluding the parapets, backwalls, and wingwalls of abutments.

Supplemental Agreement.

A written agreement between the Contractor and the Department, and signed by the surety, modifying the Contract within the limitations set forth in these Specifications.

Supplemental Specifications.

See definition for Specifications.

Surety.

The corporate body that is bound by the Contract Bond with and for the Contractor and responsible for the performance of the Contract and for payment of all legal debts pertaining thereto.

Technical Special Provisions.
See definition for Specifications.

Traveled Way.
The portion of the roadway providing for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

Unilateral Payment.
A payment of money made to the Contractor by the Department pursuant to Section 337.11(11), Florida Statutes (1997), for sums the Department determines to be due to the Contractor for work performed on the project, and whereby the Contractor by acceptance of such payment does not waive any rights the Contractor may otherwise have against the Department for payment of any additional sums the Contractor claims are due for the work.

Work.
All labor, materials and incidentals required to execute and complete the requirements of the Contract including superintendence, use of equipment and tools, and all services and responsibilities prescribed or implied.

Working Day.
Any calendar day on which the Contractor works or is expected to work in accordance with the approved work progress schedule.

SECTION 2
PROPOSAL REQUIREMENTS AND CONDITIONS

2-1 Prequalification of Bidders.
Except as noted below, prequalify with the Department to be eligible to bid. The Department publishes regulations covering prequalification of bidders under separate cover.

The Department does not require the Contractor to be prequalified if bidding construction contracts of $250,000 or less, or if constructing buildings. In addition, at its sole discretion, the Department may waive prequalification requirements on contracts of $500,000 or less.

For construction contracts requiring prequalification, file an application for qualification on forms furnished by the Department, giving detailed information with respect to financial resources, equipment, past record, personnel, and experience. For qualified applicants, the Department will issue a certificate fixing the types of work and the aggregate amount of work that the Department allows the prequalified bidder to have under contract at any one time.

A person or affiliate who has been placed on the convicted vendor list following a conviction for a public entity crime may not submit the following:

(a) A bid on a contract to provide any goods or services to a public entity.

(b) A bid on a contract with a public entity for the construction or repair of a public building or public work.

(c) Bids on leases of real property to a public entity.

A person or affiliate who has been placed on the convicted vendor list following a conviction for a public entity may not be awarded or perform work as a contractor, supplier, subcontractor, or consultant under a contract with any public entity, and may not transact business with any public entity in excess of the threshold amount provided in Section 287.017 F.S., for Category Two. All restrictions apply for a period of 36 months from the date of placement on the convicted vendor list.

All prequalified Contractors bidding on any Contract must certify their total dollar amount of Work Underway and submit Form 375-020-39 or a spreadsheet in a similar format prior to submitting a bid. This information must be submitted at least once during the month the bid is due via the "Work Underway" link in the Contractor Pre-Qualification System.

2-2 Proposals.

2-2.1 Obtaining Proposals: Obtain a proposal under the conditions stipulated in the Advertisement. The proposal states the location and description of the work to be performed; the estimate of the various quantities (if applicable); the items of work to be performed (if applicable); the Contract Time; the amount of proposal guaranty; and the date, time, and place of the opening of proposals.

The plans, Specifications and other documents designated in the proposal are part of the proposal, whether attached or not.

Upon receipt of a proposal order, the Department will provide a computer diskette or CD-ROM for use on a personal computer that is suitable for preparing the bid. This diskette or CD-ROM contains the Expedite Proposal file to be used by the Contractor to prepare the bid and print a proposal form for submittal.

The Department is not responsible for loss of or damage to a diskette or CD-ROM after it has been mailed or delivered to the bidder. If loss or damage occurs, the bidder may order another diskette or CD-ROM.

If the bidder requests a replacement diskette or CD-ROM during a seven calendar day period prior to the letting, the request must be by Internet E-mail as specified in the Advertisement. The Department will attempt to replace the diskette or CD-ROM by sending another diskette or CD-ROM by overnight delivery or by electronic transmittal of the files. The Department will not be held responsible if the bidder cannot complete and submit a bid due to failure or incomplete delivery of the files.

Unless otherwise indicated in the Advertisement, the Contractor has the option to submit a bid either as an Internet Bid Submittal in accordance with 2-2.3 or as a Hard Copy Bid Submittal in accordance with 2-2.4. When an Internet bid submittal is used, the hard copy will not be considered.

2-2.2 Department Modifications to Contract Documents: Modifications to any Contract Documents will be posted on the Department's website at the following URL address: www.dot.state.fl.us/cc-admin/addend.htm .

The bidder shall take responsibility for checking and downloading the revised data from the Department's website upon notification from the Department. The bidder must provide an e-mail address to the Department for

receipt of addenda notification. Contractors must follow the amendment access instructions provided on the website. If the Department's website cannot be accessed, contact the Department's Contracts Administration Office Web Coordinator at (850) 414-4000.

2-2.3 Internet Bid Submittals: Unless otherwise indicated in the Advertisement, the Contractor may use the Expedite Proposal file to prepare a bid for Internet submittal. The Department will accept, as the official bid, the set of proposal forms generated from the Expedite Proposal file along with a complete proposal package, submitted via the Internet in accordance with 2-5 and 2-8. A Digital ID is required to submit a bid via the Internet. Digital IDs may be obtained as outlined in the Advertisement.

The Department will not be responsible for any communications or machine breakdowns, transmission interruptions, delays, or any other problems that interfere with the receipt of proposals as required above either at the Bidder's transmitting location, at the Department's receiving location, or anywhere between these locations. Receipt or non-receipt of a proposal will not be considered grounds for a bid protest. The Department will not be held responsible if the bidder cannot complete and submit a bid due to failure or incomplete delivery of the files submitted via the Internet.

2-2.4 Hard Copy Bid Submittals: Unless otherwise indicated in the Advertisement, the Contractor may use the Expedite Proposal file to prepare a bid for hard copy submittal.

Print and submit bid item sheets generated from the Expedite Proposal file on letter size paper. Ensure that all computer generated sheets are legible. Do not submit computer generated sheets using a font size smaller than 9 point. The Department prefers 12 point font size and recommends a minimum of 20 pound paper.

The Department will accept, as the official bid, this set of proposal forms generated from the Expedite Proposal file along with a complete proposal package, delivered to the Department in hard copy in accordance with the instructions listed below and the requirements of 2-5 and 2-8.

Return the Expedite Proposal file used to generate the official bid with the proposal on the diskette furnished by the Department, or on another diskette labeled with the Contractor's Name, Vendor Number, Letting Date, Revision Date (if applicable) and the Proposal ID. Failure to follow proper diskette-handling and shipping procedures could result in the Department being unable to process the diskette and cause the bid to be declared irregular.

In case of a discrepancy between the unit or lump sum prices submitted on the program-printed proposal form and those contained on the diskette returned to the Department, the Department will use the unit or lump sum prices submitted on the program-printed proposal form.

2-3 Interpretation of Estimated Quantities.

2-3.1 Lump Sum Contracts: The bidder is responsible for the determination of the quantities for those items constructed within the authorized plan limits or dimensions.

The Department does not assume any responsibility for any incidental information in bid documents that may be construed as a quantity of work and/or materials.

2-3.2 Contracts other than Lump Sum: For those items constructed within authorized plan limits or dimensions, use the quantities shown in the plans and in the proposal form as the basis of the bid. The Department will also use these quantities for final payment as limited by the provisions for the individual items. For those items having variable final pay quantities that are dependent on actual field conditions, use and measurement, the quantities shown in the plans and in the proposal form are approximate and provide only a basis for calculating the bid upon which the Department will award the Contract. Where items are listed for payment as lump sum units and the plans show estimates of component quantities, the Department is responsible for the accuracy of those quantities limited to the provisions of 9-3.3. Where items are listed for payment as lump sum units and the plans do not show estimates of component quantities, the Contractor is solely responsible for his own estimates of such quantities.

The Department may increase, decrease, or omit the estimated quantities of work to be done or materials to be furnished.

2-4 Examination of Plans, Specifications, Special Provisions and Site of Work.

Examine the Contract Documents and the site of the proposed work carefully before submitting a proposal for the work contemplated. Investigate the conditions to be encountered, as to the character, quality, and quantities of work to be performed and materials to be furnished and as to the requirements of all Contract Documents.

The Department does not guarantee the details pertaining to borings, as shown on the plans, to be more than a general indication of the materials likely to be found adjacent to holes bored at the site of the work, approximately at the locations indicated. The Contractor shall examine boring data, where available, and make his own interpretation of the subsoil investigations and other preliminary data, and shall base his bid on his own opinion of the conditions likely to be encountered.

The bidder's submission of a proposal is prima facie evidence that the bidder has made an examination as described in this Article.

2-5 Preparation of Proposals.

2-5.1 General: Submit proposals on the form described in 2-2. Any pay item that will be provided free or at no cost to the Department shall be indicated as "free" or "$.00". If the pay item is left blank or n/a is used, the bid may be declared irregular. Show the total of the bid on the face of the proposal.

2-5.2 Internet Bid Submittals: The bidder shall execute the proposal under the bidders Digital ID and enter the firm's bidding office street address on the Bidders Information Tab in the Expedite Bidding Program. This Digital ID represents the firm as an individual, partnership, corporation, limited liability company, or joint venture. By entering and submitting the Digital ID the authorized parties obligate the firm to the bid. Internet Bid Submittals must

acknowledge, on behalf of, the person, firm, association, or corporation submitting the bid certifying that such person, firm, association, or corporation has not, either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with the submitted bid, by indicating such in the Expedite Proposal File. The Department will not consider any bid unless such acknowledgement is included.

2-5.3 Hard Copy Bid Submittals: If the proposal is made by an individual, either in the bidder's own proper person or under a trade or firm name, the bidder shall execute the proposal under the bidder's signature and enter the firm's bidding office street address. If made by a partnership, execute the proposal by setting out in full the names of the partners, the firm name of the partnership, if any, have two or more of the general partners sign the proposal and enter the firm's bidding office street address. If made by a corporation, execute the proposal by setting out in full the corporate name and have the president or other legally authorized corporate officer or agent sign the proposal, affix the corporate seal and enter the corporation's bidding office street address. If made by a limited liability company, execute the proposal by setting out the company name, have the manager or authorized member sign the proposal and enter the company's bidding office address. If made by a joint venture, execute the proposal by setting out the joint venture name, have the authorized parties sign the proposal and enter the bidding office's street address. File with the Department Form 375-020-08, contained in the proposal, which includes an unsworn statement executed by, or on behalf of, the person, firm, association, or corporation submitting the bid certifying that such person, firm, association, or corporation has not, either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with the submitted bid. The Department will not consider any bid unless such form is properly completed in accordance with the requirements shown thereon.

2-6 Rejection of Irregular Proposals.

A proposal is irregular and the Department may reject it if it shows omissions, alterations of form, additions not specified or required, conditional or unauthorized alternate bids, or irregularities of any kind; or if the unit prices are obviously unbalanced, or if the cost is in excess of or below the reasonable cost analysis values.

When the Department provides for alternate bids in the proposal form and the bidder submits non-computer-generated proposal form sheets, make only one entry in each design group. A proposal that provides for alternative bids is irregular and the Department may reject it if the bidder makes entries for more than one alternate.

2-7 Guaranty to Accompany Proposals.

The Department will not consider any proposal unless it is accompanied by a proposal guaranty of the character and amount indicated in the Advertisement, and unless it is made payable to the Florida Department of Transportation.

Submit proposals with the understanding that the successful bidder shall furnish a Contract Bond pursuant to the requirements of 3-5.

2-8 Delivery of Proposals.

2-8.1 Internet Bid Submittals: Unless otherwise indicated in the Advertisement, bids may be submitted via the Internet. The Department will not accept responsibility for Internet bids not meeting the time requirement stipulated in the Advertisement.

2-8.2 Hard Copy Bid Submittals: Unless otherwise indicated in the Advertisement, bids may be submitted via hard copy. Submit all bids in sealed envelopes, bearing on the outside the name of the bidder, the bidder's address, and the Proposal ID of the project for which the bidder submitted the bid. For proposals that are submitted by mail, enclose the proposal in a sealed envelope, marked as directed above. Enclose the sealed envelope in a second outer envelope addressed to the Department, at the place designated in the Advertisement. For a proposal that is not submitted by mail, deliver it to the Contracts Office of the Department, or to the place as designated in the Advertisement. The Department will not consider proposals received after the time set for opening bids. The Department will retain these proposals unopened.

2-9 Withdrawal or Revision of Proposals.

2-9.1 Internet Bid Submittals: A bidder may withdraw a proposal any time prior to the bid submittal deadline specified in the Advertisement. The resubmission of any proposal so withdrawn must be made as a complete proposal, subject to the provisions of 2-8.

A bidder may revise a proposal any time prior to the bid submittal deadline specified in the Advertisement. Revisions may be made via Internet in accordance with 2-8.1 or by fax in accordance with 2-9.2.

The Department will not be responsible for any communications or machine breakdowns, transmission interruptions, delays, or any other problems that interfere with the receipt of revisions to proposals as required above either at the Bidder's transmitting location, at the Department's receiving location, or anywhere between these locations. Receipt or non-receipt of revisions to a proposal will not be considered grounds for a bid protest. The Department will not be held responsible if the bidder cannot complete and submit revisions to a bid due to failure or incomplete delivery of the files submitted via the Internet.

2-9.2 Hard Copy Bid Submittals: A bidder may withdraw or revise a proposal after submitting it, provided the Department receives a written request to withdraw or revise the proposal prior to the time set for opening of bids. The resubmission of any proposal withdrawn under this provision is subject to the provisions of 2-8.

Legible facsimile (FAX) proposal changes will be accepted if received in full at the fax number listed in the Bid Solicitation Notice by the time proposals are due on the day of the letting and provided that all of the following conditions are met:

1. The Bidder's name is the same on the faxed proposal change as shown on the original proposal.

2. The proposal change includes the following:

The correct Proposal ID.

The correct bid item number being changed and the respective unit price change.

The correct revised total per item.

The revised total bid amount.

The signature of the President or Vice President of the Company.

Faxed proposal changes failing to meet all of these requirements will not be considered and will not change the original bid.

The Department will not be responsible for any communications or fax machine breakdowns, transmission interruptions, delays, or any other problems that interfere with the receipt of faxed proposal changes as required above either at the Bidder's fax location, at the Department's fax location, or anywhere between these locations. Receipt or non-receipt of a faxed proposal change will not be considered grounds for a bid protest.

2-10 Opening of Proposals.

The Department will open and publicly announce proposals at the time and place indicated in the Advertisement. The Department invites bidders, their authorized agents, and other interested parties to attend.

2-11 Disqualification of Bidders.

The Department may disqualify any bidder and reject the bidder's proposal or proposals for any of the following reasons:

(a) The submission of more than one proposal for the same work from an individual, firm, or corporation under the same or a different name.

(b) Evidence that one bidder has a financial interest in the firm of another bidder for the same work.

(c) Evidence of collusion among bidders. The Department will not recognize a participant in such collusion as a bidder for any future work of the Department until the Department reinstates such participant as a qualified bidder.

(d) Failure to qualify in accordance with 2-1.

(e) Uncompleted work on other projects that, in the judgment of the Department, could hinder or prevent the prompt completion of the proposed work.

(f) Failure to pay or satisfactorily settle all bills due for labor and material on other contracts in force at the time of advertisement for bids.

(g) Default under a previous contract.

(h) Employment of unauthorized aliens in violation of Section 274A (e) of the Immigration and Nationality Act.

(i) Falsification on any form required by the Department.

(j) The submission of a proposal that was not issued by the Department.

2-12 Material, Samples and Statement.

The Department may require that the bidder furnish a statement of the origin, composition, and manufacture of any and all materials to be used in the construction of the work, together with samples that may be subjected to the tests

provided for in these Specifications to determine the materials' quality and fitness for the work.

SECTION 3
AWARD AND EXECUTION OF CONTRACT

3-1 Consideration of Bids.

For the purpose of award, after opening and reading the proposals, the Department will consider as the bid the correct summation of each unit bid price multiplied by estimated quantities shown in the proposal. On this basis, the Department will compare the amounts of each bid and make the results of such comparison available to the public. Until the actual award of the Contract, however, the Department reserves the right to reject any or all proposals and to waive technical errors that the Department may deem best for the interest of the State.

The Department reserves the right to delete the bid portion of the utility relocation work from the Contract. When the Department deletes utility relocation work from the Contract, the Department will recalculate the Contract bid tabulations based on the remaining project quantities.

In the event that the Department deletes utility relocation work from the Contract, the utility owner will relocate such utilities in accordance with the utility Relocation Schedule attached to the Specifications Package.

3-2 Award of Contract.

3-2.1 General: If the Department decides to award the Contract, the Department will award the Contract to the lowest responsible bidder whose proposal complies with all the Contract Document requirements. If awarded, the Department will award the Contract within 50 days after the opening of the proposals, unless the Special Provisions change this time limit or the bidder and the Department extend the time period by mutual consent.

Prior to award of the Contract by the Department, a contractor must provide proof of authorization to do business in the State of Florida.

3-2.2 Bids Exceeding Contractor's Rating: The Department will address bids exceeding a Contractor's rating, and the resulting impact on the Contractor's qualification to bid, in accordance with Florida Administrative Code Rules 14-22.003 and 14-22.009.

The bidder's proposal guaranties are binding for all projects awarded to the Contractor pursuant to the provisions of this Subarticle.

3-3 Cancellation of Award.

The Department reserves the right to cancel the award of any contract at any time before the execution of the contract by all parties, with no compensation due any of the bidders.

3-4 Release of Proposal Guaranty.

The Department will release all proposal guaranties except those of the two lowest bidders immediately following the opening and checking of the proposals.

The Department will immediately release the proposal guaranties of the two lowest bidders after the successful bidder delivers the executed contract and a satisfactory bond to the Department, except that the Department will not retain the proposal guaranty of the next-to-lowest bidder longer than 50 days after the opening of the proposals unless the Department awards the contract to the next lowest bidder prior to the expiration of this time limit.

3-5 Contract Bond Required.

3-5.1 General Requirements of the Bond: Upon award, furnish to the Department, and maintain in effect throughout the life of the Contract, an acceptable surety bond in a sum at least equal to the amount of the Contract. Execute such bond on the form furnished by the Department. Obtain a surety that has a resident agent in the State of Florida, meets all of the requirements of the laws of Florida and the regulations of the Department, and has the Department's approval. Ensure that the surety's resident agent's name, address, and telephone number is clearly stated on the face of the Contract Bond.

On contracts of $250,000 or less, the Department may waive the requirement for all or a portion of a surety bond if it determines that the project is of a noncritical nature and nonperformance will not endanger the public health, safety, or property. The Department may require alternate means of security if it waives the requirement for a surety bond.

3-5.2 Continued Acceptability of Surety: Provide a surety bond that remains acceptable to the Department throughout the life of the Contract. In the event that the surety executing the bond, although acceptable to the Department at the time of execution of the Contract, subsequently becomes insolvent or bankrupt, or becomes unreliable or otherwise unsatisfactory due to any cause that becomes apparent after the Department's initial approval of the company, then the Department may require that the Contractor immediately replace the surety bond with a similar bond drawn on a surety company that is reliable and acceptable to the Department. In such an event, the Department will bear all costs of the premium for the new bond, after deducting any amounts that are returned to the Contractor from his payment of premium on the original bond.

3-5.3 Default by Contractor: In case of default on the part of the Contractor, the Department will charge against the bond all expenses for services incidental to ascertaining and collecting losses under the bond, including accounting, engineering, and legal services, together with any and all costs incurred in connection with renegotiation of the Contract.

3-5.4 Surety to Furnish Legal Defense: The surety company shall indemnify and provide defense for the Department when called upon to do so for all claims or suits against the Department, by third parties, pertaining to Contractor payment or performance issues arising out of the Contract. It is expressly understood that the monetary limitation on the extent of the indemnification shall be the approved Contract amount, which amount shall be the original Contract amount as may be increased by subsequent Supplemental Agreements.

3-5.5 Liability for Wrongful or Criminal Act by Contractor: The principal and surety executing the bond shall be liable to the State in any civil

action that might be instituted by the Department or any officer of the State authorized in such cases, for double any amount in money or property the State might lose, or be overcharged, or otherwise be defrauded of by any wrongful or criminal act of the Contractor, his agent or his employees.

3-6 Execution of Contract and Bond.

Within 20 days after Contract award, execute the necessary agreements to enter into a contract with the Department and return the agreement along with a satisfactory surety bond and documentation evidencing all insurance required by 7-13 to the Department's Contracts Office that awarded the Contract. For each calendar day that the successful bidder is late in delivering to the Department's Contracts Office all required documents in properly executed form, the Department will deduct one day from the allowable Contract Time as specified in 8-7.1. The Department will not be bound by any proposal until it executes the associated Contract. The Department will execute the Contract and bond in the manner stipulated in 2-5.1.

The Department will execute the Contract within 15 days after receipt of the necessary agreements and bond from the Contractor.

3-7 Failure by Contractor to Execute Contract and Furnish Bond.

In the event that the bidder fails to execute the awarded Contract and to file an acceptable bond, as prescribed in 3-5 and 3-6, within 20 days of Contract award, the Department may annul the award, causing the bidder to forfeit the proposal guaranty to the Department; not as a penalty but in liquidation of damages sustained. The Department may then award the Contract to the next lowest responsible bidder, re-advertise, or accomplish the work using day labor.

3-8 Audit of Contractor's Records.

Upon execution of the Contract, the Department reserves the right to conduct an audit of the Contractor's records pertaining to the project. The Department or its representatives may conduct an audit, or audits, at any time prior to final payment, or thereafter pursuant to 5-13. The Department may also require submittal of the records from either the prime contractor, the subcontractor, or both. As the Department deems necessary, records include all books of account, supporting documents, and papers pertaining to the cost of performance of the project work.

If the Contractor fails to comply with these requirements, the Department may disqualify or suspend the Contractor from bidding on or working as a subcontractor on future Contracts.

Ensure that the subcontractors provide access to their records pertaining to the project upon request by the Department.

3-9 Public Records.

Allow public access to all documents, papers, letters, or other material subject to the provisions of Chapter 119, Florida Statutes, made or received by the Contractor in conjunction with this Contract. Failure to grant such public access will be grounds for immediate termination of this Contract by the Department pursuant to 8-9.1.

SECTION 4
SCOPE OF THE WORK

4-1 Intent of Contract.

The intent of the Contract is to provide for the construction and completion in every detail of the work described in the Contract. Furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the Contract Documents.

4-2 Work not Covered by Standard Specifications.

Proposed construction and any contractual requirements not covered by these Standard Specifications may be covered by Contract plan notes or by Supplemental Specifications or Special Provisions for the Contract, and all requirements of such Supplemental Specifications or Special Provisions shall be considered as a part of these Specifications.

4-3 Alteration of Plans or of Character of Work.

4-3.1 General: The Engineer reserves the right to make, at any time prior to or during the progress of the work, such increases or decreases in quantities, whether a significant change or not, and such alterations in the details of construction, whether a substantial change or not, including but not limited to alterations in the grade or alignment of the road or structure or both, as may be found necessary or desirable by the Engineer. Such increases, decreases or alterations shall not constitute a breach of Contract, shall not invalidate the Contract, nor release the Surety from any liability arising out of this Contract or the Surety bond. The Contractor agrees to perform the work, as altered, the same as if it had been a part of the original Contract.

The term "significant change" applies only when:

(a) The Engineer determines that the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction, or

(b) A major item of work, as defined in 1-3, is increased in excess of 125% or decreased below 75% of the original Contract quantity. The Department will apply any price adjustment for an increase in quantity only to that portion in excess of 125% of the original Contract item quantity, or in case of a decrease below 75% to the actual amount of work performed, such allowance to be determined in accordance with 4-3.2, below.

In the instance of (a) above, the determination by the Engineer shall be conclusive and shall not subject to challenge by the Contractor in any forum, except upon the Contractor establishing by clear and convincing proof that the determination by the Engineer was without any reasonable and good-faith basis.

4-3.2 Increase, Decrease or Alteration in the Work: The Engineer reserves the right to make alterations in the character of the work which involve a substantial change in the nature of the design or in the type of construction or which materially increases or decreases the cost or time of performance. Such

alteration shall not constitute a breach of Contract, shall not invalidate the Contract or release the Surety.

Notwithstanding that the Contractor shall have no formal right whatsoever to any extra compensation or time extension deemed due by the Contractor for any cause unless and until the Contractor follows the procedures set forth in 5-12.2 for preservation, presentation and resolution of the claim, the Contractor may at any time, after having otherwise timely provided a notice of intent to claim or preliminary time extension request pursuant to 5-12.2 and 8-7.3.2, submit to the Department a request for equitable adjustment of compensation or time or other dispute resolution proposal. The Contractor shall in any request for equitable adjustment of compensation, time, or other dispute resolution proposal certify under oath and in writing, in accordance with the formalities required by Florida law, that the request is made in good faith, that any supportive data provided are accurate and complete to the Contractor's best knowledge and belief, and that the amount of the request accurately reflects what the Contractor in good faith believes to be the Department's responsibility. Such certification must be made by an officer or director of the Contractor with the authority to bind the Contractor. Any such certified statements of entitlement and costs shall be subject to the audit provisions set forth in 5-12.14. While the submittal or review of a duly certified request for equitable adjustment shall neither create, modify, nor activate any legal rights or obligations as to the Contractor or the Department, the Department will review the content of any duly certified request for equitable adjustment or other dispute resolution proposal, with any further action or inaction by the Department thereafter being in its sole discretion. Any request for equitable adjustment that fails to fully comply with the certification requirements will not be reviewed by the Department.

The monetary compensation provided for below constitutes full and complete payment for such additional work and the Contractor shall have no right to any additional monetary compensation for any direct or indirect costs or profit for any such additional work beyond that expressly provided below. The Contractor shall be entitled to a time extension only to the extent that the performance of any portion of the additional work is a controlling work item and the performance of such controlling work item actually extends completion of the project due to no fault of the Contractor. All time related costs for actual performance of such additional work are included in the compensation already provided below and any time extension entitlement hereunder will be without additional monetary compensation. The Contractor shall have no right to any monetary compensation or damages whatsoever for any direct or indirect delay to a controlling work item arising out of or in any way related to the circumstances leading up to or resulting from additional work (but not relating to the actual performance of the additional work, which is paid for as otherwise provided herein), except only as provided for under 5-12.6.2.1.

4-3.2.1 Allowable Costs for Extra Work: The Engineer may direct in writing that extra work be done and, at the Engineer's sole discretion, the Contractor will be paid pursuant to an agreed Supplemental Agreement or in the following manner:

(a) Labor and Burden: The Contractor will receive payment for actual costs of direct labor and burden for the additional or unforeseen work. Labor includes foremen actually engaged in the work; and will not include project supervisory personnel nor necessary on-site clerical staff, except when the additional or unforeseen work is a controlling work item and the performance of such controlling work item actually extends completion of the project due to no fault of the Contractor. Compensation for project supervisory personnel, but in no case higher than a Project Manager's position, shall only be for the pro-rata time such supervisory personnel spent on the contract. In no case shall an officer or director of the Company, nor those persons who own more than 1% of the Company, be considered as project supervisory personnel, direct labor or foremen hereunder.

Payment for burden shall be limited solely to the following:

Table 4-3.2.1

Item	Rate
FICA	Rate established by Law
FUTA/SUTA	Rate established by Law
Medical Insurance	Actual
Holidays, Sick & Vacation benefits	Actual
Retirement benefits	Actual
Workers Compensation	Rates based on the National Council on Compensation Insurance basic rate tables adjusted by Contractor's actual experience modification factor in effect at the time of the additional work or unforeseen work.
Per Diem	Actual but not to exceed State of Florida's rate
Insurance*	Actual

*Compensation for Insurance is limited solely to General Liability Coverage and does not include any other insurance coverage (such as, but not limited to, Umbrella Coverage, Automobile Insurance, etc.).

At the Pre-construction conference, certify to the Engineer the following:

(1) A listing of on-site clerical staff, supervisory personnel and their pro-rated time assigned to the contract,

(2) Actual Rate for items listed in Table 4-3.2.1,

(3) Existence of employee benefit plan for Holiday, Sick and Vacation benefits and a Retirement Plan, and,

(4) Payment of Per Diem is a company practice for instances when compensation for Per Diem is requested.

Such certification must be made by an officer or director of the Contractor with authority to bind the Contractor. Timely certification is a condition precedent to any right of the Contractor to recover compensations for such costs, and failure to timely submit the certification will constitute a full, complete, absolute and irrevocable waiver by the Contractor of any right to recover such costs. Any subsequent changes shall be certified to the Engineer as

part of the cost proposal or seven calendar days in advance of performing such extra work.

(b) Materials and Supplies: For materials accepted by the Engineer and used on the project, the Contractor will receive the actual cost of such materials incorporated into the work, including Contractor paid transportation charges (exclusive of equipment as hereinafter set forth). For supplies reasonably needed for performing the work, the Contractor will receive the actual cost of such supplies.

(c) Equipment: For any machinery or special equipment (other than small tools), including fuel and lubricant, the Contractor will receive 100% of the "Rental Rate Blue Book" for the actual time that such equipment is in operation on the work, and 50% of the "Rental Rate Blue Book" for the time the equipment is directed to standby and remain on the project site, to be calculated as indicated below. The equipment rates will be based on the latest edition (as of the date the work to be performed begins) of the "Rental Rate Blue Book for Construction Equipment" or the "Rental Rate Blue Book for Older Construction Equipment," whichever is applicable, as published by Machinery Information Division of PRIMEDIA Information, Inc. (version current at the time of bid), using all instructions and adjustments contained therein and as modified below. On all projects, the Engineer will adjust the rates using regional adjustments and Rate Adjustment Tables according to the instructions in the Blue Book.

Allowable Equipment Rates will be established as set out below:

(1) Allowable Hourly Equipment Rate = Monthly Rate/176 x Adjustment Factors x 100%.

(2) Allowable Hourly Operating Cost = Hourly Operating Cost x 100%.

(3) Allowable Rate Per Hour = Allowable Hourly Equipment Rate + Allowable Hourly Operating Cost.

(4) Standby Rate = Allowable Hourly Equipment Rate x 50%.

The Monthly Rate is The Basic Machine Rate Plus Any Attachments. Standby rates will apply when equipment is not in operation and is directed by the Engineer to standby at the project site when needed again to complete work and the cost of moving the equipment will exceed the accumulated standby cost. Standby rates will not apply on any day the equipment operates for eight or more hours. Standby payment will be limited to only that number of hours which, when added to the operating time for that day equals eight hours. Standby payment will not be made on days that are not normally considered work days on the project.

The Department will allow for the cost of transporting the equipment to and from the location at which it will be used. If the equipment requires assembly or disassembly for transport, the Department will pay for the time to perform this work at the rate for standby equipment.

Equipment may include vehicles utilized only by Labor, as defined above.

(d) Indirect Costs, Expenses, and Profit: Compensation for all indirect costs, expenses, and profit of the Contractor, including but not limited to

overhead of any kind, whether jobsite, field office, division office, regional office, home office, or otherwise, is expressly limited to the greater of either (1) or (2) below:

(1) Solely a mark-up of 17.5% on the payments in (a) through (c), above.

(i) Bond: The Contractor will receive compensation for any premium for acquiring a bond for such additional or unforeseen work at the original Contract bond rate paid by the Contractor. No compensation for bond premium will be allowed for additional or unforeseen work paid by the Department via initial contingency pay item.

(ii) The Contractor will be allowed a markup of 10% on the first $50,000 and a markup of 5% on any amount over $50,000 on any subcontract directly related to the additional or unforeseen work. Any such subcontractor mark-up will be allowed only by the prime Contractor and a first tier subcontractor, and the Contractor must elect the markup for any eligible first tier subcontractor to do so.

(2) Solely the formula set forth below and only as applied solely as to such number of calendar days of entitlement that are in excess of ten cumulative calendar days as defined below.

$$D = \frac{A \times C}{B}$$

Where A = Original Contract Amount
B = Original Contract Time
C = 8%
D = Average Overhead Per Day

Cumulative Calendar Days is defined as the cumulative total number of calendar days granted for time extension due to delay of a controlling work item caused solely by the Department is, or the cumulative total number of calendar days for which entitlement to a time extension due to delay of a controlling work item caused solely by the Department is otherwise ultimately determined in favor of the Contractor to be.

Further, in the event there are concurrent delays to one or more controlling work items, one or more being caused by the Department and one or more being caused by the Contractor, the Contractor shall be entitled to a time extension for each day that a controlling work item is delayed by the Department but shall have no right to nor receive any monetary compensation for any indirect costs for any days of concurrent delay. No compensation, whatsoever, will be paid to the Contractor for any jobsite overhead and other indirect impacts when the total number of calendar days granted for time extension due to delay of a controlling work item caused solely by the Department is, or the total number of calendar days for which entitlement to a time extension due to delay of a controlling work item caused solely by the Department is otherwise ultimately determined in favor of the Contractor to be,

equal to or less than ten calendar days and the Contractor also fully assumes all monetary risk of any and all partial or single calendar day delay periods, due to delay of a controlling work item caused solely by the Department, that when cumulatively totaled together are equal to or less than ten calendar days and regardless of whether monetary compensation is otherwise provided for hereunder for one or more calendar days of time extension entitlement for each calendar day exceeding ten calendar days. All calculations under this provision shall exclude weather days, and days granted for performing additional work.

4-3.2.2 Subcontracted Work: For work performed by a subcontractor, compensation for the additional or unforeseen work shall be solely limited to as provided for in 4-3.2.1 (a), (b), (c) and (d)(1), with the exception of, in the instance of subcontractor performed work only, the subcontractor may receive compensation for any premium for acquiring a bond for the additional or unforeseen work; provided, however, that such payment for additional subcontractor bond will only be paid upon presentment to the Department of clear and convincing proof that the subcontractor has actually provided and paid for separate bond premiums for such additional or unforeseen work in such amount.

The Contractor shall require the subcontractor to provide a certification, in accordance with 4-3.2.1 (a), as part of the cost proposal and provide such to the Engineer. Such certification must be made by an officer or director of the subcontractor with authority to bind the subcontractor. Timely certification is a condition precedent to any right of the Contractor to recover compensation for such subcontractor costs, and failure to timely submit the certification will constitute a full, complete, absolute and irrevocable waiver by the Contractor of any right to recover such subcontractor costs.

4-3.3 No Waiver of Contract: Changes made by the Engineer will not be considered to waive any of the provisions of the Contract, nor may the Contractor make any claim for loss of anticipated profits because of the changes, or by reason of any variation between the approximate quantities and the quantities of work actually performed. All work shall be performed as directed by the Engineer and in accordance with the Contract Documents.

4-3.4 Conditions Requiring a Supplemental Agreement or Unilateral Payment: A Supplemental Agreement or Unilateral Payment will be used to clarify the plans and specifications of the Contract; to provide for unforeseen work, grade changes, or alterations in plans which could not reasonably have been contemplated or foreseen in the original plans and specifications; to change the limits of construction to meet field conditions; to provide a safe and functional connection to an existing pavement; to settle documented Contract claims; to make the project functionally operational in accordance with the intent of the original Contract and subsequent amendments thereto.

A Supplemental Agreement or Unilateral Payment may be used to expand the physical limits of the project only to the extent necessary to make the project functionally operational in accordance with the intent of the original Contract. The cost of any such agreement extending the physical limits of the project shall not exceed $100,000 or 10% of the original Contract price, whichever is greater.

Perform no work to be covered by a Supplemental Agreement or Unilateral Payment before written authorization is received from the Engineer. The Engineer's written authorization will set forth sufficient work information to allow the work to begin. The work activities, terms and conditions will be reduced to written Supplemental Agreement or Unilateral Payment form promptly thereafter. No payment will be made on a Supplemental Agreement or Unilateral Payment prior to the Department's approval of the document.

4-3.5 Extra Work: Extra work authorized in writing by the Engineer will be paid in accordance with the formula in 4-3.2. Such payment will be the full extent of all monetary compensation entitlement due to the Contractor for such extra work. Any entitlement to a time extension due to extra work will be limited solely to that provided for in 4-3.2 for additional work.

4-3.6 Connections to Existing Pavement, Drives and Walks: Generally adhere to the limits of construction at the beginning and end of the project as detailed in the plans. However, if the Engineer determines that it is necessary to extend the construction in order to make suitable connections to existing pavement, the Engineer will authorize such a change in writing.

For necessary connections to existing walks and drives that are not indicated on the plans, the Engineer will provide direction regarding the proper connections in accordance with the Design Standards.

4-3.7 Differing Site Conditions: During the progress of the work, if subsurface or latent physical conditions are encountered at the site differing materially from those indicated in the Contract, or if unknown physical conditions of an unusual nature differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the Contract are encountered at the site, the party discovering such conditions shall promptly notify the other party in writing of the specific differing conditions before the Contractor disturbs the conditions or performs the affected work.

Upon receipt of written notification of differing site conditions from the Contractor, the Engineer will investigate the conditions, and if it is determined that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the Contract, an adjustment will be made, excluding loss of anticipated profits, and the Contract will be modified in writing accordingly. The Engineer will notify the Contractor whether or not an adjustment of the Contract is warranted.

The Engineer will not allow a Contract adjustment for a differing site condition unless the Contractor has provided the required written notice.

The Engineer will not allow a Contract adjustment under this clause for any effects caused to any other Department or non-Department projects on which the Contractor may be working.

4-3.8 Changes Affecting Utilities: The Contractor shall be responsible for identifying and assessing any potential impacts to a utility that may be caused by the changes proposed by the Contractor, and the Contractor shall at the time of making the request for a change notify the Department in writing of any such potential impacts to utilities.

Department approval of a Contractor proposed change does not relieve the Contractor of sole responsibility for all utility impacts, costs, delays or

damages, whether direct or indirect, resulting from Contractor initiated changes in the design or construction activities from those in the original Contract Specifications, design plans (including traffic control plans) or other Contract Documents and which effect a change in utility work different from that shown in the utility plans, joint project agreements or utility relocation schedules.

4-3.9 Value Engineering Incentive:

4-3.9.1 Intent and Objective:

(1) This Subarticle applies to any cost reduction proposal (hereinafter referred to as a Value Engineering Change Proposal or VECP) that the Contractor initiates and develops for the purpose of refining the Contract to increase cost effectiveness or significantly improve the quality of the end result. This Subarticle does not, however, apply to any such proposal unless the Contractor identifies it at the time of its submission to the Department as a proposal submitted pursuant to this Subarticle.

(2) The Department will consider VECPs that would result in net savings to the Department by providing a decrease in the cost of the Contract. VECPs must result in savings without impairing essential functions and characteristics such as safety, service, life, reliability, economy of operation, ease of maintenance, aesthetics and necessary standard design features. However, nothing herein prohibits the Contractor from submitting VECPs when the required functions and characteristics can be combined, reduced or eliminated because they are nonessential or excessive. The Department will not recognize the Contractor's correction of plan errors that result in a cost reduction, as a VECP.

(3) The Department reserves the right to reject at its discretion any VECP submitted that proposes a change in the design of the pavement system or that would require additional right-of-way. The Department will not allow the substitution of another design alternate, on which the Contractor could have bid, that is detailed in the plans for the one on which the Contractor has bid, under this Subarticle. Pending the Department's execution of a formal supplemental agreement implementing an approved VECP, the Contractor shall remain obligated to perform the work in accordance with the terms of the existing Contract. The Department will not grant any time extensions to allow for the time required to review a VECP.

4-3.9.2 Subcontractors: The Department encourages the Contractor to include the provisions of this Subarticle in Contracts with subcontractors and to encourage submission of VECPs from subcontractors. However, it is not mandatory to submit VECPs to the Department or to accept or transmit subcontractor proposed VECPs to the Department.

4-3.9.3 Data Requirements: As a minimum, submit the following information with each VECP:

(1) a description of the difference between the existing Contract requirement and the proposed change, and the comparative advantages and disadvantages.

(2) separate detailed cost estimates for both the existing Contract requirement and the proposed change. Break down the cost estimates by pay item numbers indicating quantity increases or decreases and deleted pay items.

Identify additional proposed work not covered by pay items within the Contract, by using pay item numbers on the Master Pay Item list. In preparing the estimates, include overhead, profit, and bond within pay items in the Contract. Separate pay item(s) for the cost of overhead, profit, and bond will not be allowed.

(3) an itemization of the changes, deletions or additions to plan details, plan sheets, design standards and Specifications that are required to implement the VECP if the Department adopts it. Provide preliminary plan drawings sufficient to describe the proposed changes.

(4) engineering or other analysis in sufficient detail to identify and describe specific features of the Contract that must be changed if the Department accepts the VECP with a proposal as to how these changes can be accomplished and an assessment of their effect on other project elements. The Department may require that engineering analyses be performed by a prequalified consultant in the applicable class of work. Support all design changes that result from the VECP with prints of drawings and computations signed and sealed by the Contractor's Engineer of Record. Written documentation or drawings will be provided clearly delineating the responsibility of the Contractor's Engineer of Record.

(5) the date by which the Department must approve the VECP to obtain the total estimated cost reduction during the remainder of the Contract, noting any effect on the Contract completion time or delivery schedule.

(6) a revised project schedule that would be followed upon approval of the VECP. This schedule would include submittal dates and review time for the Department and Peer reviews.

4-3.9.4 Processing Procedures: Submit two copies of each VECP to the Engineer or his duly authorized representative. The Department will process VECPs expeditiously; however, the Department is not liable for any delay in acting upon a VECP submitted pursuant to this Subarticle. The Contractor may withdraw, in whole or in part, a VECP not accepted by the Department within the period specified in the VECP. The Department is not liable for any VECP development cost in the case where the Department rejects or the Contractor withdraws a VECP.

The Engineer is the sole judge of the acceptability of a VECP and of the estimated net savings in construction costs from the adoption of all or any part of such proposal. In determining the estimated net savings, the Department reserves the right to disregard the Contract bid prices if, in the judgment of the Engineer, such prices do not represent a fair measure of the value of work to be performed or to be deleted.

Prior to approval, the Engineer may modify a VECP, with the concurrence of the Contractor, to make it acceptable. If any modification increases or decreases the net savings resulting from the VECP, the Department will determine the Contractor's fair share upon the basis of the VECP as modified and upon the final quantities. The Department will compute the net savings by subtracting the revised total cost of all bid items affected by the VECP from the total cost of the same bid items as represented in the original Contract.

Prior to approval of the VECP that initiates the supplemental agreement, provide acceptable Contract-quality plan sheets revised to show all details consistent with the VECP design.

4-3.9.5 Computations for Change in Contract Cost of Performance: The Department will not pay for the Contractor's VECP development and implementation costs. If the VECP is adopted, the Contractor's share of the net savings as defined hereinafter represents full compensation to the Contractor for the VECP.

The Department will not include its costs to process and implement a VECP in the estimate. However, the Department reserves the right, where it deems such action appropriate, to require the Contractor to pay the Department's cost of investigating and implementing a VECP as a condition of considering such proposal. When the Department imposes such a condition, the Contractor shall accept this condition in writing, authorizing the Department to deduct amounts payable to the Department from any monies due or that may become due to the Contractor under the Contract.

4-3.9.6 Conditions of Acceptance for Major Design Modifications of Category 2 Bridges: A VECP that proposes major design modifications of a category 2 bridge, as determined by the Engineer, shall have the following conditions of acceptance:

All bridge plans shall be reviewed by a single independent engineering firm (the independent Engineer) not involved in the VECP design, pre-qualified in accordance with Chapter 14-75, to assure that the design is in compliance with all Department requirements. The independent Engineer's comments, along with the resolution of each comment, shall be submitted to the Department. The independent Engineer shall sign and seal a cover letter stating that all of the independent Engineer's comments have been adequately addressed and the design is in compliance with the Department requirements. If there are any unresolved comments the independent Engineer shall specifically list all unresolved issues in the signed and sealed cover letter. Peer review will be funded by the Contractor.

Contractor shall designate a primary engineer responsible for the VECP design and as such will be designated as the Contractors Engineer of Record for the VECP design. The Department reserves the right to require the Contractor's Engineer of Record to assume responsibility for the entire structure.

The Contractor shall have all permanent engineering work affected by the VECP, peer reviewed by an independent engineer other than the engineer initially performing the work. Engineering work includes but is not limited to: requests for acceptance for noncompliant work, repair procedures, shop drawing review, or design and review of activities affecting public safety. If the Specialty Engineer and Contractor's Engineer of Record are separate entities, either party may initiate the action; the other shall check and certify the work as being complete and correct prior to submittal to the Engineer. If the Specialty Engineer and Contractor's Engineer of Record are the same entity, the Specialty Engineer/Contractor's Engineer of Record will initiate the action of the independent firm contracted to prepare these requests and the Specialty Engineer/Contractor's Engineer of Record will check and certify the work of the

independent firm as being complete and correct prior to submittal to the Engineer.

New designs shall be in compliance with all applicable Department, FHWA and AASHTO criteria requirements including bridge load ratings.

4-3.9.7 Sharing Arrangements: If the Department approves a VECP, the Contractor may be entitled to share in construction savings to the full extent provided for in this Subarticle. The Contractor shall receive 50% of the net reduction in the cost of performance of the Contract due to an approved VECP as determined by the final negotiated agreement between the Contractor and the Department.

4-3.9.8 Notice of Intellectual Property Interests and Department's Future Rights to a VECP:

4-3.9.8.1 Notice of Intellectual Property Interests: The Contractor's VECP submittal shall identify with specificity any and all forms of intellectual property rights that either the Contractor or any officer, shareholder, employee, consultant, or affiliate, of the Contractor, or any other entity who contributed in any measure to the substance of the Contractor's VECP development, have or may have that are in whole or in part implicated in the VECP. Such required intellectual property rights notice includes, but is not limited to, disclosure of any: issued patents, copyrights, or licenses; pending patent, copyright or license applications; and any intellectual property rights that though not yet issued, applied for or intended to be pursued, could nevertheless otherwise be subsequently the subject of patent, copyright or license protection by the Contractor or others in the future. This notice requirement does not extend to intellectual property rights as to stand-alone or integral components of the VECP that are already on the Department's QPL or design standard indexes, or are otherwise generally known in the industry as being subject to patent or copyright protection.

4-3.9.8.2 Department's Future Rights to a VECP: Notwithstanding 7-3 nor any other provision of the Standard Specifications, upon acceptance of a VECP, the Contractor hereby grants to the Department and its contractors (such grant being expressly limited solely to any and all existing or future Department construction projects and any other Department projects that are partially or wholly funded by or for the Department) a royalty-free and perpetual license under all forms of intellectual property rights to manufacture, to use, to design, to construct, to disclose, to reproduce, to prepare and fully utilize derivative works, to distribute, display and publish, in whole or in part, and to permit others to do any of the above, and to otherwise in any manner and for any purpose whatsoever do anything reasonably necessary to fully utilize any and all aspects of such VECP on any and all existing and future construction projects and any other Department projects.

Contractor shall hold harmless, indemnify and defend the Department and its contractors and others in privity therewith from and against any and all claims, liabilities, other obligations or losses, and reasonable expenses related thereto (including reasonable attorneys' fees), which are incurred or are suffered by any breach of the foregoing grants, and regardless of whether such intellectual property rights were or were not disclosed by the

Contractor pursuant to 4-3.9.8.1, unless the Department has by express written exception in the VECP acceptance process specifically released the Contractor from such obligation to hold harmless, indemnify and defend as to one or more disclosed intellectual property rights.

4-4 Unforeseeable Work.

When the Department requires work that is not covered by a price in the Contract and such work does not constitute a "Significant Change" as defined in 4-3.1, and the Department finds that such work is essential to the satisfactory completion of the Contract within its intended scope, the Department will make an adjustment to the Contract. The Engineer will determine the basis of payment for such an adjustment in a fair and equitable amount.

4-5 Rights in and Use of Materials Found on the Site of the Work.

4-5.1 Ownership and Disposal of Existing Materials: Take ownership and dispose of all materials that are not designated as the property of other parties, in both roadway and structures, found on the right-of-way, and all material in structures designated for removal. Such materials do not include earth or other excavated material required for the construction of the project. During construction, the Contractor may use materials from existing structures that are required to be removed and that are designated to remain the property of the Department. Do not cut or otherwise damage such material during removal unless the Engineer gives permission to do so. Store material in an accessible location as the Engineer directs. The Department is not responsible for the quality or quantity of any material salvaged.

4-5.2 Ornamental Trees and Shrubs: Take ownership of all ornamental trees or shrubs existing in the right-of-way that are required to be removed for the construction operations and which are not specifically designated on the plans to be reset, or to be removed by others prior to the construction operations.

4-6 Final Cleaning Up of Right-of-Way.

Upon completion of the work, and before the Department accepts the work and makes final payment, remove from the right-of-way and adjacent property all falsework, equipment, surplus and discarded materials, rubbish and temporary structures; restore in an acceptable manner all property, both public and private, that has been damaged during the prosecution of the work; and leave the waterways unobstructed and the roadway in a neat and presentable condition throughout the entire length of the work under Contract. Do not dispose of materials of any character, rubbish or equipment, on abutting property, with or without the consent of the property owners. The Engineer will allow the Contractor to temporarily store equipment, surplus materials, usable forms, etc., on a well-kept site owned or leased by the Contractor, adjacent to the project. However, do not place or store discarded equipment, materials, or rubbish on such a site.

Shape and dress areas adjacent to the project right-of-way that were used as plant sites, materials storage areas or equipment yards when they are no longer needed for such purposes. Grass these areas when the Engineer directs. The

Department will pay for directed grassing work under the appropriate Contract items.

SECTION 5
CONTROL OF THE WORK

5-1 Plans and Working Drawings.

5-1.1 Contract Documents: The Contractor may purchase copies of the Standard Specifications and Design Standards from the Department or access them from the Department's website. Have available on the worksite, at all times, one copy of the Contract Documents.

5-1.2 Department's Plans: Plans consist of general drawings showing such details as are necessary to give a comprehensive idea of the construction contemplated. In general, roadway plans will show alignment, profile grades, typical cross-sections and general cross-sections. In general, structure plans will show in detail all dimensions of the work contemplated. When the structure plans do not show the dimensions in detail, they will show general features and such details as are necessary to give a comprehensive idea of the structure.

Grades shown are finished grades, and B.M. Datum is North American Vertical Datum 1988 (NAVD-1988) National Geodetic Vertical Datum of 1929 (NGVD-1929) or other datum as noted in the plans.

5-1.3 Alterations in Plans: The Department will issue, in writing, all authorized alterations affecting the requirements and information given on the approved plans.

5-1.4 Shop Drawings:

5-1.4.1. Definitions:

(a) Shop Drawings: All working, shop and erection drawings, associated trade literature, calculations, schedules, manuals and similar documents submitted by the Contractor to define some portion of the project work. The type of work includes both permanent and temporary works as appropriate to the project.

(b) Permanent Works: All the permanent structures and parts thereof required of the completed Contract.

(c) Temporary Works: Any temporary construction work necessary for the construction of the permanent works. This includes but is not limited to bracing, falsework, formwork, scaffolding, shoring, temporary earthworks, sheeting, cofferdams, and special erection equipment.

(d) Construction Affecting Public Safety: Construction that may jeopardize public safety such as structures spanning functioning vehicular roadways, pedestrian walkways, railroads, navigation channels of navigable waterways and walls or other structure foundations located in embankments immediately adjacent to functioning roadways. It does not apply to those areas of the site under the Contractor's control and outside the limits of normal public access.

(e) Major and Unusual Structures: Bridges of complex geometry and/or complex design. Generally, this includes the following types of structures:

1. Bridges with an individual span longer than 300 feet.

2. Structurally continuous superstructures with spans over 150 feet.

3. Steel box and plate girder bridges.

4. Steel truss bridges.

5. Concrete segmental and longitudinally post-tensioned continuous girder bridges.

6. Cable stayed or suspension bridges.

7. Arch bridges.

8. Tunnels.

9. Movable bridges (specifically electrical and mechanical components).

10. Rehabilitation, widening, or lengthening of any of the above.

(f) Special Erection Equipment includes launching gantries, beam and winch equipment, form travelers, stability towers, strong-backs, erection trusses, launching noses or similar items made purposely for construction of the structure. It does not apply to commonly available proprietary construction equipment such as cranes.

(g) Falsework includes any temporary construction work used to support the permanent structure until it becomes self-supporting. Falsework includes steel or timber beams, girders, columns, piles and foundations, and any proprietary equipment including modular shoring frames, post shores, and adjustable horizontal shoring.

(h) Formwork includes any structure or mold used to retain plastic or fluid concrete in its designated shape until it hardens. Formwork comprises common materials such as wood or metal sheets, battens, soldiers and walers, ties, proprietary forming systems such as stay-in-place metal forms, and proprietary supporting bolts, hangers and brackets. Formwork may be either permanent formwork requiring a shop drawing submittal such as stay-in-place metal or concrete forms, or may be temporary formwork which requires certification by the Specialty Engineer for Construction Affecting Public Safety and for Major and Unusual Structures.

(i) Scaffolding is an elevated work platform used to support workmen, materials and equipment, but not intended to support the structure.

(j) Shoring is a component of falsework such as horizontal, vertical or inclined support members. In this Section, this term is interchangeable with falsework.

(k) Bracing is a temporary structural member(s) placed between beams, girders, piles columns, etc. to provide stability during construction activities.

(l) Contractor Originated Designs: Items which the Contract Documents require the Contractor to design, detail and incorporate into the permanent works.

5-1.4.2 Work Items Requiring Shop Drawings: In general, the Department requires shop drawings for items of work not fully detailed in the plans which require additional drawings and coordination prior to constructing the item, including but not limited to:

(a) Bridge components not fully detailed in the plans, i.e. segments, steel girder details, post-tensioning details, handrails, etc.

(b) Retaining Wall Systems

(c) Precast Box Culverts

(d) Non-standard lighting, signalization and signing structures and components

(e) Building structures

(f) Drainage structures, attenuators, and other nonstructural items

(g) Design and structural details furnished by the Contractor in compliance with the Contract

(h) Temporary Works affecting public safety

Additional clarification for certain types of bridge structures is provided in 5-1.4.7. Other provisions of the Contract Documents may waive the requirement for submittals for certain items; i.e., items constructed from standard drawings or those complying with alternate details for prestressed members under Section 450. Review the Contract Documents to determine the submittals required.

5-1.4.3 Schedule of Submittals: Prepare and submit a schedule of submittals that identifies the work for which shop drawings apply. For each planned submittal, define the type, and approximate number of drawings or other documents that are included and the planned submittal date, considering the processing requirements herein. Submit the schedule of submittals to the Department's Shop Drawing Review Office and the Engineer of Record within 60 days of the start of the Contract, and prior to the submission of any shop drawings.

Coordinate subsequent submittals with construction schedules to allow sufficient time for review, approval, and re-submittal as necessary.

5-1.4.4 Style, Numbering, and Material of Submittals:

5-1.4.4.1 Drawings: Furnish two clearly legible photographic or xerographic copies of all shop drawings that are necessary to complete the structure in compliance with the design shown on the plans. Prepare all shop drawings using the same units of measure as those used in the Department's plans. Use sheets no larger than 11 by 17 inches. Consecutively number each sheet in the submittal series, and indicate the total number in the series (i.e., 1 of 12, 2 of 12, . . ., 12 of 12). Include on each sheet the following items as a minimum requirement: the complete Financial Project Identification Number, Bridge Number(s), drawing title and number, a title block showing the names of the fabricator or producer and the Contractor for which the work is being done, the initials of the person(s) responsible for the drawing, the date on which the drawing was prepared, the location of the item(s) within the project, the Contractor's approval stamp with date and initials, and, when applicable, the documents shall be signed and sealed by the Specialty Engineer or Contractor's Engineer of Record, as appropriate. A re-submittal will be requested when any of the required information is not included.

5-1.4.4.2 Other Documents: Provide four sets of original documents or clearly legible photographic or xerographic copies of documents other than drawings, such as trade literature, catalogue information, calculations, and

manuals. Provide sheets no larger than 11 by 17 inches. Clearly label and number each sheet in the submittal to indicate the total number of sheets in the series (i.e., 1 of 12, 2 of 12, . . ., 12 of 12). Provide an additional three sets of documentation for items involved with precast prestressed components. Provide an additional two sets of documentation for items involving structural steel components.

Prepare all documents using the same units of measure as those used in the Department's plans. Bind and submit all documents with a Table of Contents cover sheet. List on the cover sheet the total number of pages and appendices, and include the complete Financial Project Identification Number, a title referencing the submittal item(s), the name of the firm and person(s) responsible for the preparation of the document, the Contractor's approval stamp with date and initials, and, when applicable, the documents shall be signed and sealed by the Specialty Engineer or Contractor's Engineer of Record, as appropriate.

Submit appropriately prepared and checked calculations and manuals that clearly outline the design criteria. Include on the internal sheets the complete Financial Project Identification Number and the initials of the person(s) responsible for preparing and checking the document.

Clearly label trade literature and catalogue information on the front cover with the title, Financial Project Identification Number, date and name of the firm and person(s) responsible for that document.

5-1.4.5 Submittal Paths and Copies:

5-1.4.5.1 General: Shop drawings are not required for prequalified items. For non-prequalified items, determine the submittal path to be followed based upon the identity of the Engineer of Record as shown adjacent to the title block on the structural plan sheets, and on the key sheets of roadway plans, signing, and pavement marking plans, and/or lighting plans. At the preconstruction conference, the Department will notify the Contractor of any changes in the submittal path and whether the Department's or the Consultant's red-ink review stamp will signify an officially reviewed shop drawing.

(a) When the Florida Department of Transportation is the Engineer of Record, submit shop drawings to the appropriate Department Shop Drawing Review Office with a copy of the letter of transmittal sent to the Resident Engineer. For work requiring other information (e.g., catalog data, procedure manuals, fabrication/welding procedures, and maintenance and operating procedures), submit the required number of copies to the appropriate Department Shop Drawing Review Office. If not shown on the plans, the Department will furnish the mailing address of the appropriate Department Shop Drawing Review Office. Provide copies of material certifications and material tests to the Resident Engineer.

(b) When the Engineer of Record is a consultant hired by the Department, submit shop drawings to the consultant with a copy of the letter of transmittal sent to the Resident Engineer and, when requested, to the appropriate Department Shop Drawing Review Office. For work requiring other documentation (e.g., catalog data, procedure manuals, fabrication/welding procedures, and maintenance and operating manuals), submit the required number of copies with the prints. If not shown on the plans, the Department will

furnish the mailing address of the Consulting Engineer of Record. Provide copies of material certifications and material tests to the Resident Engineer.

5-1.4.5.2 Building Structures: Submit working, shop and erection drawings, and all correspondence related to building structures, such as Rest Area Pavilions, Office Buildings, and Maintenance Warehouses, to the Architect of Record for review and approval. Send a copy of the transmittal to the Resident Engineer.

5-1.4.5.3 Contractor-Originated Design: Submit shop drawings and applicable calculations to the Engineer of Record for review. Ensure that each sheet of the shop drawings and the cover sheet of the calculations are signed and sealed by the Specialty Engineer or the Contractor's Engineer of Record. Transmit the submittal and copies of the transmittal letters in accordance with the requirements of 5-1.4.5.1 through 5-1.4.5.3, as appropriate.

5-1.4.5.4 Temporary Works: For Construction Affecting Public Safety, submit to the Engineer of Record shop drawings and the applicable calculations for the design of special erection equipment, bracing, falsework, scaffolding, etc. Ensure that each sheet of the shop drawings and the cover sheet of the applicable calculations is signed and sealed by the Specialty Engineer. Transmit the submittal and copies of the transmittal letters in accordance with the requirements of 5-1.4.5.1 through 5-1.4.5.3, as appropriate.

5-1.4.5.5 Formwork and Scaffolding: The Contractor is solely responsible for the safe installation and use of all formwork and scaffolding. The Department does not require any formwork or scaffolding submittals unless such work would be classified as Construction Affecting Public Safety.

5-1.4.5.6 Beam and Girder Temporary Bracing: The Contractor is solely responsible for ensuring stability of beams and girders during all handling, storage, shipping and erection. Adequately brace beams and girders to resist wind, weight of forms and other temporary loads, especially those eccentric to the vertical axis of the products, considering actual beam geometry and support conditions during all stages of erection and deck construction. Develop the required designs following the AASHTO Guide Design Specifications for Bridge Temporary Works and Construction Handbook for Bridge Temporary Works and the Contract Documents.

For Construction Affecting Public Safety, submit signed and sealed calculations for stability for all beams and girders.

5-1.4.5.7 Erection Plan: Submit, for the Engineer's review, an Erection Plan that meets the specific requirements of Sections 450, 452 and 460 and this section. Refer to Index 600 for construction activities not permitted over traffic.

5-1.4.5.8 Other Miscellaneous Design and Structural Details Furnished by the Contractor in Compliance with the Contract: Submit to the Engineer of Record shop drawings and the applicable calculations. Ensure that each sheet of the shop drawings and the cover sheet of the applicable calculations is signed and sealed by the Specialty Engineer. Transmit the submittal and copies of the transmittal letters in accordance with the requirements of 5-1.4.5.1 through 5-1.4.5.3, as appropriate.

5-1.4.6 Processing of Shop Drawings:

5-1.4.6.1 Contractor Responsibility for Accuracy and Coordination of Shop Drawings: Coordinate, schedule, and control all submittals, with a regard for the required priority, including those of the various subcontractors, suppliers, and engineers, to provide for an orderly and balanced distribution of the work.

Coordinate, review, date, stamp, approve and sign all shop drawings prepared by the Contractor or agents (subcontractor, fabricator, supplier, etc.) prior to submitting them to the Engineer of Record for review. Submittal of the drawings confirms verification of the work requirements, units of measurement, field measurements, construction criteria, sequence of assembly and erection, access and clearances, catalog numbers, and other similar data. Indicate on each series of drawings the specification section and page or drawing number of the Contract plans to which the submission applies. Indicate on the shop drawings all deviations from the Contract drawings and itemize all deviations in the letter of transmittal. Likewise, whenever a submittal does not deviate from the Contract plans, clearly state so in the transmittal letter.

Schedule the submission of shop drawings to allow for a 45 day review period. The review period commences upon the Engineer of Record's receipt of the valid submittal or valid re-submittal and terminates upon the transmittal of the submittal back to the Contractor. A valid submittal includes all the minimum requirements outlined in 5-1.4.4.

Submit shop drawings to facilitate expeditious review. The Contractor is discouraged from transmitting voluminous submittals of shop drawings at one time. For submittals transmitted in this manner, allow for the additional review time that may result.

Only shop drawings distributed with the "red ink" stamps are valid and all work that the Contractor performs in advance of approval will be at the Contractor's risk.

5-1.4.6.2 Scope of Review by Engineer: The Engineer of Record's review of the shop drawings is for conformity to the requirements of the Contract Documents and to the intent of the design. The Engineer of Record's review of shop drawings which include means, methods, techniques, sequences, and construction procedures are limited to the effects on the permanent works. The Engineer of Record's review of submittals which include means, methods, techniques, sequences, and construction procedures does not include an in-depth check for the ability to perform the work in a safe or efficient manner. Review by the Engineer of Record does not relieve the Contractor of responsibility for dimensional accuracy to ensure field fit and for conformity of the various components and details.

5-1.4.6.3 Special Review by Engineer of Shop Drawings for Construction Affecting Public Safety: For Construction Affecting Public Safety, the Engineer of Record, or other Engineer as the Department appoints for this purpose, will make an independent review of all relevant shop drawings and similar documents. Do not proceed with construction of the permanent works until receiving the Engineer of Record's approval. The review of these shop drawings is for overall structural adequacy of the item to support the imposed

loads and does not include a check for economy, efficiency or ease of construction.

5-1.4.7 Other Requirements for Shop Drawings for Bridges:

5-1.4.7.1 Shop Drawings for Structural Steel and Miscellaneous Metals: Furnish shop drawings for structural steel and miscellaneous metals. Shop drawings shall consist of working, shop, and erection drawings, welding procedures, and other working plans, showing details, dimensions, sizes of material, and other information necessary for the complete fabrication and erection of the metal work.

5-1.4.7.2 Shop Drawings for Concrete Structures: Furnish shop drawings for concrete components that are not cast-in-place and are not otherwise exempted from submittal requirements. Also, furnish shop drawings for all details that are required for the effective prosecution of the concrete work and are not included in the Contract Documents such as: special erection equipment, masonry layout diagrams, and diagrams for bending reinforcing steel, in addition to any details required for concrete components for the permanent work.

5-1.4.7.3 Shop Drawings for Major and Unusual Structures: In addition to any other requirements, within 60 days from the Notice to Proceed, submit information to the Engineer outlining the integration of the Major and Unusual Structure into the overall approach to the project. Where applicable to the project, include, but do not limit this information to:

(1) The overall construction program for the duration of the Contract. Clearly show the Milestone dates. (For example, the need to open a structure by a certain time for traffic operations.)

(2) The overall construction sequence. The order in which individual structures are to be built, the sequence in which individual spans of girders or cantilevers are erected, and the sequence in which spans are to be made continuous.

(3) The general location of any physical obstacles to construction that might impose restraints or otherwise affect the construction, and an outline of how to deal with such obstacles while building the structure(s). (For example, obstacles might include road, rail and waterway clearances, temporary diversions, transmission lines, utilities, property, and the Contractor's own temporary works, such as haul roads, cofferdams, plant clearances and the like.)

(4) The approximate location of any special lifting equipment in relation to the structure, including clearances required for the operation of the equipment. (For example, crane positions, operating radii and the like.)

(5) The approximate location of any temporary falsework, and the conceptual outline of any special erection equipment. Provide the precise locations and details of attachments, fixing devices, loads, etc. in later detailed submittals.

(6) An outline of the handling, transportation, and storage of fabricated components, such as girders or concrete segments. Provide the precise details in later detailed submittals.

(7) Any other information pertinent to the proposed scheme or intended approach.

Clearly and concisely present the above information on as few drawings as possible in order to provide an overall, integrated summary of the intended approach to the project. The Department will use these drawings for information, review planning, and to assess the Contractor's approach in relation to the intent of the original design. The delivery to and receipt by the Engineer does not constitute any Department acceptance or approval of the proposals shown thereon. Include the details of such proposals on subsequent detailed shop drawing submittals. Submit timely revisions and re-submittals for all variations from these overall scheme proposals.

5-1.4.8 Modifications for Construction: Where the Engineer allows the Contractor to make modifications to the permanent works for the purposes of expediting the Contractor's chosen construction methods, the Contractor shall submit proposals to the Engineer of Record for review and approval prior to modifying the works. Submit proposals for minor modifications under the shop drawing process. Indicate on all drawings the deviations from the Contract Documents and itemize all deviations in the letter of transmittal. The Department will require additional submittals and/or submittal under a Value Engineering Change Proposal for major modifications.

Minor modifications are those items that, in the opinion of the Engineer, do not significantly affect the quantity of measured work, or the integrity or maintainability of the structure or its components. (For example, adjusting concrete dimensions, substituting steel plate sizes, changing reinforcing bar size and spacing, etc., all within the acceptable limits of the design.)

Major modifications are any modifications that, in the opinion of the Engineer, significantly affect the quantity of measured work, or the integrity or maintainability of the structure or its' components. (For example, substituting alternative beam sizes and spacings, changing material strength or type, and the like.)

Provide signed and sealed revised sheets to the Engineer for any required revisions to the Contract plans prior to submitting shop drawings.

The Engineer's decision on the delineation between a minor and a major modification and the disposition of a proposal is final.

5-1.4.9 Cost of Shop Drawings: Include the cost of furnishing shop and working drawings in the Contract prices for the work requiring the shop and working drawings. The Department will not pay the Contractor additional compensation for such drawings.

5-1.5 Certifications:

5-1.5.1 Special Erection Equipment: Prior to its use, ensure that the Specialty Engineer personally inspects the special erection equipment and certifies to the Engineer in writing that the equipment has been fabricated in accordance with the submitted drawings and calculations. In addition, after assembly, ensure that the Specialty Engineer observes the equipment in use and certifies to the Engineer in writing that it is being used as intended and in accordance with the submitted drawings and calculations. In each case, ensure that the Specialty Engineer also signs and seals the letter of certification.

5-1.5.2 Falsework and Shoring Requiring Shop Drawings: After its erection or installation but prior to the application of any superimposed load,

ensure that the Specialty Engineer personally inspects the falsework and certifies to the Engineer in writing that the falsework has been constructed in accordance with the materials and details shown on the submitted drawings and calculations. Ensure that the Specialty Engineer also signs and seals the letter of certification.

5-1.5.3 Temporary Formwork: For Construction Affecting Public Safety and for Major and Unusual Structures, prior to the placement of any concrete, ensure that the Specialty Engineer inspects the formwork and certifies to the Engineer in writing that the formwork has been constructed to safely withstand the superimposed loads to which it will be subjected. Ensure that the Specialty Engineer signs and seals the letter of certification.

5-1.5.4 Erection: For Construction Affecting Public Safety, submit an erection plan signed and sealed by the Specialty Engineer to the Engineer at least four (4) weeks prior to erection commencing. Include as part of this submittal signed and sealed calculations and details for any falsework, bracing or other connection(s) supporting the structural elements shown in the erection plan.

At least two (2) weeks prior to beginning erection, conduct a Pre-erection meeting with the Specialty Engineer and Engineer to review details of the plan.

After erection of the elements but prior to opening of the roadway below the structure, ensure that a Specialty Engineer has personally inspected the erected member(s) and certified to the Engineer that the structure has been erected in accordance with the signed and sealed erection plan.

Perform daily inspections of the erected structural systems. For structures without temporary supports but with temporary girder bracing systems, perform inspections until all the diaphragms and cross frames are in place. For structures with temporary supports, perform inspections until the temporary supports are no longer needed as indicated in the erection plans. Provide written documentation of the inspections to the Engineer within 24 hours of the inspection.

5-1.6 Corrections for Construction Errors: For work that the Contractor constructs incorrectly or does not meet the requirements of the Contract Documents, the Contractor has the prerogative to submit an acceptance proposal to the Engineer for review and disposition. The acceptance proposal shall describe the error or defect and either describe remedial action for its correction or propose a method for its acceptance. In either case, the acceptance proposal shall address structural integrity, aesthetics, maintainability, and the effect on Contract Time. The Department will judge any such proposal for its effect on these criteria and also for its effect on Contract Administration.

When the Engineer judges that a proposal infringes on the structural integrity or maintainability of the structure, the Contractor's Engineer of Record will perform a technical assessment and submit it to the Engineer for approval. Do not take any corrective action without the Engineer's approval.

Carry out all approved corrective construction measures at no expense to the Department.

Notwithstanding any disposition of the compensation aspects of the defective work, the Engineer's decision on the technical merits of a proposal is final.

5-2 Coordination of Contract Documents.

These Specifications, the Plans, Special Provisions, and all supplementary documents are integral parts of the Contract; a requirement occurring in one is as binding as though occurring in all. All parts of the Contract are complementary and describe and provide for a complete work. In addition to the work and materials specified in the Specifications as being included in any specific pay item, include in such pay items additional, incidental work, not specifically mentioned, when so shown in the plans, or if indicated, or obvious and apparent, as being necessary for the proper completion of the work under such pay item and not stipulated as being covered under other pay items.

In cases of discrepancy, the governing order of the documents is as follows:

1. Special Provisions.
2. Technical Special Provisions.
3. Plans.
4. Design Standards.
5. Developmental Specifications.
6. Supplemental Specifications.
7. Standard Specifications.

Computed dimensions govern over scaled dimensions.

5-3 Conformity of Work with Contract Documents.

Perform all work and furnish all materials in reasonably close conformity with the lines, grades, cross-sections, dimensions, and material requirements, including tolerances, as specified in the Contract Documents.

In the event that the Engineer finds that the Contractor has used material or produced a finished product that is not in reasonably close conformity with the Contract Documents, but that the Contractor has produced reasonably acceptable work, the Engineer will determine if the Department will accept the work in place. In this event, the Engineer will document the basis of acceptance by Contract modification, which provides for an appropriate reduction in the Contract price for such work or materials included in the accepted work as deemed necessary to conform to the determination based on engineering judgment.

In the event that the Engineer finds that the Contractor has used material or produced a finished product that is not in reasonably close conformity with the Contract Documents, and that the Contractor has produced an inferior or unsatisfactory product, the Contractor shall remove and replace or otherwise correct the work or materials at no expense to the Department.

For base and surface courses, the Department will allow the finished grade to vary as much as 0.1 foot from the grade shown in the plans, provided that the Contractor's work meets all templates and straightedge requirements and contains suitable transitions.

5-4 Errors or Omissions in Contract Documents.

Do not take advantage of any apparent error or omission discovered in the Contract Documents, but immediately notify the Engineer of such discovery. The

Engineer will then make such corrections and interpretations as necessary to reflect the actual spirit and intent of the Contract Documents.

5-5 Authority of the Engineer.

Perform all work to the satisfaction of the Engineer.

The Director, Office of Construction will decide all questions, difficulties, and disputes, of whatever nature, that may arise relative to the interpretation of the plans, construction, prosecution, and fulfillment of the Contract, and as to the character, quality, amount, and value of any work done, and materials furnished, under or by reason of the Contract.

5-6 Authority and Duties of Engineer's Assistants.

The Director, Office of Construction may appoint such assistants and representatives as he desires. These assistants and representatives are authorized to inspect all work done and all materials furnished. Such inspection may extend to all or any part of the work and to the manufacture, preparation, or fabrication of the materials to be used. Such assistants and representatives are not authorized to revoke, alter, or waive any requirement of these Specifications. Rather, they are authorized to call to the attention of the Contractor any failure of the work or materials to meet the Contract Documents, and have the authority to reject materials or suspend the work until any questions at issue can be referred to and decided by the Engineer. The Engineer will immediately notify the Contractor in writing of any such suspension of the work, stating in detail the reasons for the suspension. The presence of the inspector or other assistant in no way lessens the responsibility of the Contractor.

5-7 Engineering and Layout.

5-7.1 Control Points Furnished by the Department: The Engineer will provide centerline control points (Begin Project, End Project, PIs, PTs, etc.) and bench marks at appropriate intervals along the line of the project to facilitate the proper layout of the work. Normally, the Engineer will furnish only one bench mark for water crossings. Preserve all reference points and bench marks that the Department furnishes.

As an exception to the above, for projects where the plans do not show a centerline or other survey control line for construction of the work (e.g., resurfacing, safety modifications, etc.) the Engineer will provide only points marking the beginning and ending of the project, and all exceptions.

5-7.2 Furnishing of Stake Materials: Furnish all stakes, templates, and other materials necessary for establishing and maintaining the lines and grades necessary for control and construction of the work.

5-7.3 Layout of Work: Utilizing the control points furnished by the Department in accordance with 5-7.1, establish all horizontal and vertical controls necessary to construct the work in conformity to the Contract Documents. Perform all calculations required, and set all stakes needed such as grade stakes, offset stakes, reference point stakes, slope stakes, and other reference marks or points necessary to provide lines and grades for construction of all roadway, bridge, and miscellaneous items.

When performing utility construction as part of the project, establish all horizontal and vertical controls necessary to carry out such work.

5-7.4 Specific Staking Requirements: When performing new base construction as part of the project, set stakes to establish lines and grades for subgrade, base, curb, and related items at intervals along the line of the work no greater than 50 feet on tangents and 25 feet on curves. Set grade stakes at locations that the Engineer directs to facilitate checking of subgrade, base, and pavement elevations in crossovers, intersections, and irregular shaped areas.

For bridge construction stakes and other control, set references at sufficiently frequent intervals to ensure construction of all components of a structure in accordance with the lines and grades shown in the plans.

For projects where the plans do not show a centerline or other survey control line for construction of the work (resurfacing, safety modifications, etc.), provide only such stakes as necessary for horizontal and vertical control of work items.

For resurfacing and resurfacing-widening type projects, establish horizontal controls adequate to ensure that the asphalt mix added matches with the existing pavement. In tangent sections, set horizontal control points at 100 foot intervals by an instrument survey. In curve sections, set horizontal control points at 25 foot intervals by locating and referencing the centerline of the existing pavement.

Establish by an instrument survey, and mark on the surface of the finished pavement at 25 foot intervals, the points necessary for striping of the finished roadway. As an exception, for resurfacing and resurfacing/widening projects, establish these points in the same manner as used for horizontal control of paving operations. Mark the pavement with white paint. If performing striping, the Engineer may approve an alternate method for layout of striping provided that the Contractor achieves an alignment equal to or better than the alignment that would be achieved using an instrument survey.

For projects that include temporary or permanent striping of “no passing zones”, provide the location and length of these zones as shown in the plans, except projects where the vertical or horizontal alignment is new or altered from preconstruction alignment. For projects that consist of new or altered vertical or horizontal alignment, the Department will provide the location and length of the "no passing zones" during construction. For these projects, notify the Engineer not less than 21 calendar days prior to beginning striping.

For all projects, set a station identification stake at each right-of-way line at 100 foot intervals and at all locations where a change in right-of-way width occurs. Mark each of these stakes with painted numerals, of a size readable from the roadway, corresponding to the project station at which it is located. As an exception to the above, for projects where plans do not show right-of-way lines, set station identification stakes at locations and intervals appropriate to the type of work being done. For resurfacing and resurfacing/widening projects, set station identification stakes at 200 foot intervals.

5-7.5 Personnel, Equipment, and Record Requirements: Employ only competent personnel and use only suitable equipment in performing layout work.

Do not engage the services of any person or persons in the employ of the Department for performance of layout work.

Keep adequate field notes and records while performing as layout work. Make these field notes and records available for the Engineer's review as the work progresses, and furnish copies to the Engineer at the time of completion of the project. The Engineer's inspection, checking, or acceptance of the Contractor's field notes or layout work does not relieve the Contractor of his responsibility to achieve the lines, grades, and dimensions shown in the Contract Documents.

Prior to final acceptance of the project, mark, in a permanent manner on the surface of the completed work, all horizontal control points originally furnished by the Department.

5-7.6 Payment: Include the cost of performing layout work as described above in the Contract unit prices for the various items of work that require layout.

5-8 Contractor's Supervision.

5-8.1 Prosecution of Work: Give the work the constant attention necessary to ensure the scheduled progress, and cooperate fully with the Engineer and with other contractors at work in the vicinity.

5-8.2 Contractor's Superintendent: Maintain a competent superintendent at the site at all times while work is in progress to act as the Contractor's agent. Provide a superintendent who is a competent superintendent capable of properly interpreting the Contract Documents and is thoroughly experienced in the type of work being performed. Provide a superintendent with the full authority to receive instructions from the Engineer and to execute the orders or directions of the Engineer, including promptly supplying any materials, tools, equipment, labor, and incidentals that may be required. Furnish such superintendence regardless of the amount of work sublet.

Provide a superintendent who speaks and understands English, and maintain at least one other responsible person who speaks and understands English, on the project during all working hours.

5-8.3 Supervision for Emergencies: Provide a responsible person, who speaks and understands English, and who is available at or reasonably near the worksite on a 24 hour basis, seven days a week. Designate this person as the point of contact for emergencies and in cases that require immediate action to maintain traffic or to resolve any other problem that might arise. Submit, by certified mail, the phone numbers and names of personnel designated to be contacted in cases of emergencies, along with a description of the project location, to the Florida Highway Patrol and all other local law enforcement agencies.

5-9 General Inspection Requirements.

5-9.1 Cooperation by Contractor: Do not perform work or furnish materials without obtaining inspection by the Engineer or his representative. Furnish the Engineer with every reasonable facility for ascertaining whether the work performed and materials used are in accordance with the requirements and

intent of the Contract Documents. If the Engineer so requests at any time before final acceptance of the work, remove or uncover such portions of the finished work as directed. After examination, restore the uncovered portions of the work to the standard required by the Contract Documents. If the Engineer determines that the work so exposed or examined is unacceptable, perform the uncovering or removal, and the replacing of the covering or making good of the parts removed, at no expense to the Department. However, if the Engineer determines that the work thus exposed or examined is acceptable, the Department will pay for the uncovering or removing, and the replacing of the covering or making good of the parts removed in accordance with Section 4-4.

5-9.2 Failure of Engineer to Reject Work During Construction: If, during or prior to construction operations, the Engineer fails to reject defective work or materials, whether from lack of discovery of such defect or for any other reason, such initial failure to reject in no way prevents the later rejection when such defect is discovered, or obligates the Department to final acceptance. The Department is not responsible for losses suffered due to any necessary removals or repairs of such defects.

5-9.3 Failure to Remove and Renew Defective Materials and Work: If the Contractor fails or refuses to remove and renew any defective materials used or work performed, or to make any necessary repairs in an acceptable manner and in accordance with the requirements of the Contract within the time indicated in writing, the Engineer has the authority to repair, remove, or renew the unacceptable or defective materials or work as necessary, all at the Contractor's expense. The Department will obtain payment for any expense it incurs in making these repairs, removals, or renewals, that the Contractor fails or refuses to make, by deducting such expenses from any moneys due or which may become due the Contractor, or by charging such amounts against the Contract bond.

5-9.4 Inspection by Federal Government: When the United States Government pays a portion of the cost of construction, its representatives may inspect the construction work as they deem necessary. However, such inspection will in no way make the Federal Government a party to the Contract.

5-10 Final Inspection.

5-10.1 Maintenance until Acceptance: Maintain all Work until the Engineer has given final acceptance in accordance with 5-11.

5-10.2 Inspection for Acceptance: Upon notification that all Contract Work, or all Contract Work on the portion of the Contract scheduled for acceptance, has been completed, the Engineer will make an inspection for acceptance. The inspection will be made within seven days of the notification. If the Engineer finds that all work has been satisfactorily completed, the Department will consider such inspection as the final inspection. If any or all of the Work is found to be unsatisfactory, the Engineer will detail the remedial work required to achieve acceptance. Immediately perform such remedial work. Subsequent inspections will be made on the remedial work until the Engineer accepts all Work.

Upon satisfactory completion of the Work, the Department will provide written notice of acceptance, either partial or final, to the Contractor.

Until final acceptance in accordance with 5-11, replace or repair any damage to the accepted Work. Payment of such work will be as provided in 7-14.

5-10.3 Partial Acceptance: At the Engineer's sole discretion, the Engineer may accept any portion of the Work under the provisions of 5-10.2.

5-10.4 Conditional Acceptance: The Engineer will not make, or consider requests for conditional acceptance of a project.

5-11 Final Acceptance.

When, upon completion of the final construction inspection of the entire project, the Engineer determines that the Contractor has satisfactorily completed the work, the Engineer will give the Contractor written notice of final acceptance.

5-12 Claims by Contractor.

5-12.1 General: When the Contractor deems that extra compensation or a time extension is due beyond that agreed to by the Engineer, whether due to delay, additional work, altered work, differing site conditions, breach of Contract, or for any other cause, the Contractor shall follow the procedures set forth herein for preservation, presentation and resolution of the claim.

Submission of timely notice of intent to file a claim, preliminary time extension request, time extension request, and the certified written claim, together with full and complete claim documentation, are each a condition precedent to the Contractor bringing any circuit court, arbitration, or other formal claims resolution proceeding against the Department for the items and for the sums or time set forth in the Contractor's certified written claim. The failure to provide such notice of intent, preliminary time extension request, time extension request, certified written claim and full and complete claim documentation within the time required shall constitute a full, complete, absolute and irrevocable waiver by the Contractor of any right to additional compensation or a time extension for such claim.

5-12.2 Notice of Claim:

5-12.2.1 Claims For Extra Work: Where the Contractor deems that additional compensation or a time extension is due for work or materials not expressly provided for in the Contract or which is by written directive expressly ordered by the Engineer pursuant to 4-3, the Contractor shall notify the Engineer in writing of the intention to make a claim for additional compensation before beginning the work on which the claim is based, and if seeking a time extension, the Contractor shall also submit a preliminary request for time extension pursuant to 8-7.3.2 within ten calendar days after commencement of a delay and a request for Contract Time extension pursuant to 8-7.3.2 within thirty calendar days after the elimination of the delay. If such notification is not given and the Engineer is not afforded the opportunity for keeping strict account of actual labor, material, equipment, and time, the Contractor waives the claim for additional compensation or a time extension. Such notice by the Contractor, and the fact that the Engineer has kept account of the labor, materials and equipment, and time, shall not in any way be construed as establishing the validity of the claim or

method for computing any compensation or time extension for such claim. On projects with an original Contract amount of $3,000,000 or less within 90 calendar days after final acceptance of the project in accordance with 5-11, and on projects with an original Contract amount greater than $3,000,000 within 180 calendar days after final acceptance of the project in accordance with 5-11, the Contractor shall submit full and complete claim documentation as described in 5-12.3 and duly certified pursuant to 5-12.9. However, for any claim or part of a claim that pertains solely to final estimate quantities disputes the Contractor shall submit full and complete claim documentation as described in 5-12.3 and duly certified pursuant to 5-12.9, as to such final estimate claim dispute issues, within 90 or 180 calendar days, respectively, of the Contractor's receipt of the Department's final estimate.

If the Contractor fails to submit a certificate of claim as described in 5-12.9, the Department will so notify the Contractor in writing. The Contractor shall have ten calendar days from receipt of the notice to resubmit the claim documentation, without change, with a certificate of claim as described in 5-12.9, without regard to whether the resubmission is within the applicable 90 or 180 calendar day deadline for submission of full and complete claim documentation. Failure by the Contractor to comply with the ten calendar day notice shall constitute a waiver of the claim.

5-12.2.2 Claims For Delay: Where the Contractor deems that additional compensation or a time extension is due on account of delay, differing site conditions, breach of Contract, or any other cause other than for work or materials not expressly provided for in the Contract (Extra Work) or which is by written directive of the Engineer expressly ordered by the Engineer pursuant to 4-3, the Contractor shall submit a written notice of intent to the Engineer within ten days after commencement of a delay to a controlling work item expressly notifying the Engineer that the Contractor intends to seek additional compensation, and if seeking a time extension, the Contractor shall also submit a preliminary request for time extension pursuant to 8-7.3.2 within ten calendar days after commencement of a delay to a controlling work item, as to such delay and providing a reasonably complete description as to the cause and nature of the delay and the possible impacts to the Contractor's work by such delay, and a request for Contract Time extension pursuant to 8-7.3.2 within thirty calendar days after the elimination of the delay. On projects with an original Contract amount of $3,000,000 or less within 90 calendar days after final acceptance of the project in accordance with 5-11, and on projects with an original Contract amount greater than $3,000,000 within 180 calendar days after final acceptance of the project in accordance with 5-11, the Contractor shall submit full and complete documentation as described in 5-12.3 and duly certified pursuant to 5-12.9.

If the Contractor fails to submit a certificate of claim as described in 5-12.9, the Department will so notify the Contractor in writing. The Contractor shall have ten calendar days from receipt of the notice to resubmit the claim documentation, without change, with a certificate of claim as described in 5-12.9, without regard to whether the resubmission is within the applicable 90 or 180 calendar day deadline for submission of full and complete claim documentation.

Failure by the Contractor to comply with the ten calendar day notice shall constitute a waiver of the claim.

There shall be no Contractor entitlement to any monetary compensation or time extension for any delays or delay impacts, whatsoever, that are not to a controlling work item, and then as to any such delay to a controlling work item entitlement to any monetary compensation or time extension shall only be to the extent such is otherwise provided for expressly under 4-3 or 5-12, except that in the instance of delay to a non-controlling item of work the Contractor may be compensated for the direct costs of idle labor or equipment only, at the rates set forth in 4-3.2.1(c), and then only to the extent the Contractor could not reasonably mitigate such idleness.

5-12.3 Content of Written Claim: As a condition precedent to the Contractor being entitled to additional compensation or a time extension under the Contract, for any claim, the Contractor shall submit a certified written claim to the Department which will include for each individual claim, at a minimum, the following information:

(a) A detailed factual statement of the claim providing all necessary dates, locations, and items of work affected and included in each claim;

(b) The date or dates on which actions resulting in the claim occurred or conditions resulting in the claim became evident;

(c) Identification of all pertinent documents and the substance of any material oral communications relating to such claim and the name of the persons making such material oral communications;

(d) Identification of the provisions of the Contract which support the claim and a statement of the reasons why such provisions support the claim, or alternatively, the provisions of the Contract which allegedly have been breached and the actions constituting such breach;

(e) A detailed compilation of the amount of additional compensation sought and a breakdown of the amount sought as follows:

(1) documented additional job site labor expenses;

(2) documented additional cost of materials and supplies;

(3) a list of additional equipment costs claimed, including each piece of equipment and the rental rate claimed for each;

(4) any other additional direct costs or damages and the documents in support thereof;

(5) any additional indirect costs or damages and all documentation in support thereof.

(f) A detailed compilation of the specific dates and the exact number of calendar days sought for a time extension, the basis for entitlement to time for each day, all documentation of the delay, and a breakout of the number of days claimed for each identified event, circumstance or occurrence.

Further, the Contractor shall be prohibited from amending either the bases of entitlement or the amount of any compensation or time stated for any and all issues claimed in the Contractor's written claim submitted hereunder, and any circuit court, arbitration, or other formal claims resolution proceeding shall be limited solely to the bases of entitlement and the amount of any compensation or time stated for any and all issues claimed in the Contractor's written claim

submitted hereunder. This shall not, however, preclude a Contractor from withdrawing or reducing any of the bases of entitlement and the amount of any compensation or time stated for any and all issues claimed in the Contractor's written claim submitted hereunder at any time.

5-12.4 Action on Claim: The Engineer will respond on projects with an original Contract amount of $3,000,000 or less within 90 calendar days of receipt of a complete claim submitted by a Contractor in compliance with 5-12.3, and on projects with an original Contract amount greater than $3,000,000 within 120 calendar days of receipt of a complete claim submitted by a Contractor in compliance with 5-12.3. Failure by the Engineer to respond to a claim within 90 or 120 days, respectively, after receipt of a complete claim in compliance with 5-12.3 constitutes a denial of the claim by the Engineer. If the Engineer finds the claim or any part thereof to be valid, such partial or whole claim will be allowed and paid for to the extent deemed valid and any time extension granted, if applicable, as provided in the Contract. No circuit court or arbitration proceedings on any claim, or a part thereof, may be filed until after final acceptance per 5-11 of all Contract work by the Department or denial hereunder, whichever occurs last.

5-12.5 Pre-Settlement and Pre-Judgment Interest: Entitlement to any pre-settlement or pre-judgment interest on any claim amount determined to be valid subsequent to the Department's receipt of a certified written claim in full compliance with 5-12.3, whether determined by a settlement or a final ruling in formal proceedings, the Department shall pay to the Contractor simple interest calculated at the Prime Rate (as reported by the Wall Street Journal as the base rate on corporate loans posted by at least 75% of the nations 30 largest banks) as of the 60th calendar day following the Department's receipt of a certified written claim in full compliance with 5-12.3, such interest to accrue beginning 60 calendar days following the Department's receipt of a certified written claim in full compliance with 5-12.3 and ending on the date of final settlement or formal ruling.

5-12.6 Compensation for Extra Work or Delay:

5-12.6.1 Compensation for Extra Work: Notwithstanding anything to the contrary contained in the Contract Documents, the Contractor shall not be entitled to any compensation beyond that provided for in 4-3.2.

5-12.6.2 Compensation for Delay: Notwithstanding anything to the contrary contained in the Contract Documents, the additional compensation set forth in 5-12.6.2.1 shall be the Contractor's sole monetary remedy for any delay other than to perform extra work caused by the Department unless the delay shall have been caused by acts constituting willful or intentional interference by the Department with the Contractor's performance of the work and then only where such acts continue after Contractor's written notice to the Department of such interference. The parties anticipate that delays may be caused by or arise from any number of events during the term of the Contract, including, but not limited to, work performed, work deleted, change orders, supplemental agreements, disruptions, differing site conditions, utility conflicts, design changes or defects, time extensions, extra work, right-of-way issues, permitting issues, actions of suppliers, subcontractors or other contractors, actions by third parties,

suspensions of work by the Engineer pursuant to 8-6.1, shop drawing approval process delays, expansion of the physical limits of the project to make it functional, weather, weekends, holidays, special events, suspension of Contract time, or other events, forces or factors sometimes experienced in construction work. Such delays or events and their potential impacts on the performance by the Contractor are specifically contemplated and acknowledged by the parties in entering into this Contract, and shall not be deemed to constitute willful or intentional interference with the Contractor's performance of the work without clear and convincing proof that they were the result of a deliberate act, without reasonable and good-faith basis, and specifically intended to disrupt the Contractor's performance.

5-12.6.2.1 Compensation for Direct Costs, Indirect Costs, Expenses, and Profit thereon, of or from Delay: For any delay claim, the Contractor shall be entitled to monetary compensation for the actual idle labor and equipment, and indirect costs, expenses, and profit thereon, as provided for in 4-3.2.1(d) and solely for costs incurred beyond what reasonable mitigation thereof the Contractor could have undertaken.

5-12.7 Mandatory Claim Records: After giving the Engineer notice of intent to file a claim for extra work or delay, the Contractor must keep daily records of all labor, material and equipment costs incurred for operations affected by the extra work or delay. These daily records must identify each operation affected by the extra work or delay and the specific locations where work is affected by the extra work or delay, as nearly as possible. The Engineer may also keep records of all labor, material and equipment used on the operations affected by the extra work or delay. The Contractor shall, once a notice of intent to claim has been timely filed, and not less than weekly thereafter as long as appropriate, provide the Engineer a copy of the Contractor's daily records and be likewise entitled to receive a copy of the Department's daily records. The copies of daily records to be provided hereunder shall be provided at no cost to the recipient.

5-12.8 Claims For Acceleration: The Department shall have no liability for any constructive acceleration of the work, nor shall the Contractor have any right to make any claim for constructive acceleration nor include the same as an element of any claim the Contractor may otherwise submit under this Contract. If the Engineer gives express written direction for the Contractor to accelerate its efforts, such written direction will set forth the prices and other pertinent information and will be reduced to a written Contract Document promptly. No payment will be made on a Supplemental Agreement for acceleration prior to the Department's approval of the documents.

5-12.9 Certificate of Claim: When submitting any claim, the Contractor shall certify under oath and in writing, in accordance with the formalities required by Florida law, that the claim is made in good faith, that the supportive data are accurate and complete to the Contractor's best knowledge and belief, and that the amount of the claim accurately reflects what the Contractor in good faith believes to be the Department's liability. Such certification must be made by an officer or director of the Contractor with the authority to bind the Contractor.

5-12.10 Non-Recoverable Items: The parties agree that for any claim the Department will not have liability for the following items of damages or expense:

a. Loss of profit, incentives or bonuses;

b. Any claim for other than extra work or delay;

c. Consequential damages, including, but not limited to, loss of bonding capacity, loss of bidding opportunities, loss of credit standing, cost of financing, interest paid, loss of other work or insolvency;

d. Acceleration costs and expenses, except where the Department has expressly and specifically directed the Contractor in writing "to accelerate at the Department's expense"; nor

e. Attorney fees, claims preparation expenses and costs of litigation.

5-12.11 Exclusive Remedies: Notwithstanding any other provision of this Contract, the parties agree that the Department shall have no liability to the Contractor for expenses, costs, or items of damages other than those which are specifically identified as payable under 5-12. In the event any legal action for additional compensation, whether on account of delay, acceleration, breach of contract, or otherwise, the Contractor agrees that the Department's liability will be limited to those items which are specifically identified as payable in 5-12.

5-12.12 Settlement Discussions: The content of any discussions or meetings held between the Department and the Contractor to settle or resolve any claims submitted by the Contractor against the Department shall be inadmissible in any legal, equitable, arbitration or administrative proceedings brought by the Contractor against the Department for payment of such claim. Dispute Resolution Board, State Arbitration Board and Claim Review Committee proceedings are not settlement discussions, for purposes of this provision.

5-12.13 Personal Liability of Public Officials: In carrying out any of the provisions of the Contract or in exercising any power or authority granted to the Secretary of Transportation, Engineer or any of their respective employees or agents, there shall be no liability on behalf of any employee, officer or official of the Department for which such individual is responsible, either personally or as officials or representatives of the Department. It is understood that in all such matters such individuals act solely as agents and representatives of the Department.

5-12.14 Auditing of Claims: All claims filed against the Department shall be subject to audit at any time following the filing of the claim, whether or not such claim is part of a suit pending in the Courts of this State. The audit may be performed, at the Department's sole discretion, by employees of the Department or by any independent auditor appointed by the Department, or both. The audit may begin after ten days written notice to the Contractor, subcontractor, or supplier. The Contractor, subcontractor, or supplier shall make a good faith effort to cooperate with the auditors. As a condition precedent to recovery on any claim, the Contractor, subcontractor, or supplier must retain sufficient records, and provide full and reasonable access to such records, to allow the Department's auditors to verify the claim and failure to retain sufficient records of the claim or failure to provide full and reasonable access to such records shall constitute a waiver of that portion of such claim that cannot be verified and shall bar recovery thereunder. Further, and in addition to such audit access, upon the Contractor

submitting a written claim, the Department shall have the right to request and receive, and the Contractor shall have the affirmative obligation to provide to the Department, copies of any and all documents in the possession of the Contractor or its subcontractors, materialmen or suppliers as may be deemed relevant by the Department in its review of the basis, validity or value of the Contractor's claim.

Without limiting the generality of the foregoing, the Contractor shall upon written request of the Department make available to the Department's auditors, or upon the Department's written request for copies provide copies at the Department's expense, any or all of the following documents:

1. Daily time sheets and foreman's daily reports and diaries;
2. Insurance, welfare and benefits records;
3. Payroll register;
4. Earnings records;
5. Payroll tax return;
6. Material invoices, purchase orders, and all material and supply acquisition contracts;
7. Material cost distribution worksheet;
8. Equipment records (list of company owned, rented or other equipment used);
9. Vendor rental agreements and subcontractor invoices;
10. Subcontractor payment certificates;
11. Canceled checks for the project, including, payroll and vendors;
12. Job cost report;
13. Job payroll ledger;
14. General ledger, general journal, (if used) and all subsidiary ledgers and journals together with all supporting documentation pertinent to entries made in these ledgers and journals;
15. Cash disbursements journal;
16. Financial statements for all years reflecting the operations on this project;
17. Income tax returns for all years reflecting the operations on this project;
18. All documents which reflect the Contractor's actual profit and overhead during the years this Contract was being performed and for each of the five years prior to the commencement of this Contract;
19. All documents related to the preparation of the Contractor's bid including the final calculations on which the bid was based;
20. All documents which relate to each and every claim together with all documents which support the amount of damages as to each claim;
21. Worksheets used to prepare the claim establishing the cost components for items of the claim including, but not limited to, labor, benefits and insurance, materials, equipment, subcontractors, and all documents that establish which time periods and individuals were involved, and the hours and rates for such individuals.

5-13 Recovery Rights, Subsequent to Final Payment.

The Department reserves the right, if it discovers an error in the partial or final estimates, or if it discovers that the Contractor performed defective work or used defective materials, after the final payment has been made, to claim and recover from the Contractor or his surety, or both, by process of law, such sums as may be sufficient to correct the error or make good the defects in the work and materials.

Retain all records pertaining to the project for a period of three years from the date of the Engineer's final acceptance of the project. Upon request, make all such records available to the Department or its representative. For the purpose of this Article, records include all books of account, supporting documents, and papers that the Department deems necessary to ensure compliance with the Contract provisions.

SECTION 6
CONTROL OF MATERIALS

6-1 Acceptance Criteria.

6-1.1 General: Acceptance of materials is based on the following criteria. All requirements may not apply to all materials. Use only materials in the work that meet the requirements of these Specifications. The Engineer may inspect and test any material, at points of production, distribution and use.

6-1.2 Sampling and Testing: Use the Department's current sample identification and tracking system to provide related information and attach the information to each sample. Restore immediately any site from which material has been removed for sampling purposes to the pre-sampled condition with materials and construction methods used in the initial construction, at no additional cost to the Department.

Ensure when a material is delivered to the location as described in the Contract Documents, there is enough material delivered to take samples, at no expense to the Department.

6-1.2.1 Pretest by Manufacturers: Submit certified manufacturer's test results to the Engineer for qualification and use on Department projects. Testing will be as specified in the Contract Documents. The Department may require that manufacturers submit samples of materials for independent verification purposes.

6-1.2.2 Point of Production Test: Test the material during production as specified in the Contract Documents.

6-1.2.3 Point of Distribution Test: Test the material at Distribution facilities as specified in the Contract Documents.

6-1.2.4 Point of Use Test: Test the material immediately following placement as specified in the Specifications. After delivery to the project, the Department may require the retesting of materials that have been tested and accepted at the source of supply, or may require the testing of materials that are to be accepted by Producer Certification. The Department may reject all materials that, when retested, do not meet the requirements of these Specifications.

6-1.3 Certification:

6-1.3.1 Producer Certification: Provide complete certifications for materials as required. Furnish to the Engineer for approval, Producer Certifications for all products listed on the Qualified Products List and when required by the applicable material Specification(s). Do not incorporate any manufactured products or materials into the project without approval from the Engineer. Materials will not be considered for payment when not accompanied by Producer Certification. Producers may obtain sample certification forms through the Department's website. Ensure that the certification is provided on the producer's letterhead and is signed by a legally responsible person from the producer and notarized.

6-1.3.1.1 Qualified Products List: The Product Evaluation Section in the State Specifications and Estimates Office publishes and maintains a Qualified Products List. This list provides assurance to Contractors, consultants, designers, and Department personnel that specific products and materials are approved for use on Department facilities. The Department will limit the Contractor's use of products and materials that require pre-approval to items listed on the Qualified Products List effective at the time of placement.

Manufacturers seeking evaluation in accordance with Departmental procedures of an item must submit a Product Evaluation Application, available on the Department's website www.dot.state.fl.us/specificationsestimates/productevaluation/qpl/submittalprocess.aspx , with supporting documentation as defined and detailed by the applicable Specifications and Standards. This may include certified test reports from an independent test laboratory, certification that the material meets all applicable specifications, signed and sealed drawings and calculations, quality control plans, samples, infrared scans, or other technical data.

Manufacturers successfully completing the Department's evaluation are eligible for inclusion on the Qualified Products List. The Department will consider any marked variations from original test values for a material or any evidence of inadequate field performance of a material as sufficient evidence that the properties of the material have changed, and the Department will remove the material from the Qualified Products List.

6-1.3.1.2 Approved Products List: The State Traffic Operations Office maintains the Approved Products List of Traffic Control Signal Devices. Traffic Monitoring Site Equipment and Materials are also included on the Approved Products List. This list provides assurance to Maintaining Agencies, Contractors, consultants, designers, and Department personnel that the specific items listed are approved for use on Department facilities. The Department will limit the Contractor's procurement and use of Traffic Control Signal Devices, and Traffic Monitoring Site equipment and materials to only those items listed on the Approved Products List that is effective at the time of procurement, except as provided in Section 603.

The approval process is described in detail on the State Traffic Operation website, www.dot.state.fl.us/trafficoperations/terl/apl2.htm .

Manufacturers seeking evaluation of a specific device must submit an application which can be obtained from the State Traffic Operations Office.

6-1.3.2 Contractor Installation Certification: Provide installation certifications as required by the Contract Documents.

6-2 Applicable Documented Authorities Other Than Specifications.

6-2.1 General: Details on individual materials are identified in various material specific Sections of the Specifications that may refer to other documented authorities for requirements. When specified, meet the requirements as defined in such references.

6-2.2 Test Methods: Methods of sampling and testing materials are in accordance with the Florida Methods (FM). If a Florida Method does not exist for a particular test, perform the testing in accordance with the method specified in the Specification. When test methods or other standards are referenced in the Specifications without identification of the specific time of issuance, use the most current issuance, including interims or addendums thereto, at the time of bid opening.

6-2.3 Construction Aggregates: Aggregates used on Department projects must be in accordance with Rule 14-103, FAC.

6-3 Storage of Materials and Samples.

6-3.1 Method of Storage: Store materials in such a manner as to preserve their quality and fitness for the work, to facilitate prompt inspection, and to minimize noise impacts on sensitive receivers. More detailed specifications concerning the storage of specific materials are prescribed under the applicable Specifications. The Department may reject improperly stored materials.

6-3.2 Use of Right-of-Way for Storage: If the Engineer allows, the Contractor may use a portion of the right-of-way for storage purposes and for placing the Contractor's plant and equipment. Use only the portion of the right-of-way that is outside the clear zone, which is the portion not required for public vehicular or pedestrian travel. When used, restore the right-of-way to pre-construction condition at no additional cost to the Department or as specified in the Contract Documents. Provide any additional space required at no expense to the Department.

6-3.3 Responsibility for Stored Materials: Accept responsibility for the protection of stored materials. The Department is not liable for any loss of materials, by theft or otherwise, or for any damage to the stored materials.

6-3.4 Storage Facilities for Samples: Provide facilities for storage of samples as described in the Contract Documents and warranted by the test methods and Specifications.

6-4 Defective Materials.

Materials not meeting the requirements of these Specifications will be considered defective. The Engineer will reject all such materials, whether in place or not. Remove all rejected material immediately from the site of the work and from storage areas, at no expense to the Department.

Do not use material that has been rejected and the defects corrected, until the Engineer has approved the material's use. Upon failure to comply promptly with any order of the Engineer made under the provisions of this Article, the Engineer will remove and replace defective material and deduct the cost of removal and replacement from any moneys due or to become due the Contractor.

As an exception to the above, the Contractor may submit, upon approval of the Engineer, an engineering and/or laboratory analysis to evaluate the effect of defective in place materials. A Specialty Engineer, who is an independent consultant or the Contractor's Engineer of Record as stated within each individual Section shall perform any such analysis. The Engineer will determine the final disposition of the material after review of the information submitted by the Contractor. No additional monetary compensation or time extension will be granted for the impact of any such analysis or review.

6-5 Products and Source of Supply.

6-5.1 Source of Supply–Convict Labor (Federal-Aid Contracts Only): Do not use materials that were produced after July 1, 1991, by convict labor for Federal-aid highway construction projects unless the prison facility has been producing convict-made materials for Federal-aid highway construction projects before July 1, 1987.

Use materials that were produced prior to July 2, 1991, by convicts on Federal-aid highway construction projects free from the restrictions placed on the use of these materials by 23 U.S.C. 114. The Department will limit the use of materials produced by convict labor for use in Federal-aid highway construction projects to:

1. Materials produced by convicts on parole, supervised release, or probation from a prison or,
2. Materials produced in a qualified prison facility.

The amount of such materials produced for Federal-aid highway construction during any 12-month period shall not exceed the amount produced in such facility for use in such construction during the 12-month period ending July 1, 1987.

6-5.2 Source of Supply-Steel (Federal-Aid Contracts Only): For Federal-aid Contracts, only use steel and iron produced in the United States, in accordance with the Buy America provisions of 23 CFR 635.410, as amended. Ensure that all manufacturing processes for this material occur in the United States. As used in this specification, a manufacturing process is any process that modifies the chemical content, physical shape or size, or final finish of a product, beginning with the initial melding and mixing and continuing through the bending and coating stages. A manufactured steel or iron product is complete only when all grinding, drilling, welding, finishing and coating have been completed. If a domestic product is taken outside the United States for any process, it becomes foreign source material. When using steel and iron as a component of any manufactured product incorporated into the project (e.g., concrete pipe, prestressed beams, corrugated steel pipe, etc.), these same provisions apply, except that the manufacturer may use minimal quantities of foreign steel and iron when the cost of such foreign materials does not exceed

0.1% of the total Contract amount or $2,500, whichever is greater. These requirements are applicable to all steel and iron materials incorporated into the finished work, but are not applicable to steel and iron items that the Contractor uses but does not incorporate into the finished work. Provide a certification from the producer of steel or iron, or any product containing steel or iron as a component, stating that all steel or iron furnished or incorporated into the furnished product was manufactured in the United States in accordance with the requirements of this specification and the Buy America provisions of 23 CFR 635.410, as amended. Such certification shall also include (1) a statement that the product was produced entirely within the United States, or (2) a statement that the product was produced within the United States except for minimal quantities of foreign steel and iron valued at $ (actual value). Furnish each such certification to the Engineer prior to incorporating the material into the project. When FHWA allows the use of foreign steel on a project, furnish invoices to document the cost of such material, and obtain the Engineer's written approval prior to incorporating the material into the project.

6-5.3 Unfit, Hazardous, and Dangerous Materials: Do not use any material that, after approval and/or placement, has in any way become unfit for use. Do not use materials containing any substance that has been determined to be hazardous by the State of Florida Department of Environmental Protection or the U.S. Department of Environmental Protection. Provide workplaces free from serious recognized hazards and to comply with occupational safety and health standards, as determined by the U.S. Department of Labor Occupational Safety and Health Administration.

SECTION 7
LEGAL REQUIREMENTS AND RESPONSIBILITY TO THE PUBLIC

7-1 Laws to be Observed.

7-1.1 General: Become familiar with and comply with all Federal, State, county, and city laws, by-laws, ordinances, and regulations that control the action or operation of those engaged or employed in the work or that affect materials used. Pay particular attention called to the safety regulations promulgated by the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA). In addition, comply with Chapter 403, of the Florida Statutes, regarding control of air pollution. Direct special attention to that portion of Chapter 17-5 of the Rules and Regulations, pertaining to open burning in land clearing operations. Where work or structures included in the Contract are in "Navigable Waters of the U.S.," (reference 33 of the Code of Federal Regulations, Part 329); "Waters of the U.S.," (reference 33 of the Code of Federal Regulations, Parts 323 and 328); or "Waters of the State," (reference Part 4, Chapters 253 and 373 of the Florida Statutes and Section 62-340 of the Florida Administrative Code); comply with the regulatory provisions of Section 404 of the Federal Clean Water Act of 1977; Sections 9 and 10 of the Federal River and Harbor Act of 1899;

Chapter 161 of the Florida Statutes; and any local authority having jurisdiction over such waters.

Comply with Part IV, Chapter 378, of the Florida Statutes regarding land reclamation. Direct special attention to Chapters 62c-36 and 62c-39 of the Florida Administrative Code. Submit the Notice of Intent to Mine to:

Department of Environmental Protection
Collins Building
2051 East Dirac Drive
Tallahassee, Florida 32310-3760

with a copy to the Engineer. The Engineer will determine consistency with the environmental documents prior to commencement of mining.

Obtain certification from the Construction Industry Licensing Board as required by Part I, Chapter 489, of the Florida Statutes, regardless of exemptions allowed by Section 489.103, prior to removing underground pollutant storage tanks. Dispose of tanks and pollutants in accordance with the requirements and regulations of any Federal, State, or local, agency having jurisdiction.

Prior to building construction or renovation, provide copies of current registrations or certifications issued by the Florida Construction Industry Licensing Board in accordance with Chapter 489, for the appropriate category of construction.

Corporations must be registered with the State of Florida, Department of State, Division of Corporations, and hold a current State Corporate Charter Number in accordance with Chapter 607, Florida Statutes.

The Contractor or the authorized subcontractor applying the roofing material must be licensed or be an approved dealer and applicator of the proposed roofing material.

Indemnify, defend, and save harmless the Department and all of its officers, agents, and employees, in the amount of the Contract price, against all claims or liability arising from or based on the violation of any such laws, by-laws, ordinances, regulations, order, or decrees; whether by himself or his employees.

The Contractor shall comply with all environmental permits, including measures identified in the National Pollutant Discharge Elimination System (NPDES) Stormwater Pollution Prevention Plan and Sediment and Erosion Control Plan for the work.

The Contractor shall exert every reasonable and diligent effort to ensure that all labor employed by the Contractor and his subcontractors for work on the project work harmoniously and compatibly with all labor used by other building and construction contractors now or hereafter on the site of the work covered by this Contract. Include this provision in all subcontracts, and require all subcontractors to include it in their subcontracts with others. However, do not interpret or enforce this provision so as to deny or abridge, on account of membership or non-membership in any labor union or labor organization, the right of any person to work as guaranteed by Article I, Section 6 of the Florida Constitution.

Comply with Chapter 556 of the Florida Statutes during the performance of excavation or demolition operations.

The Executive Order 11246 Electronic version, dated September 24, 1965 is posted on the Department's website at the following URL address: www.dot.state.fl.us/specificationsoffice/federal/deo11246.pdf . Take responsibility to obtain the information posted on this website up through five calendar days before the opening of bids and comply with the provisions contained in Executive Order 11246.

If the Department's website cannot be accessed, contact the Department's Specifications Office Web Coordinator at (850) 414-4101.

7-1.2 Plant Quarantine Regulations: The U.S. Department of Agriculture and the Florida Department of Agriculture and Consumer Services have issued quarantine regulations pertaining to control of the nematodes of citrus, Rule 5B-44, Florida Administrative Code, and other plant pests. Contact the local (or other available) representatives of the Animal and Plant Health Inspection Service of the U.S. Department of Agriculture, and the Division of Plant Industry of the Florida Department of Agriculture and Consumer Services to ascertain all current restrictions regarding plant pests that are imposed by these agencies. Keep advised of current quarantine boundary lines throughout the construction period.

These restrictions may affect operations in connection with such items as clearing and grubbing, earthwork, grassing and mulching, sodding, landscaping, and other items which might involve the movement of materials containing plant pests across quarantine lines.

Obtain quarantine regulations and related information from the following:

Animal and Plant Health Inspection Service
U.S. Department of Agriculture
3029 Lake Alfred Road
Winter Haven, Florida 33881

Director, Division of Plant Industry
Florida Department of Agriculture and Consumer Services
Post Office Box 147100
Gainesville, Florida 32614-7100

7-1.3 Introduction or Release of Prohibited Aquatic Plants, Plant Pests, or Noxious Weeds: Do not introduce or release prohibited aquatic plants, plant pests, or noxious weeds into the project limits as a result of clearing and grubbing, earthwork, grassing and mulching, sodding, landscaping, or other such activities. Immediately notify the Engineer upon discovery of all prohibited aquatic plants, plant pests, or noxious weeds within the project limits. Do not move prohibited aquatic plants, plant pests, or noxious weeds within the project limits or to locations outside of the project limits without the Engineer's permission. Maintain all borrow material brought onto the project site free of prohibited aquatic plants, plant pests, noxious weeds, and their reproductive

parts. Refer to Rule 16C-52 and Rule 5B-57, of the Florida Administrative Code for the definition of prohibited aquatic plants, plant pests, and noxious weeds.

Furnish the Engineer, prior to incorporation into the project, with a certification from the Florida Department of Agriculture and Consumer Services, Division of Plant Industry, stating that the sod, hay, straw, and mulch materials are free of noxious weeds, including Tropical Soda Apple.

7-1.4 Compliance with Federal Endangered Species Act and other Wildlife Regulations: : The Federal Endangered Species Act requires that the Department investigate the potential impact to a threatened or endangered species prior to initiating an activity performed in conjunction with a highway construction project. If the Department's investigation determines that there is a potential impact to a protected, threatened or an endangered species, the Department will conduct an evaluation to determine what measures may be necessary to mitigate such impact. When mitigation measures and/or special conditions are necessary, these measures and conditions will be addressed on the plans or in permits as identified in 7-2.1.

In addition, in cases where certain protected, threatened or endangered species may unexpectedly be found or appear within close proximity to the project boundaries, the Department has established guidelines that will apply when interaction with certain species occurs, absent of any special mitigation measures or permit conditions otherwise identified for the project.

These guidelines are posted at the following URL address: www.dot.state.fl.us/specificationsestimates/federal/endangeredwildlifeguidelines.pdf .

Take responsibility to obtain this information and take all actions and precautions necessary to comply with the conditions of these guidelines during all project activities.

Prior to establishing any off-project activity in conjunction with a project, notify the Engineer of the proposed activity. Covered activities include but are not necessarily limited to borrow pits, concrete or asphalt plant sites, disposal sites, field offices, and material or equipment storage sites. Include in the notification the Financial Project ID, a description of the activity, the location of the site by township, range, section, county, and city, a site location map including the access route, the name of the property owner, and a person to contact to arrange a site inspection. Provide this notification sufficiently in advance of planned commencement of the off-site activity, to allow a reasonable period of time for the Engineer to conduct an investigation without delaying job progress.

Do not perform any off-project activity without obtaining written clearance from the Engineer. In the event the Department's investigation determines a potential impact to a protected, threatened or endangered species and mitigation measures or permits are necessary, coordinate with the appropriate resource agencies for clearance, obtain permits and perform mitigation measures as necessary. Immediately notify the Engineer in writing of the results of this coordination with the appropriate resource agencies. Additional compensation or time will not be allowed for permitting or mitigation, associated with Contractor initiated off-project activities.

7-1.5 Occupational Safety and Health Requirements: The Contractor shall take all precautions necessary for the protection of life, health, and general occupational welfare of all persons, including employees of both the Contractor and the Department, until the Contractor has completed the work required under the Contract as provided in 5-10 and 5-11.

Comply at all times with applicable Federal, State, and local laws, provisions, and policies governing safety and health, including 29 CFR 1926, including all subsequent revisions and updates.

7-1.6 Discovery of an Unmarked Human Burial: When an unmarked human burial is discovered, immediately cease all activity that may disturb the unmarked human burial and notify the Engineer. Do not resume activity until specifically authorized by the Engineer.

7-1.7 Insecticides and Herbicides: Use products found on the following website, www.flpesticide.us/ , approved by the Florida Department of Agriculture for the State of Florida. The use of restricted products is prohibited. Do not use any products in the sulfonylurea family of chemicals. Herbicide application by broadcast spraying is not allowed.

Procure any necessary licenses, pay all charges and fees, and give all notices necessary for lawful performance of the work.

Ensure that all employees applying insecticides and herbicides possess a current Florida Department of Agriculture Commercial Applicator license with the categories of licensure in Right-of-Way Pest Control and Aquatic Pest Control. Provide a copy of current certificates upon request, to the Engineer.

Ensure that employees who work with herbicides comply with all applicable Federal, State, and local regulations.

Comply with all regulations and permits issued by any regulatory agency within whose jurisdiction work is being performed. Post all permit placards in a protected, conspicuous location at the work site.

Acquire any permits required for work performed on the rights-of-way within the jurisdiction of National Forests in Florida. Contact the Local National Forest Ranger District, or the United States Department of Agriculture (USDA) office for the proper permits and subsequent approval.

Acquire all permits required for aquatic plant control as outlined in Chapter 62C-20, Florida Administrative Code, Rules of the Florida Department of Environmental Protection. Contact the Regional Field Office of Bureau of Invasive Plant Management of the Florida Department of Environmental Protection for proper permits and subsequent approval. If application of synthetic organo-auxin herbicides is necessary, meet the requirements of Chapter 5E-2, Florida Administrative Code.

7-1.8 Compliance with Section 4(f) of the USDOT Act: Section 4(f) of the USDOT Act prohibits the U. S. Secretary of Transportation from approving a project which requires the use of publicly owned land of a public park, recreation area or a wildlife and waterfowl refuge, or of any historic site of national, state, or local significance unless there is no prudent or feasible alternative to using that land and the program or project includes all possible planning to minimize the harm to the site resulting from the use.

Before undertaking any off-project activity associated with any federally assisted undertaking, ensure that the proposed site does not represent a public park, recreation area, wildlife or waterfowl refuge, or a historic site (according to the results of the Cultural Resources Survey discussed in 120-6.2). If such a site is proposed, notify the Engineer and provide a description of the proposed off-site activity, the Financial Project ID, the location of the site by township, range, section, a county or city map showing the site location and including the access route and the name of the property. It is the Contractor's responsibility to provide justification for use of Section 4(f) property that is sufficient for the Florida Department of Transportation and the Federal Highway Administration to make a Section 4(f) determination. Provide this notification sufficiently in advance of planned commencement of the off-site activity to allow a reasonable time for the Engineer to conduct an investigation without delaying job progress. Do not begin any off-project activity without obtaining written clearance from the Engineer.

7-1.9 Florida Minority Business Loan Mobilization Program:

The Loan Mobilization Program is established by Section 288.706 of the Florida Statutes, and has as its goal to assist minority business enterprises by facilitating working capital loans to those eligible businesses that are Contractors or subcontractors on Department contracts.

The limits of such advances under this program shall be as specified in Section 288.706 of the Florida Statutes. In the case of a subcontractor, the amount of the advance will be based on the subcontract unit prices, not the contract unit prices.

All prime Contractor vendors shall be required to incorporate the designated loan mobilization payment procedures in subcontract agreements with minority business enterprise vendors participating in this program and to cooperate in the release of designated loan mobilization payments to achieve the objective of providing working capital for minority business enterprise subcontract vendors.

When the Contract has been awarded or, in the case of a subcontractor, a subcontract has been signed with the prime Contractor, application for participation in this program will be made in writing to the Engineer. Such application must be made prior to commencement of the work. If the application is made on behalf of a subcontractor, it shall be considered incomplete if not accompanied by a copy of the subcontract with the unit prices of the work clearly delineated.

When all applicable conditions have been met, approval for participation will be made by the Office of the Comptroller and the applicant will be notified of the approval action taken.

Once approval has been obtained and the Notice to Proceed has been issued, disbursement of the monies will be made at the request of the applicant. The designated loan mobilization payment may be paid prior to the commencement of work on the Contract. However, if the work on the Contract has not commenced and the payment has not been made, then the Contract Time may not commence until the payment is made. All designated loan mobilization payments will be made payable jointly to the prime Contractor and the participating financial institution. When a subcontractor is the participant in the

program, such payments shall be paid to the participant within 10 business days after receipt of the funds from the Department.

Repayment of monies advanced through this program will be made after the value of the work accomplished by the participant reaches 50 percent. Contractors are encouraged to make weekly or bi-weekly payments to subcontractors participating in this program.

7-2 Permits and Licenses.

7-2.1 General: Except for permits procured by the Department, as incorporated by Special Provision expanding this Subarticle, if any, procure all permits and licenses, pay all charges and fees, and give all notices necessary and incidental to the due and lawful prosecution of the work.

The Department will also acquire any modifications or revisions to an original permit incorporated by Special Provision to this Subarticle when the Contractor requires such modifications or revisions to complete the construction operations specified in the plans or Special Provisions and within the right-of-way limits.

Acquire all permits for work performed outside the right-of-way or easements for the project.

In carrying out the work in the Contract, when under the jurisdiction of any environmental regulatory agency, comply with all regulations issued by such agencies and with all general, special, and particular conditions relating to construction activities of all permits issued to the Department as though such conditions were issued to the Contractor. Post all permit placards in a protected location at the worksite.

In case of a discrepancy between any permit condition and other Contract Documents, the more stringent condition shall prevail.

7-2.2 Work or Structures in Navigable Waters of the U.S., Waters of the U.S., and Waters of the State: In general, one or more governmental agencies will exercise regulatory authority over work or structures, including related construction operations, in all tidal areas (Channelward of the mean high water lines on the Atlantic and Gulf Coast); in the ocean and gulf waters to the outer limits of the continental shelf; in all rivers, streams, and lakes to the ordinary high water line; in marshes and shallows that are periodically inundated and normally characterized by aquatic vegetation capable of growth and 0reproduction; in all artificially created channels and canals used for recreational, navigational, or other purposes that are connected to navigable waters; and in all tributaries of navigable waters up to their headwaters.

Whenever the work under or incidental to the Contract requires structures or dredge/fill/construction activities in “Navigable Waters of the U.S.,” “Waters of the U.S.,” and “Waters of the State,” the Federal, State, county, and local regulatory agencies may require the Department to obtain a permit. For such dredge/fill /construction specified in the plans to be accomplished within the limits of the project, or for any dredge/fill/construction within the limits of Department-furnished borrow areas, the Department will procure the necessary permits prior to advertising for bids.

7-3 Patented Devices, Materials and Processes.

Include all royalties and costs arising from patents, trademarks, and copyrights, in any way involved in the work in the Contract price. Whenever using any design, device, material, or process covered by letters patent or copyright, obtain the right for such use by suitable legal agreement with the patentee or owner of the copyright. File a copy of such agreement with the Engineer. However, whether or not such agreement is made or filed as noted, the Contractor and the surety in all cases shall indemnify, defend, and save harmless, the Department from all claims for infringement by reason of the use of any such patented design, device, material, or process on work under the Contract, and shall indemnify the Department for all costs, expenses, and damages that it may be obliged to pay by reason of any such infringement, at any time during the prosecution or after the completion of the work.

7-4 Right-of-Way Furnished by the Department.

Except as otherwise stipulated in these Specifications or as shown in the plans, the Department will furnish all rights-of-way necessary for the proper completion of the work at no expense to the Contractor.

Should Department-furnished areas for obtaining borrow material, contain limerock material, do not remove such material from the pit unless the Engineer gives specific approval.

7-5 Restoration of Surfaces Opened by Permit.

Upon the presentation of a duly authorized and satisfactory permit that provides that all necessary repair work will be paid for by the party holding such permit, the Engineer may authorize the Contractor to allow parties bearing such permits to make openings in the highway. Upon the Engineer's written order, perform, in an acceptable manner, all necessary repairs due to such openings, and such necessary work that the Engineer orders, subject to the same conditions as the original work performed. The Department will pay the Contractor for such work either under applicable Contract items or in accordance with 4-4 when Contract items are not applicable.

7-6 Sanitary Provisions.

The Contractor shall provide and maintain, in a neat and sanitary condition, such accommodations for the use of his employees as are necessary to comply with the requirements and regulations of the State and local boards of health. Commit no public nuisance.

7-7 Control of the Contractor's Equipment.

7-7.1 Traffic Interference: Do not allow equipment, while it is on or traversing a road or street, to unreasonably interfere with traffic.

7-7.2 Overloaded Equipment: Do not operate on any road or street any hauling unit or equipment loaded in excess of (1) the maximum weights specified in the Florida Uniform Traffic Control Law, or (2) lower weights legally established for any section of road or bridge by the Department or local authorities. The governmental unit having jurisdiction over a particular road or bridge may provide exceptions by special permit under the provisions of 7-7.3.

This restriction applies to all roads and bridges inside and outside the Contract limits as long as these roads and bridges are open for public use. The Contractor may overload roads and bridges which are to be demolished after they are permanently closed to the public. The Contractor is responsible for all loss or damages resulting from equipment operated on a structure permanently closed to the public.

7-7.3 Crossings: Where it is necessary to cross an existing road or street, including specifically the existing traveled lanes of a divided highway within the limits of the project, obtain permits from the Department, for crossing overloaded or oversized equipment. Cross existing roads or streets only at Engineer-designated points. The Engineer may require the Contractor to protect the pavement or Roadway at the crossing by using lumber, planks, or fill. Provide flagging and watchman service, or approved signal devices, for the protection of traffic at all such crossings, in accordance with an approved written plan for that activity.

7-7.4 Protection from Damage by Tractor-Type Equipment: Take positive measures to ensure that tractor-type equipment does not damage the road. If any such damage should occur, repair it without delay, at no expense to the Department and subject to the Engineer's approval.

7-7.5 Contractor's Equipment on Bridge Structures: The Specialty Engineer shall analyze the effect of imposed loads on bridge structures, within the limits of a construction contract, resulting from the following operations:

(1) Overloaded Equipment as defined in 7-7.2:

(a) Operating on or crossing over completed bridge structures.

(b) Operating on or crossing over partially completed bridge structures.

(2) Equipment within legal load limits:

(a) Operating on or crossing over partially completed bridge structures.

(3) Construction cranes:

(a) Operating on completed bridge structures.

(b) Operating on partially completed bridge structures.

Any pipe culvert(s) or box culvert(s) qualifying as a bridge under 1-3 is excluded from the requirements above.

A completed bridge structure is a bridge structure in which all elemental components comprising the load carrying assembly have been completed, assembled, and connected in their final position. The components to be considered shall also include any related members transferring load to any bridge structure.

The Specialty Engineer shall determine the effect that equipment loads have on the bridge structure and develop the procedures for using the loaded equipment without exceeding the structure's design load capacity.

Submit to the Department for approval eight copies of design calculations, layout drawings, and erection drawings showing how the equipment is to be used so that the bridge structure will not be overstressed. The Specialty Engineer shall sign and seal one set of the eight copies of the drawings and the

cover sheet of one of the eight copies of the calculations for the Department's Record Set.

7-7.6 Posting of the Legal Gross Vehicular Weight: Display the maximum legal gross weight, as specified in the Florida Uniform Traffic Code, in a permanent manner on each side of any dump truck or dump type tractor-trailer unit hauling embankment material, construction aggregates, road base material, or hot bituminous mixture to the project over any public road or street. Display the weight in a location clearly visible to the scale operator, in numbers that contrast in color with the background and that are readily visible and readable from a distance of 50 feet.

7-8 Structures over Navigable Waters.

7-8.1 Compliance with Federal and Other Regulations: Where erecting structures in, adjacent to, or over, navigable waters, observe all regulations and instructions of Federal and other authorities having control over such waters. Do not obstruct navigation channels without permission from the proper authority, and provide and maintain navigation lights and signals in accordance with the Federal requirements for the protection of the structure, of false work, and of navigation.

In the event of accidental blocking of the navigation channel, immediately notify the U.S. Coast Guard of the blockage and upon removal of the blockage.

When work platforms are indicated in the permit for construction, submit work platform construction plans to the appropriate Coast Guard District for approval. Obtain approval prior to beginning construction on the platform.

7-8.2 Maintenance of Channel: Where the work includes the excavation of a channel or other underwater areas to a required section, maintain the section from shoaling or other encroachment until final acceptance of the project.

7-9 Use of Explosives.

When using explosives for the prosecution of the work, exercise the utmost care not to endanger life or property, including new work. The Contractor is responsible for all damage resulting from the use of explosives.

Store all explosives in a secure manner in compliance with all laws and ordinances, and clearly mark all such storage places with the words: "DANGEROUS - EXPLOSIVES". Place such storage in the care of a competent watchman. Where no local laws or ordinances apply, provide storage satisfactory to the Engineer and, in general, not closer than 1,000 feet from the road or from any building, camping area, or place of human occupancy.

Notify each public utility company having structures in proximity to the site of the work of the intention to use explosives. Give such notice sufficiently in advance to enable the companies to take precautionary steps to protect their property from injury.

7-10 Forest Protection.

7-10.1 Compliance with State and Federal Regulations: In carrying out work within or adjacent to State or National forests or parks, comply with all of

the regulations of the State or Federal authority having jurisdiction, governing the protection of and the carrying out of work in forests or parks, and observe all sanitary laws and regulations with respect to the performance of work in these areas. Keep the areas in an orderly condition, dispose of all refuse, and obtain permits for the construction, installation, and maintenance of any construction camps, living quarters, stores, warehouses, sanitary facilities, and other structures; all in accordance with the requirements of the forest or park official.

7-10.2 Prevention and Suppression of Forest Fires: Take all reasonable precautions to prevent and suppress forest fires. Require employees and subcontractors, both independently and at the request of forest officials, to do all reasonably within their power to prevent and suppress forest fires. Assist in preventing and suppressing forest fires, and make every possible effort to notify a forest official at the earliest possible moment of the location and extent of all fires. Extinguish the fire if practicable.

7-11 Preservation of Property.

7-11.1 General: Preserve from damage all property which is in the vicinity of or is in any way affected by the work, the removal or destruction of which is not specified in the plans. This applies to public and private property, public and private utilities (except as modified by the provisions of 7-11.6), trees, shrubs, crops, signs, monuments, fences, guardrail, pipe and underground structures, and public highways (except natural wear and tear of highway resulting from legitimate use thereof by the Contractor), etc., Whenever the Contractor's activities damage or injure such property, immediately restore it to a condition similar or equal to that existing before such damage occurred, at no expense to the Department.

Protect existing bridges during the entire construction period from damage caused by the construction operations or equipment. The Department will not require the Contractor to provide routine repairs or maintenance for such structures. However, immediately repair, at no expense to the Department, all damage occasioned by the construction operations. In the event that the Contractor's construction operations result in damage to a bridge requiring repairs, the Contractor shall make such repairs with any equipment, materials, or labor at the Contractor's disposal prior to continuing Contract work.

Direct special attention to the protection of all geodetic monuments, horizontal or vertical, located within the limits of construction.

7-11.2 Failure to Restore Damaged Property: In case of failure on the part of the Contractor to restore such property, bridge, road or street, or to make good such damage or injury, the Engineer may, upon 48 hours notice, proceed to repair, rebuild, or otherwise restore such property, road, or street as may be deemed necessary, and the Department will deduct the cost thereof from any monies due or which may become due the Contractor under the Contract. Nothing in this clause prevents the Contractor from receiving proper compensation for the removal, damage, or replacement of any public or private property, not shown on the plans, that is made necessary by alteration of grade or alignment. The Engineer will authorize such work, provided that the Contractor,

or his employees or agents, have not, through their own fault, damaged such property.

7-11.3 Contractor's Use of Streets and Roads:

7-11.3.1 On Systems Other than the State Highway System: When hauling materials or equipment to the project over roads and bridges on the State park road system, county road system, or city street system, and such use causes damage, immediately, at no expense to the Department, repair such road or bridge to as good a condition as before the hauling began.

The Department may modify the above requirement in accordance with any agreement the Contractor might make with the governmental unit having jurisdiction over a particular road or bridge, provided that the Contractor submits written evidence of such agreement to the Engineer.

7-11.3.2 On the State Highway System: The Department is responsible for the repair of any damage that hauling materials to the site causes to roads outside the limits of the project, that are either on the State highway system (roads under the jurisdiction of the Department) or specifically designated in the plans as haul roads from Department-furnished material pits, except in the event damage is due to failure to comply with 7-7.2. The Contractor is responsible for all damages to any road or bridge caused by the Contractor's failure to comply with 7-7.2.

7-11.3.3 Within the Limits of a Construction Project: The Department will not allow the operation of equipment or hauling units of such weight as to cause damage to previously constructed elements of the project, including but not necessarily limited to bridges, drainage structures, base course, and pavement. Do not operate hauling units or equipment loaded in excess of the maximum weights specified in 7-7.2 on existing pavements that are to remain in place (including pavement being resurfaced), cement-treated subgrades and bases, concrete pavement, any course of asphalt pavement, and bridges. The Engineer may allow exceptions to these weight restrictions for movement of necessary equipment to and from its worksite, for hauling of offsite fabricated components to be incorporated into the project, and for crossings as specified in 7-7.3.

7-11.4 Traffic Signs, Signal Equipment, Highway Lighting and Guardrail: Protect all existing roadside signs, signal equipment, highway lighting and guardrail, for which permanent removal is not indicated, against damage or displacement. Whenever such signs, signal equipment, highway lighting or guardrail lie within the limits of construction, or wherever so directed by the Engineer due to urgency of construction operations, take up and properly store the existing roadside signs, signal equipment, highway lighting and guardrail and subsequently reset them at their original locations or, in the case of widened pavement or roadbed, at locations designated by the Engineer.

If the Department determines that damage to such existing or permanent installations of traffic signs, signal equipment, highway lighting or guardrail is caused by a third party(ies), and is not otherwise due to any fault or activities of the Contractor, the Department will, with the exception of any damage resulting from vandalism, compensate the Contractor for the costs associated with the repairs. Repair damage caused by vandalism at no expense to the Department.

Payment for repairs will be in accordance with 4-3.4.

7-11.5 Operations Within Railroad Right-of-Way:

7-11.5.1 Notification to the Railroad Company: Notify the superintendent of the railroad company, as shown on the plans, and the Engineer at least 72 hours before beginning any operation within the limits of the railroad right-of-way; any operation requiring movement of employees, trucks, or other equipment across the tracks of the railroad company at other than an established public crossing; and any other work that may affect railroad operations or property.

7-11.5.2 Contractor's Responsibilities: Comply with whatever requirements an authorized representative of the railroad company deems necessary in order to safeguard the railroad's property and operations. The Contractor is responsible for all damages, delays, or injuries and all suits, actions, or claims brought on account of damages or injuries resulting from the Contractor's operations within or adjacent to railroad company right-of-way.

7-11.5.3 Watchman or Flagging Services: The railroad company will furnish protective services (i.e., watchman or flagging services) to ensure the safety of railroad operations during certain periods of the project. The Department will reimburse the railroad company for the cost thereof. Schedule work that affects railroad operations so as to minimize the need for protective services by the railroad company.

7-11.6 Utilities:

7-11.6.1 Arrangements for Protection or Adjustment: Do not commence work at points where the construction operations are adjacent to utility facilities or other property, until making arrangements with the utility facilities to protect against damage that might result in expense, loss, disruption of service, or other undue inconvenience to the public or to the owners. The Contractor is solely and directly responsible to the owners and operators of such properties for all damages, injuries, expenses, losses, inconveniences, or delays caused by the Contractor's operations.

The Department will make the necessary arrangements with utility owners for removal or adjustment of utilities where the Engineer determines that such removal or adjustment is essential to the performance of the required construction. The Department will not consider relocation or adjustment requests based on the Contractor's proposed use of a particular method of construction or a particular type of equipment as essential to the construction of the project if the Contractor could use other common methods and equipment without relocating or adjusting the utility. The Engineer will determine the responsibility for any such required adjustments of utilities. The Contractor shall make all requested relocations or adjustments because of delivery to the job site of Contractor-furnished materials, at no expense to the Department.

The Department considers relocations and adjustments (or other protection) under the following circumstances as essential to the construction of the project:

(1) Utilities lying within the vertical and horizontal construction limits, plus the reasonably required working room necessary for operation of equipment normally used for the particular type of construction, all as determined by the Engineer (and except as provided in paragraph (4) below). (In the case of

overhead electrical conductors that carry more than 400 V, a minimum of 10 feet clearance between the conductor and the nearest possible approach of any part of the equipment is required, except where the utility owner effects safeguards approved by OSHA.)

(2) Utilities lying within the horizontal limits of the project and within 12 inches below the ground surface or the excavation surface on which the Contractor operates construction equipment, or within 12 inches below the bottom of any stabilizing course specified in the plans.

(3) Utilities lying within the normal limits of excavation for underground drainage facilities or other structures (except as provided in paragraph (4) below). Such normal limits shall extend to side slopes along the angle of repose, as established by sound engineering practice, unless the Contract Documents require support of the excavation sides by sheeting or the Contractor elects to sheet such excavation for his own convenience.

(4) Where utilities cross pipe trenches transversely within the excavation area, but not within positions from which relocation or removal is necessary, the utility owner is responsible for providing and effecting all reasonable measures for their support and protection during construction operations. Cooperate with the utility owner in the owner's effecting of such support and protective measures. The Contractor is responsible for all damage to the utility that is caused by the Contractor's neglect or failure to cooperate or to use proper precaution in performing his work.

In the event that a temporary relocation of a utility or a particular sequence of timing in the relocation of a utility is necessary, the Engineer will direct such relocation so as to cause the least impediment to the overall construction operations. The Department is not responsible for utility adjustments or temporary relocation work, or for the conditions resulting therefrom, where such adjustments are (1) not necessitated by the construction of the project, (2) done solely for the benefit or convenience of the utility owner or its contractor, or the highway contractor where the Department considers his construction procedures to be other than normal, or (3) not shown on the approved plans for the utility relocation or the construction of the project.

7-11.6.2 Cooperation with Utility Owners: Cooperate with the owners of all underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner, that duplication or rearrangement work may be reduced to a minimum, and that services rendered by the utility owners will not be unnecessarily interrupted.

In the event of interruption of water or other utility services as a result of accidental breakage, exposure, or lack of support, promptly notify the proper authority and cooperate with the authority in the prompt restoration of service. If water service is interrupted and the Contractor is performing the repair work, the Contractor shall work continuously until the service is restored. Do not begin work around fire hydrants until the local fire authority has approved provisions for continued service.

7-11.6.3 Utility Adjustments: Certain utility adjustments and reconstruction work may be underway during the progress of the Contract. Cooperate with the various utility construction crews who are maintaining utility

service. Exercise due caution when working adjacent to relocated utilities. The Contractor shall repair all damage to the relocated utilities resulting from his operations at no expense to the Department. The requirements of 7-11.1 and 7-11.6.2 outline the Contractor's responsibility for of protecting utility facilities. The Department will include in the Contract the utility authorities who are scheduled to perform utility work on the project.

7-11.6.4 Weekly Meetings: Conduct weekly meetings on the job site with all the affected utility companies and the Engineer in attendance to coordinate project construction and utility relocation. Submit a list of all attendees one week in advance to the Engineer for approval.

Provide the approved Work Progress Schedule and Work Plan for the project, as specified in 8-3.2, to document the schedule and plan for road construction and utility adjustments.

When utility relocations no longer affect construction activities, the Contractor may discontinue the meetings with the Engineer's approval.

7-12 Responsibility for Damages, Claims, etc.

7-12.1 Contractor to Provide Indemnification: The Contractor shall indemnify and hold harmless the Department, its officers and employees from liabilities, damages, losses and costs, including, but not limited to, reasonable attorney's fees, to the extent caused by the negligence, recklessness, or intentional wrongful misconduct of the Contractor and persons employed or utilized by the Contractor in the performance of the construction Contract.

It is specifically agreed between the parties executing this Contract that it is not intended by any of the provisions of any part of the Contract to create in the public or any member thereof, a third party beneficiary hereunder, or to authorize anyone not a party to this Contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of this Contract.

7-12.2 Guaranty of Payment for Claims: The Contractor guaranties the payment of all just claims for materials, supplies, tools, or labor and other just claims against him or any subcontractor, in connection with the Contract. The Department's final acceptance and payment does not release the Contractor's bond until all such claims are paid or released.

7-13 Insurance.

7-13.1 Workers' Compensation Insurance: Provide Workers' Compensation Insurance in accordance with the laws of the State of Florida and in amounts sufficient to secure the benefits of the Florida Workers' Compensation Law for all employees. If subletting any of the work, ensure that the employees of the subcontractors are covered by similar insurance. Ensure that any equipment rental agreements that include operators who are employees of independent Contractors, sole proprietorships or partners are covered by similar insurance. The Engineer will accept equivalent approved protection in lieu of insurance.

7-13.2 Contractors' Public Liability and Property Damages Liability Insurance: Furnish evidence to the Department that, with respect to the operations performed, regular Contractors' Public Liability Insurance providing

for a limit of not less than $1,000,000 for all damages arising out of bodily injuries to, or death of, one person and, subject to that limit for each person, a total limit of $5,000,000 for all damages arising out of bodily injuries to, or death of, two or more persons in any one occurrence; and regular Contractors' Property Damage Liability Insurance providing for a limit of not less than $50,000 for all damages arising out of injury to, or destruction of, property in any one occurrence and, subject to that limit per occurrence, a total (or aggregate) limit of $100,000 for all damages arising out of injury to, or destruction of, property during the policy period is carried.

Cause the Department to be an additional insured party on the Contractor's Public Liability and Property Damages Liability Insurance policies that insure the Contractor for the described work that it performs under the Contract.

7-13.3 Contractors' Protective Public Liability and Property Damage Liability Insurance: Furnish evidence to the Department that, with respect to the operations performed by subcontractors, regular Contractors' Protective Public Liability Insurance providing for a limit of not less than $1,000,000 for all damages arising out of bodily injuries to, or death of, one person and, subject to that limit for each person, a total limit of $5,000,000 for all damages arising out of bodily injuries to, or death of, two or more persons in any one occurrence; and regular Contractors' Protective Property Damage Liability Insurance providing for a limit of not less than $50,000 for all damages arising out of injury to, or destruction of, property in any one occurrence and, subject to that limit per occurrence, a total (or aggregate) limit of $100,000 for all damages arising out of injury to, or destruction of, property during the policy period is carried.

Cause the Department to be an additional insured party on the Contractor's Protective Public Liability and Property Damage Liability Insurance policies that insure the Contractor for the described work that it performs under the Contract.

7-13.4 Insurance Required for Construction at Railroads:

7-13.4.1 General: In addition to any other forms of insurance or bonds required under the terms of the Contract, when the Contract includes the construction of a railroad grade crossing, overpass, or underpass structure, or a railroad crossing signal installation, or any other work or operations by the Contractor within the limits of the railroad right-of-way, including any encroachments thereon from work or operations in the vicinity of the railroad right-of-way, provide insurance of the types set forth below and in amounts not less than specified herein.

7-13.4.2 Railroads' Protective Public Liability and Property Damage Liability Insurance: Furnish the Department with an original insurance policy that, with respect to the operations performed, will provide for and in behalf of the railroad company regular liability insurance providing coverage for bodily injury, death, and property damage limited to a combined single limit of $2,000,000 per occurrence with an aggregate limit of $6,000,000 for the term of the policy.

7-13.5 Insurance for Protection of Utility Owners: When the work under the Contract involves work on or in the vicinity of utility-owned property or

facilities, furnish the Department with evidence that, with respect to the operations performed, General Comprehensive Liability Insurance or its equivalent providing for a limit of not less than $1,000,000 for bodily injury or death to person(s) per occurrence and $300,000 property damage each occurrence is carried. The Department and Utility Company are to be Additional Named Insureds, and the policy will be primary to any coverage maintained by the Department or Company. Do not make any material change or cancellation to the policy without providing the Department with ten days prior written notice.

7-13.6 Submission and Approval of Policies; Termination: Furnish two copies of each required policy to the Engineer at the Preconstruction Conference.

Provide all insurance policies in such form and with insurers that are acceptable to the Department, and to the railroad company or the utility owner. Keep insurance in behalf of a railroad company in force until the Department accepts that the Contractor has satisfactorily completed all work required under the Contract. Keep insurance in behalf of a utility owner in force, in the full amount specified herein, until 30 days after the Department accepts the work.

7-14 Contractor's Responsibility for Work.

Until the Department's acceptance of the work, take charge and custody of the work, and take every necessary precaution against injury or damage to the work by the action of the elements or from any other cause whatsoever, arising either from the execution or from the nonexecution of the work. Rebuild, repair, restore, and make good, without additional expense to the Department, all injury or damage to any portion of the work occasioned by any of the above causes before its completion and acceptance, except that in case of extensive or catastrophic damage, the Department may, at its discretion, reimburse the Contractor for the repair of such damage due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to Acts of God, of the public enemy, or of governmental authorities.

7-15 Opening Sections of Highway to Traffic.

Whenever any bridge or section of roadway is in acceptable condition for travel, the Engineer may direct the Contractor to open it to traffic. The Department's direction to open a bridge or roadway does not constitute an acceptance of the bridge or roadway, or any part thereof, or waive any Contract provisions. Perform all necessary repairs or renewals, on any section of the roadway or bridge thus opened to traffic under instructions from the Engineer, due to defective material or work or to any cause other than ordinary wear and tear, pending completion and the Engineer's acceptance of the roadway or bridge, or other work, at no expense to the Department.

7-16 Wage Rates for Federal-Aid Projects.

For all projects that include Federal-aid participation, the Special Provisions contain requirements with regard to payment of predetermined minimum wages. Predetermined Wage Rate Decisions (U.S. Department of Labor provided Wage Rate Tables) exist for Heavy, Highway, and Building Construction Projects.

7-17 Supplemental Agreements.

Section 337.11 of the Florida Statutes as amended, which prescribe certain limitations on the use of supplemental agreements, are a part of the Contract.

7-18 Scales for Weighing Materials.

7-18.1 Applicable Regulations: When determining the weight of material for payment, use scales meeting the requirements of Chapter 531 of Florida Statutes, pertaining to specifications, tolerances, and regulations, as administered by the Bureau of Weights and Measures of the Florida Department of Agriculture.

7-18.2 Base for Scales: Place such scales on a substantial horizontal base to provide adequate support and rigidity and to maintain the level of the scales.

7-18.3 Protection and Maintenance: Maintain all scale parts in proper condition as to level and vertical alignment, and fully protect them against contamination by dust, dirt, and other matter that might affect their operation.

7-19 Source of Forest Products.

As required by Section 255.20 of the Florida Statutes, where price and quality are equal, and when available, use only timber, timber piling, or other forest products that are produced and manufactured in the State of Florida. This provision does not apply to Federal-aid projects.

7-20 Regulations of Air Pollution from Asphalt Plants.

7-20.1 General: Perform all work in accordance with all Federal, State, and local laws and regulations regarding air pollution and burning. In particular, pay attention to Chapters 17-2 and 17-5 of the Rules and Regulations of the Department of Environmental Protection, and to any part of the State Implementation Plan applicable to the project. See also 110-9.2 regarding burning of debris.

7-20.2 Dust Control: Ensure that excessive dust is not transported beyond the limits of construction in populated areas. The Contractor may control dust for embankments or other cleared or unsurfaced areas by applying water or calcium chloride, as directed by the Engineer. Use calcium chloride in accordance with 102-5. When included in the plans, install mulch, seed, sod, or temporary paving as early as practical. Control dust during the storage and handling of dusty materials by wetting, covering, or other means as approved by the Engineer.

7-20.3 Asphalt Material: Use only emulsified asphalt, unless otherwise stated in the plans and allowed by Chapter 17-2 of the Rules and Regulations of the Department of Environmental Protection. Store and handle asphalt materials and components so as to minimize unnecessary release of hydrocarbon vapors.

7-20.4 Asphalt Plants: Operate and maintain asphalt plants in accordance with Chapter 17-2 of the Rules and Regulations of the Department of Environmental Protection. Provide the plant site with a valid permit as required under Chapter 17-2 prior to start of work.

7-21 Dredging and Filling.

Section 370.033 of the Florida Statutes, requires that all persons, who engage in certain dredge or fill activities in the State of Florida, obtain a certificate of

registration from the Florida Department of Environmental Protection, Tallahassee, Florida 32301, and that they keep accurate logs and records of all such activities for the protection and conservation of the natural resources. Obtain details as to the application of this law from the Department of Environmental Protection.

7-22 Available Funds.

For Contracts in excess of $25,000 or a term for more than one year, comply with the following provisions of Chapter 339 of the Florida Statutes:

The Department will not, during any fiscal year, expend money, incur any liability, or enter into any Contract that, by its terms, involves the expenditures of money in excess of the amounts budgeted as available for expenditure during such fiscal year. If the Department enters into such a Contract, verbal or written, in violation of this subsection, such Contract is null and void, and the Department will not make any payments thereon. The Department will require a statement from the Department's comptroller that funds are available prior to entering into any such Contract or other binding commitment of funds. Nothing herein contained prevents the Department from executing Contracts for a period exceeding one year, but the Department will make such Contracts executory only for the value of the services to be rendered or agreed to be paid for in succeeding fiscal years. The Department will incorporate this paragraph verbatim in all Contracts in excess of $25,000 or having a term for more than one year.

7-23 Contractor's Motor Vehicle Registration.

The Contractor shall provide the Department with proof that all motor vehicles operated or caused to be operated by such Contractor are registered in compliance with Chapter 320 of the Florida Statutes. Submit such proof of registration in the form of a notarized affidavit to the Department.

The Department will not make payment to the Contractor until the required proof of registration is on file with the Department.

If the Contractor fails to register any motor vehicle that he operates in Florida, pursuant to Chapter 320 of the Florida Statutes, the Department may disqualify the Contractor from bidding, or the Department may suspend and revoke the Contractor's certificates of qualification.

7-24 Disadvantaged Business Enterprise Program.

7-24.1 General: Prior to award of the Contract, have an approved Disadvantaged Business Enterprise (DBE) Affirmative Action Program Plan filed with the Equal Opportunity Office. Update and resubmit the plan every three years. No Contract will be awarded until the Department approves the Plan. The DBE Affirmative Action Program Plan and commitment to carry out the Plan must be incorporated into and become a part of the awarded Contract.

7-24.2 Required Contract and Subcontract DBE Assurance Language: Per 49 CFR 26.13 (b) each Contract FDOT signs with a Contractor (and each subcontract the prime contractor signs with a subcontractor) must include the following assurance: "The Contractor, sub-recipient or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance

of this contract. The Contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of DOT-assisted Contracts. Failure by the Contractor to carry out these requirements is a material breach of this Contract, which may result in the termination of this Contract or such other remedy as the recipient deems appropriate."

7-24.3 Plan Requirements: Include the following in the DBE Affirmative Action Program Plan:

(a) A policy statement, expressing a commitment to use DBEs in all aspects of contracting to the maximum extent feasible. The policy making body must issue a policy statement signed by the chairperson, which expresses its commitment to utilize DBEs, outlines the various levels of responsibility, and states the objectives of the program. Circulate the policy statement throughout the Contractor's organization.

(b) The designation of a Liaison Officer within the Contractor's organization, as well as support staff, necessary and proper to administer the program, and a description of the authority, responsibility, and duties of the Liaison Officer and support staff. The Liaison Officer and staff are responsible for developing, managing, and implementing the program on a day-to-day basis for carrying out technical assistance activities for DBEs and for disseminating information on available business opportunities so that DBEs are provided an equitable opportunity to participate in Contracts let by the Department.

Use techniques to facilitate DBE participation in contracting activities which include, but are not limited to:

1. Soliciting price quotations and arranging a time for the review of plans, quantities, specifications, and delivery schedules, and for the preparation and presentation of quotations.

2. Providing assistance to DBEs in overcoming barriers such as the inability to obtain bonding, financing, or technical assistance.

3. Carrying out information and communication programs or workshops on contracting procedures and specific contracting opportunities in a timely manner, with such programs being bilingual where appropriate.

4. Encouraging eligible DBEs to apply for certification with the Department.

5. Contacting Minority Contractor Associations and city and county agencies with programs for disadvantaged individuals for assistance in recruiting and encouraging eligible DBE contractors to apply for certification with the Department.

7-24.4 DBE Records and Reports: Submit the Anticipated DBE Participation Statement at or before the Pre-Construction Conference. Report monthly, through the Equal Opportunity Reporting System on the Department's Website, actual payments, retainage, of all DBE and Minority Business Enterprise (MBE) subcontractors and DBE and MBE construction material and major suppliers. The Equal Opportunity Office will provide instructions on accessing this system. Develop a record keeping system to monitor DBE affirmative action efforts which include the following:

(a) the procedures adopted to comply with these Specifications;

(b) the number of subordinated Contracts on Department projects awarded to DBEs;

(c) the dollar value of the Contracts awarded to DBEs;

(d) the percentage of the dollar value of all subordinated Contracts awarded to DBEs as a percentage of the total Contract amount;

(e) a description of the general categories of Contracts awarded to DBEs; and

(f) the specific efforts employed to identify and award Contracts to DBEs.

Upon request, provide the records to the Department for review.

All such records are required to be maintained for a period of five years following acceptance of final payment and have them available for inspection by the Department and the Federal Highway Administration.

7-25 On-The-Job Training Requirements.

As part of the Contractor's equal employment opportunity affirmative action program, training shall be provided as follows:

The Contractor shall provide on-the-job training aimed at developing full journeymen in the type(s) of trade or job classification(s) involved in the work. In the event the Contractor subcontracts a portion of the contract work, he/she shall determine how many, if any, of the trainees are to be trained by the subcontractor provided, that the Contractor shall retain the primary responsibility for meeting the training requirements imposed by this Section. The Contractor shall apply the requirements of this Section to such subcontract. Where feasible, 25% of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training.

The number of trainees will be estimated on the number of calendar days of the contract, the dollar value, and the scope of work to be performed. The trainee goal will be finalized at a Post-Preconstruction Trainee Evaluation Meeting and the goal will be distributed among the work classifications based on the following criteria:

1) Determine the number of trainees on Federal Aid Contract:

(a) No trainees will be required for contracts with a contract time allowance of less than 225 calendar days.

(b) If the contract time allowance is 225 calendar days or more, the number of trainees shall be established in accordance with the following chart:

Estimated Contract Amount	Trainees Required
Under $1,000,000	0
Over $1,000,000 to 3,000,000	2
Over $3,000,000 to 5,000,000	3
Over $5,000,000 to $10,000,000	5
Over 10,000,000 to 15,000,000	7
Over 15,000,000 to 20,000,000	9
Over 20,000,000 to *	12

* One Additional trainee per $5,000,000 of estimated construction contract amount over $20,000,000.

Further, if the Contractor or subcontractor requests to utilize banked trainees as discussed later in this Section, a Banking Certificate will be validated at this meeting allowing credit to the Contractor for previously banked trainees. The Contractor's Project Manager, the Construction Project Engineer and the Department's District Compliance Manager will attend this meeting. Within ten days after the Post-Preconstruction Training Evaluation Meeting, the Contractor shall submit to the Department for approval an On-The-Job Training Schedule indicating the number of trainees to be trained in each selected classification and the portion of the contract time during which training of each trainee is to take place. This schedule may be subject to change if the following occur:

1. When a start date on the approved On-The-Job Training Schedule has been missed by 14 or more days;
2. When there is a change(s) in previously approved classifications;
3. When replacement trainees are added due to voluntary or involuntary termination.

The revised schedule will be resubmitted to and approved by the Department's District Compliance Manager.

The following criteria will be used in determining whether or not the Contractor has complied with this Section as it relates to the number of trainees to be trained:

1. Full credit will be allowed for each trainee that is both enrolled and satisfactorily completes training on this Contract. Credit for trainees, over the established number for this Contract, will be carried in a "bank" for the Contractor and credit will be allowed for those surplus trainees in subsequent, applicable projects. A "banked" trainee is described as an employee who has been trained on a project, over and above the established goal, and for which the Contractor desires to preserve credit for utilization on a subsequent project.
2. Full credit will be allowed for each trainee that has been previously enrolled in the Department's approved training program on another contract and continues training in the same job classification for a significant period and completes his/her training on this Contract.
3. Full credit will be allowed for each trainee who, due to the amount of work available in his/her classification, is given the greatest practical amount of training on the contract regardless of whether or not the trainee completes training.
4. Full credit will be allowed for any training position indicated in the approved On-The-Job Training Schedule, if the Contractor can demonstrate that he/she has made his/her a good faith effort to provide training in that classification.
5. No credit will be allowed for a trainee whose employment by the Contractor is involuntarily terminated unless the Contractor can clearly demonstrate good cause for this action.

The Contractor shall, as far as is practical, comply with the time frames established in the approved On-The-Job Training Schedule. When this proves to

be impractical, a revised schedule shall be submitted and approved as provided above.

Training and upgrading of minorities, women and economically disadvantaged persons toward journeyman status is a primary objective of this Section. Accordingly, the Contractor shall make every effort to enroll minority trainees and women (e.g., by conducting systematic and direct recruitment through public and private sources likely to yield minority and women trainees) to the extent such persons are available within a reasonable area of recruitment. If a non-minority male is enrolled into On-The-Job Training, the On-The-Job Training Notification of Personnel Action Form notifying the District Compliance Manager of such action shall be accompanied by a disadvantaged certification or a justification for such action acceptable to the Department's District Compliance Manager. The Contractor will be given an opportunity and will be responsible for demonstrating the steps that he has taken in pursuance thereof, prior to a determination as to whether the Contractor is in compliance with this Section. This training is not intended, and shall not be used, to discriminate against any applicant for training, whether a minority, woman or disadvantaged person.

No employee shall be employed as a trainee in any classification in which he/she has successfully completed a training course leading to journeyman status, has been employed as a journeyman, or has had extensive experience in the classification being considered for training. The Contractor shall satisfy this requirement by including appropriate questions in the employee application or by other suitable means. Regardless of the method used, the Contractor's records should document the findings in each case.

The minimum length and type of training for each classification will be as established at the Post-Preconstruction Trainee Evaluation Meeting and approved by the Department. Graduation to journeyman status will be based upon satisfactory completion of Proficiency Demonstrations set up as milestones in each specific training classification, completion of the minimum hours in a training classification range and the employer's satisfaction that the trainee does meet journeyman status in the classification of training. Upon reaching journeyman status, the following documentation must be forwarded to the District Compliance Office; Trainee Enrollment and Personnel Action Form, the Proficiency Demonstration Verification Form signed at each milestone by a representative of both the Contractor and the Department and a letter stating that the trainee has sufficiently progressed in the craft and is being promoted to journeyman status.

The Department and the Contractor shall establish a program that is tied to the scope of the work in the project and the length of operations providing it is reasonably calculated to meet the equal employment opportunity obligations of the Contractor and to qualify the average trainee for journeyman status in the classifications concerned, by at least, the minimum hours prescribed for a training classification. Furthermore, apprenticeship programs registered with the U.S. Department of Labor, Bureau of Apprenticeship and Training, or with a State apprenticeship agency recognized by the Bureau and training programs approved but not necessarily sponsored by the U.S. Department of Labor,

Manpower Administration, Bureau of Apprenticeship and Training shall also be considered acceptable provided it is being administered in a manner consistent with the equal employment obligations of Federal Aid highway construction contract. Approval or acceptance of a training schedule shall be obtained from the Department prior to commencing work on the classifications covered by the program.

A voluntary On-The-Job Training Program is available to a Contractor which has been awarded a state funded project. Through this program, the Contractor will have the option to train employees on state funded projects for "banked credit" as discussed previously in this provision, to be utilized on subsequent Federal Aid Projects where training is required. Those Contractors availing themselves of this opportunity to train personnel on state funded projects and bank trainee hours for credit shall comply with all training criteria set forth in this Section.

It is the intention of these provisions that training is to be provided in the construction crafts rather than clerk-typists or secretarial type positions. Training is permissible in positions such as office engineers, estimators, etc., where the training is oriented toward construction applications. Training in the laborer classification may be permitted provided that significant and meaningful training is provided and approved by the District Compliance Office. Some offsite training is permissible as long as the training is an integral part of an approved training program and does not compromise a significant part of the overall training.

As approved in advance by the District Compliance Manager, credit will be given for training of persons in excess of the number specified herein under the current contract or a Contractor will be allowed to bank trainees who have successfully completed a training program and may apply those trainees to a training requirement in subsequent project(s) upon approval of the Department's District Compliance Manager. This credit will be given even though the Contractor may receive training program funds from other sources, provided such other source do not specifically prohibit the Contractor from receiving other form of compensation. Credit for offsite training indicated above may only be made to the Contractor where he does one or more of the following and the trainees are concurrently employed on a Federal Aid Project; contributes to the cost of the training, provides the instruction to the trainee and pays the trainee's wages during the offsite training period.

No credit shall be given to the Contractor if either the failure to provide the required training, or the failure to hire the trainee as a journeyman, is caused by the Contractor and evidences a lack of good faith on the part of the Contractor in meeting the requirements of this Section.

The Contractor shall compensate the trainee at no less than the laborer rate established in the Contract at the onset of training. This compensation rate will be increased to the journeyman's wage for that classification upon graduation from the training program.

The Contractor shall furnish the trainee a copy of the program he will follow in providing the training. The Contractor shall provide each trainee with a certification showing the type and length of training satisfactorily completed.

The Contractor shall maintain records to document the actual hours each trainee is engaged in training on work being performed as a part of this Contract.

The Contractor shall submit to the District Compliance Manager a copy of an On-The-Job Training Notification of Personnel Action form no later than seven days after the effective date of the action when the following occurs: a trainee is transferred on the project, transferred from the project to continue training on another contract, completes training, upgraded to journeyman status or voluntary terminates or is involuntary terminated from the project.

The Contractor shall furnish to the District Compliance Manager a copy of a Monthly Time Report for each trainee. The monthly report for each month shall be submitted no later than the tenth day of the subsequent month. The Monthly Time Report shall indicate the phases and sub-phases of the number of hours devoted to each.

Highway or Bridge Carpenter Helper, Mechanic Helper, Rodman/Chainman, Timekeeper, trainees will not be approved for the On-The-Job Training Program.

Painters, Electricians, and Mechanics are identified as crafts under-utilized by minorities. All training classifications except Laborers are identified as under-utilized by females.

Priority selection should also include those crafts under-utilized and/or void of minorities and/or female by that particular company's workforce.

If the Contractor does not select a training classification that has been targeted as an under-utilized craft, and those classifications can be used for the selection of training for this project, the On-The-Job Training Schedule will not be approved unless written justification for exceptions is attached.

SECTION 8
PROSECUTION AND PROGRESS

8-1 Subletting or Assigning of Contracts.

Do not, sell, transfer, assign or otherwise dispose of the Contract or Contracts or any portion thereof, or of the right, title, or interest therein, without written consent of the Department. If the Contractor chooses to sublet any portion of the Contract, the Contractor must provide a written request to sublet work on the Certification of Sublet Work form developed by the Department for this purpose. With the Engineer's acceptance of the request, the Contractor may sublet a portion of the work, but shall perform with his own organization work amounting to not less than 40% of the total Contract amount. The Certification of Sublet Work request will be deemed acceptable by the Department, for purposes of the Department's consent, unless the Engineer notifies the Contractor within 5 business days of receipt of the Certification of Sublet Work that the Department is not consenting to the requested subletting.

Include in the total Contract amount the cost of materials and manufactured component products, and their transportation to the project site. For the purpose of meeting this requirement the Department will not consider off-site commercial production of materials and manufactured component products that the

Contractor purchases, or their transportation to the project, as subcontracted work.

If the Contractor sublets a part of a Contract item, the Department will use only the sublet proportional cost in determining the percentage of subcontracted normal work.

Execute all agreements to sublet work in writing and include all pertinent provisions and requirements of the Contract. Upon request, furnish the Department with a copy of the subcontract. The subletting of work does not relieve the Contractor or the surety of their respective liabilities under the Contract.

The Department recognizes a subcontractor only in the capacity of an employee or agent of the Contractor, and the Engineer may require the Contractor to remove the subcontractor as in the case of an employee.

8-2 Work Performed by Equipment-Rental Agreement.

The limitations set forth in 8-1, concerning the amount of work that may be sublet, do not apply to work performed by equipment-rental agreement. However, for any work proposed to be performed by equipment-rental agreement, notify the Engineer in writing of such intention before using the rented equipment, and indicate whether the equipment will be rented on an operated or non-operated basis. Include with the written notice a listing and description of the equipment and a description of the particular work to be performed with such equipment. As an exception to the above requirements, the Department will not require written notice for equipment to be rented (without operators) from an equipment dealer or from a firm whose principal business is the renting or leasing of equipment.

The operators of all rented equipment, whether rented on an operated or a non-operated basis, are subject to all wage rate requirements applicable to the project. When renting equipment without operators, the Contractor shall carry the operators on his own payroll. For equipment that is rented on an operated basis, and when required by the Contract or requested by the Engineer, furnish payrolls from the lessor with the names of the operators shown thereon.

When a lessor provides rentals of equipment on an operated basis that exceed $10,000, such lessor is subject to any Equal Employment Opportunity requirements that are applicable to the project.

8-3 Prosecution of Work.

8-3.1 Compliance with Time Requirements: Commence work in accordance with the accepted working schedule and provide sufficient labor, materials and equipment to complete the work within the time limit(s) set forth in the proposal. Should the Contractor fail to furnish sufficient and suitable equipment, forces, and materials, as necessary to prosecute the work in accordance with the required schedule, the Engineer may withhold all estimates that are, or may become due, or suspend the work until the Contractor corrects such deficiencies.

8-3.2 Submission of Working Schedule: Within 21 calendar days after Contract award or at the preconstruction conference, whichever is earlier, submit

to the Engineer a work progress schedule for the project. The Engineer will review and respond to the Contractor within 15 calendar days of receipt.

Provide a schedule that shows the various activities of work in sufficient detail to demonstrate a reasonable and workable plan to complete the project within the Contract Time. Show the order and interdependence of activities and the sequence for accomplishing the work. Describe all activities in sufficient detail so that the Engineer can readily identify the work and measure the progress on of each activity. Show each activity with a beginning work date, a duration, and a monetary value. Include activities for procurement fabrication, and deliver of materials, plant, and equipment, and review time for shop drawings and submittals. Include milestone activities when milestones are required by the Contract Documents. In a project with more than one phase, adequately identify each phase and its completion date, and do not allow activities to span more than one phase.

Conduct sufficient liaison and provide sufficient information to indicate coordination activities with utility owners that have facilities within the limits of construction have been resolved. Incorporate in the schedule any utility adjustment schedules included in the Contract Documents unless the utility company and the Department mutually agree to changes to the utility schedules shown in the Contract.

Submit a working plan with the schedule, consisting of a concise written description of the construction plan.

The Engineer will return inadequate schedules to the Contractor for corrections. Resubmit a corrected schedule within 15 calendar days from the date of the Engineer's return transmittal.

Submit an updated Work Progress Schedule, for Engineer's acceptance, if there is a significant change in the planned order or duration of an activity. The Engineer will review the corrected schedule and respond within 7 calendar days of receipt.

By acceptance of the schedule, the Engineer does not endorse or otherwise certify the validity or accuracy of the activity durations or sequencing of activities. The Engineer will use the accepted schedule as the baseline against which to measure the progress.

If the Contractor fails to finalize either the initial or a revised schedule in the time specified, the Engineer will withhold all Contract payments until the Engineer accepts the schedule.

8-3.3 Beginning Work: Notify the Engineer not less than five days in advance of the planned start day of work. Upon the receipt of such notice, the Engineer may give the Contractor Notice to Proceed and may designate the point or points to start the work. In the Notice to Proceed, the Engineer may waive the five day advance notice and authorize the Contractor to begin immediately. Notify the Engineer in writing at least two days in advance of the starting date of important features of the work. Do not commence work under the Contract until after the Department has issued the Notice to Proceed. The Department will issue the Notice to Proceed within 30 days after execution of the Contract.

8-3.4 Provisions for Convenience of Public: Schedule construction operations so as to minimize any inconvenience to adjacent businesses or

residences. Where necessary, the Engineer may require the Contractor to first construct the work in any areas along the project where inconveniences caused by construction operations would present a more serious handicap. In such critical locations, where there is no assurance of continuous effective prosecution of the work once the construction operations are begun, the Engineer may require the Contractor to delay removal of the existing (usable) facilities.

8-3.5 Preconstruction Conference: Immediately after awarding the Contract but before the Contractor begins work, the Engineer will call a preconstruction conference at a place the Engineer designates to go over the construction aspects of the project. Attend this meeting, along with the Department and the various utility companies that will be involved with the road construction.

8-4 Limitations of Operations.

8-4.1 Night Work: During active nighttime operations, furnish, place and maintain lighting sufficient to permit proper workmanship and inspection. Use lighting with 5 ft-cd minimum intensity. Arrange the lighting to prevent interference with traffic or produce undue glare to property owners. Operate such lighting only during active nighttime construction activities. Provide a light meter to demonstrate that the minimum light intensity is being maintained.

Lighting may be accomplished by the use of portable floodlights, standard equipment lights, existing street lights, temporary street lights, or other lighting methods approved by the Engineer.

Submit a lighting plan at the Preconstruction Conference for review and acceptance by the Engineer. Submit the plan on standard size plan sheets (not larger than 24 by 36 inch), and on a scale of either 100 or 50 feet to 1 inch. Do not start night work prior to the Engineer's acceptance of the lighting plan.

During active nighttime operations, furnish, place and maintain variable message signs to alert approaching motorists of lighted construction zones ahead. Operate the variable message signs only during active construction activities.

Include compensation for lighting for night work in the Contract prices for the various items of the Contract. Take ownership of all lighting equipment for night work.

8-4.2 Sequence of Operations: Do not open up work to the prejudice of work already started. The Engineer may require the Contractor to finish a section on which work is in progress before starting work on any additional section.

8-4.3 Interference with Traffic: At all times conduct the work in such manner and in such sequence as to ensure the least practicable interference with traffic. Operate all vehicles and other equipment safely and without hindrance to the traveling public. Park all private vehicles outside the clear zone. Place materials stored along the roadway so as to cause no obstruction to the traveling public as possible.

Where existing pavement is to be widened and stabilizing is not required, prevent any open trench from remaining after working hours by scheduling operations to place the full thickness of widened base by the end of each day. Do not construct widening strips simultaneously on both sides of the road, except

where separated by a distance of at least 1/4 mile along the road and where either the work of excavation has not been started or the base has been completed.

8-4.4 Coordination with other Contractors: Sequence the work and dispose of materials so as not to interfere with the operations of other Contractors engaged upon adjacent work; join the work to that of others in a proper manner, in accordance with the spirit of the Contract Documents; and perform the work in the proper sequence in relation to that of other contractors; all as may be directed by the Engineer.

Each contractor is responsible for any damage done by him or his agents to the work performed by another contractor.

8-4.5 Drainage: Conduct the operations and maintain the work in such condition to provide adequate drainage at all times. Do not obstruct existing functioning storm sewers, gutters, ditches, and other run-off facilities.

8-4.6 Fire Hydrants: Keep fire hydrants on or adjacent to the highway accessible to fire apparatus at all times, and do not place any material or obstruction within 15 feet of any fire hydrant.

8-4.7 Protection of Structures: Do not operate heavy equipment close enough to pipe headwalls or other structures to cause their displacement.

8-4.8 Fencing: Erect permanent fence as a first order of business on all projects that include fencing where the Engineer determines that the fencing is necessary to maintain the security of livestock on adjacent property, or for protection of pedestrians who are likely to gain access to the project from adjacent property.

8-4.9 Hazardous or Toxic Waste: When the construction operations encounter or expose any abnormal condition that may indicate the presence of a hazardous or toxic waste, discontinue such operations in the vicinity of the abnormal condition and notify the Engineer immediately. Be alert for the presence of tanks or barrels; discolored earth, metal, wood, ground water, etc.; visible fumes; abnormal odors; excessively hot earth; smoke; or other conditions that appear abnormal as possible indicators of hazardous or toxic wastes and treat these conditions with extraordinary caution.

Make every effort to minimize the spread of any hazardous or toxic waste into uncontaminated areas.

Do not resume the construction operations until so directed by the Engineer.

Dispose of the hazardous or toxic waste in accordance with the requirements and regulations of any Local, State, or Federal agency having jurisdiction. Where the Contractor performs work necessary to dispose of hazardous or toxic waste, and the Contract does not include pay items for disposal, the Department will pay for this work as provided in 4-4.

The Department may agree to hold harmless and indemnify the Contractor for damages when the Contractor discovers or encounters hazardous materials or pollutants during the performance of services for the Department when the presence of such materials or pollutants were unknown or not reasonably discoverable. Such indemnification agreements are only effective if the Contractor immediately stops work and notifies the Department of the hazardous material or pollutant problem.

Such indemnification agreement are not valid for damages resulting from the Contractor's willful, wanton, or intentional conduct or the operations of Hazardous Material Contractors.

8-5 Qualifications of Contractor's Personnel.

Provide competent, careful, and reliable superintendents, foremen, and workmen. Provide workmen with sufficient skill and experience to properly perform the work assigned to them. Provide workmen engaged on special work, or skilled work, such as bituminous courses or mixtures, concrete bases, pavements, or structures, or in any trade, with sufficient experience in such work to perform it properly and satisfactorily and to operate the equipment involved. Provide workmen that shall make due and proper effort to execute the work in the manner prescribed in the Contract Documents, or the Engineer may take action as prescribed below.

It is prohibited as a conflict of interest for a Contractor to subcontract with a Consultant to perform Contractor Quality Control when the Consultant is under contract with the Department to perform work on any project described in the Contractor's Contract with the Department. Prior to approving a Consultant for Contractor Quality Control, the Contractor shall submit to the Department a Certificate from the proposed Consultant certifying that no conflict of interest exists.

Whenever the Engineer determines that any person employed by the Contractor is incompetent, unfaithful, intemperate, disorderly, or insubordinate, the Engineer will provide written notice and the Contractor shall discharge the person from the work. Do not employ any discharged person on the project without the written consent of the Engineer. If the Contractor fails to remove such person or persons, the Engineer may withhold all estimates that are or may become due, or suspend the work until the Contractor complies with such orders. Protect, defend, indemnify, and hold the Department, its agents, officials, and employees harmless from all claims, actions, or suite arising from such removal, discharge, or suspension of employees.

8-6 Temporary Suspension of Contractor's Operations.

8-6.1 Authority to Suspend Contractor's Operations: The Engineer has the authority to suspend the Contractor's operations, wholly or in part. The Engineer will order such suspension in writing, giving in detail the reasons for the suspension. Contract Time will be charged during all suspensions of Contractor's operations. The Department may grant an extension of Contract time in accordance with 8-7.3.2 when determined appropriate in the Department's sole judgment.

No additional compensation or time extension will be paid or granted to the Contractor when the operations are suspended for the following reasons:

a. The Contractor fails to comply with the Contract Documents.

b. The Contractor fails to carry out orders given by the Engineer.

c. The Contractor causes conditions considered unfavorable for continuing the Work.

Immediately comply with any suspension order. Do not resume operations until authorized to do so by the Engineer in writing. Any operations performed by the Contractor, and otherwise constructed in conformance with the provisions of the Contract, after the issuance of the suspension order and prior to the Engineer's authorization to resume operations will be at no cost to the Department. Further, failure to immediately comply with any suspension order will also constitute an act of default by the Contractor and is deemed sufficient basis in and of itself for the Department to declare the Contractor in default, in accordance with 8-9, with the exception that the Contractor will not have ten calendar days to correct the conditions for which the suspension was ordered.

8-6.1.1 State of Emergency: The Engineer has the authority to suspend the Contractor's operations, wholly or in part, pursuant to a Governor's Declaration of a State of Emergency. The Engineer will order such suspension in writing, giving in detail the reasons for the suspension. Contract Time will be charged during all suspensions of Contractor's operations. The Department, at its sole discretion, may grant an extension of Contract Time and reimburse the Contractor for specific costs associated with such suspension. Further, in such instances, the Department's determination as to entitlement to either time or compensability will be final, unless the Contractor can prove by clear and convincing evidence to a Disputes Review Board that the Department's determination was without any reasonable factual basis

8-6.2 Prolonged Suspensions: If the Engineer suspends the Contractor's operations for an indefinite period, store all materials in such manner that they will not obstruct or impede the traveling public unnecessarily or become damaged in any way. Take every reasonable precaution to prevent damage to or deterioration of the work performed. Provide suitable drainage of the roadway by opening ditches, shoulder drains, etc., and provide any temporary structures necessary for public travel through the project.

8-6.3 Permission to Suspend Contractor's Operations: Do not suspend operations or remove equipment or materials necessary for completing the work without obtaining the Engineer's written permission. Submit all requests for suspension of operations in writing to the Engineer, and identify specific dates to begin and end the suspension. The Contractor is not entitled to any additional compensation for suspension of operations during such periods.

8-6.4 Suspension of Contractor's Operations-Holidays: Unless the Contractor submits a written request to work on a holiday at least ten days in advance of the requested date and receives written approval from the Engineer, the Contractor shall not work on the following days: Martin Luther King, Jr. Day; Memorial Day; the Saturday and Sunday immediately preceding Memorial Day; Independence Day; Labor Day; the Friday, Saturday, and Sunday immediately preceding Labor Day; Veterans Day; Thanksgiving Day; the Friday, Saturday and Sunday immediately following Thanksgiving Day; and December 24 through January 2, inclusive. Contract Time will be charged during these holiday periods regardless of whether or not the Contractor's operations have been suspended. Contract time will be adjusted in accordance with 8-7.3.2. The Contractor is not entitled to any additional compensation beyond any

allowed contract time adjustment for suspension of operations during such holiday periods.

During such suspensions, remove all equipment and materials from the clear zone, except those required for the safety of the traveling public and retain sufficient personnel at the job site to properly meet the requirements of Sections 102 and 104. The Contractor is not entitled to any additional compensation for removal of equipment from clear zones or for compliance with Section 102 and Section 104 during such holiday periods.

8-7 Computation of Contract Time.

8-7.1 General: Perform the contracted work fully, entirely, and in accordance with the Contract Documents within the Contract Time specified in the proposal, or as may be extended in accordance with the provisions herein below.

The Department considers in the computation of the allowable Contract Time the effect that utility relocation and adjustments have on job progress and the scheduling of construction operations required in order to adequately maintain traffic, as detailed in the plans or as scheduled in the Special Provisions.

8-7.2 Date of Beginning of Contract Time: The date on which Contract Time begins is either (1) the date on which the Contractor actually begins work, or (2) the date for beginning the charging of Contract Time as set forth in the proposal; whichever is earlier.

8-7.3 Adjusting Contract Time:

8-7.3.1 Increased Work: The Department may grant an extension of Contract Time when it increases the Contract amount due to overruns in original Contract items, adds new work items, or provides for unforeseen work. The Department will base the consideration for granting an extension of Contract Time on the extent that the time normally required to complete the additional designated work delays the Contract completion schedule.

8-7.3.2 Contract Time Extensions: The Department may grant an extension of Contract Time when a controlling item of work is delayed by factors not reasonably anticipated or foreseeable at the time of bid. The Department may allow such extension of time only for delays occurring during the Contract Time period or authorized extensions of the Contract Time period. When failure by the Department to fulfill an obligation under the Contract results in delays to the controlling items of work, the Department will consider such delays as a basis for granting a time extension to the Contract.

Whenever the Engineer suspends the Contractor's operations, as provided in 8-6, for reasons other than the fault of the Contractor, the Engineer will grant a time extension for any delay to a controlling item of work due to such suspension. The Department will not grant time extensions to the Contract for delays due to the fault or negligence of the Contractor.

The Department does not include an allowance for delays caused by the effects of inclement weather or suspension of Contractor's operations due to holidays as defined in 8-6.4, in establishing Contract Time. The Engineer will continually monitor the effects of weather and, when found justified, grant time extensions on either a bimonthly or monthly basis. The Engineer will not require

the Contractor to submit a request for additional time due to the effects of weather.

The Department will grant time extensions, on a day for day basis, for delays caused by the effects of rains or other inclement weather conditions, related adverse soil conditions or suspension of operations due to holidays that prevent the Contractor from productively performing controlling items of work resulting in:

(1) The Contractor being unable to work at least 50% of the normal work day on pre-determined controlling work items due to adverse weather conditions, holiday suspension; or

(2) The Contractor must make major repairs to work damaged by weather, provided that the damage is not attributable to the Contractor's failure to perform or neglect; and provided that the Contractor was unable to work at least 50% of the normal workday on pre-determined controlling work items.

No additional compensation will be made for delays caused by the effects of inclement weather.

The Department will consider the delays in delivery of materials or component equipment that affect progress on a controlling item of work as a basis for granting a time extension if such delays are beyond the control of the Contractor or supplier. Such delays may include an area-wide shortage, an industry-wide strike, or a natural disaster that affects all feasible sources of supply. In such cases, the Contractor shall furnish substantiating letters from a representative number of manufacturers of such materials or equipment clearly confirming that the delays in delivery were the result of an area-wide shortage, an industry-wide strike, etc. No additional compensation will be made for delays caused by delivery of materials or component equipment.

The Department will not consider requests for time extension due to delay in the delivery of custom manufactured equipment such as traffic signal equipment, highway lighting equipment, etc., unless the Contractor furnishes documentation that he placed the order for such equipment in a timely manner, the delay was caused by factors beyond the manufacturer's control, and the lack of such equipment caused a delay in progress on a controlling item of work. No additional compensation will be paid for delays caused by delivery of custom manufactured equipment.

The Department will consider the affect of utility relocation and adjustment work on job progress as the basis for granting a time extension only if all the following criteria are met:

(1) Delays are the result of either utility work that was not detailed in the plans, or utility work that was detailed in the plans but was not accomplished in reasonably close accordance with the schedule included in the Contract Documents.

(2) Utility work actually affected progress toward completion of controlling work items.

(3) The Contractor took all reasonable measures to minimize the effect of utility work on job progress, including cooperative scheduling of the Contractor's operations with the scheduled utility work at the preconstruction conference and providing adequate advance notification to utility companies as to

the dates to coordinate their operations with the Contractor's operations to avoid delays.

As a condition precedent to an extension of Contract Time the Contractor must submit to the Engineer:

A preliminary request for an extension of Contract Time must be made in writing to the Engineer within ten calendar days after the commencement of a delay to a controlling item of work. If the Contractor fails to submit this required preliminary request for an extension of Contract Time, the Contractor fully, completely, absolutely and irrevocably waives any entitlement to an extension of Contract Time for that delay. In the case of a continuing delay only a single preliminary request for an extension of Contract Time will be required. Each such preliminary request for an extension of Contract Time shall include as a minimum the commencement date of the delay, the cause of the delay, and the controlling item of work affected by the delay; and

Further, the Contractor must submit to the Engineer a request for a Contract Time extension in writing within 30 days after the elimination of the delay to the controlling item of work identified in the preliminary request for an extension of Contract Time. Each request for a Contract Time extension shall include as a minimum all documentation that the Contractor wishes the Department to consider related to the delay, and the exact number of days requested to be added to Contract Time. If the Contractor contends that the delay is compensable, then the Contractor shall also be required to submit with the request for a Contract Time extension a detailed cost analysis of the requested additional compensation. If the Contractor fails to submit this required request for a Contract Time extension, with or without a detailed cost analysis, depriving the Engineer of the timely opportunity to verify the delay and the costs of the delay, the Contractor waives any entitlement to an extension of Contract Time or additional compensation for the delay.

Upon timely receipt of the preliminary request of Contract Time from the Contractor, the Engineer will investigate the conditions, and if it is determined that a controlling item of work is being delayed for reasons beyond the control of the Contractor the Engineer will take appropriate action to mitigate the delay and the costs of the delay. Upon timely receipt of the request for a Contract Time extension the Engineer will further investigate the conditions, and if it is determined that there was an increase in the time or the cost of performance of the controlling item of work beyond the control of the Contractor, then an adjustment of Contract Time will be made, and a monetary adjustment will be made, excluding loss of anticipated profits, and the Contract will be modified in writing accordingly.

The existence of an accepted schedule, including any required update(s), as stated in 8-3.2, is a condition precedent to the Contractor having any right to the granting of an extension of contract time or any monetary compensation arising out of any delay. Contractor failure to have an accepted schedule, including any required update(s), for the period of potential impact, or in the event the currently accepted schedule and applicable updates do not accurately reflect the actual status of the project or fail to accurately show the true controlling or non-controlling work activities for the period of potential

impact, will result in any entitlement determination as to time or money for such period of potential impact being limited solely to the Department's analysis and identification of the actual controlling or non-controlling work activities. Further, in such instances, the Department's determination as to entitlement as to either time or compensability will be final, unless the Contractor can prove by clear and convincing evidence to a Disputes Review Board that the Department's determination was without any reasonable factual basis.

8-8 Failure of Contractor to Maintain Satisfactory Progress.

8-8.1 General: Pursue the work to completion: Section 337.16 of the Florida Statutes establishes certain requirements pertaining to the suspension or revocation of a Contractor's Certificate of Qualification because of delinquency on a previously awarded Contract.

8-8.2 Regulations Governing Suspension for Delinquency:

(a) A Contractor is delinquent when the allowed Contract Time for performing the work has expired, and the Contractor has not completed the Contract work.

(b) Once the Department determines that the Contractor is delinquent, the Department will give the Contractor written notice of intent to suspend the Contractor's Certificate of Qualification. If the Contractor disagrees with the delinquency, the Contractor shall file a request for an administrative hearing with the Clerk of Agency Proceedings within ten days of receipt of the notice of intent to suspend. If the Contractor does not file a request, the Department will make the suspension conclusive and final. The request for hearing is filed when the Contractor delivers it to, and it is received by, the Clerk of Agency Proceedings, Mail Station 58, Room 562, Haydon Burns Building, 605 Suwannee Street, Tallahassee, Florida 32399-0450.

(c) If the Contractor files a request for a hearing, the Department will schedule the hearing within 30 days of the hearing officer's receipt of the request.

(d) The Department will continue the period of suspension of the Contractor's Certificate of Qualification until the Contractor is no longer delinquent. If the Contractor requests an administrative hearing, the Department's final order, depending on the outcome of the hearing, will set forth the time period of suspension for the number of days the Department determines that the Contractor was delinquent, even if the Contractor cures the delinquency during the pendency of the administrative proceedings.

(e) During the period of suspension of the Contractor's Certificate of Qualification, the Department will not allow the Contractor and its affiliates to bid on any Department Contract, regardless of dollar amount, and will not approve the Contractor as a subcontractor on any Department contract.

(f) The Department may grant extensions of time during the prosecution of the work as allowed under these Specifications regardless of the Contractor's delinquency status.

8-9 Default and Termination of Contract.

8-9.1 Determination of Default: The following acts or omissions constitute acts of default and, except as to subparagraphs (i and k), the Department will give

notice, in writing, to the Contractor and his surety for any delay, neglect or default, if the Contractor:

(a) Fails to begin the work under the Contract within the time specified in the Notice to Proceed;

(b) Fails to perform the work with sufficient workmen and equipment or with sufficient materials to ensure prompt completion of the Contract;

(c) Performs the work unsuitably, or neglects or refuses to remove materials or to perform anew such work that the Engineer rejects as unacceptable and unsuitable;

(d) Discontinues the prosecution of the work, or fails to resume discontinued work within a reasonable time after the Engineer notifies the Contractor to do so;

(e) Becomes insolvent or is declared bankrupt, or files for reorganization under the bankruptcy code, or commits any act of bankruptcy or insolvency, either voluntarily or involuntarily;

(f) Allows any final judgment to stand against him unsatisfied for a period of ten calendar days;

(g) Makes an assignment for the benefit of creditors;

(h) Fails to comply with Contract requirements regarding minimum wage payments or EEO requirements;

(i) Fails to comply with the Engineer's written suspension of work order within the time allowed for compliance and which time is stated in that suspension of work order;

(j) For any other cause whatsoever, fails to carry on the work in an acceptable manner, or if the surety executing the bond, for any reasonable cause, becomes unsatisfactory in the opinion of the Department; or

(k) Fails to comply with 3-9.

For a notice based upon reasons stated in subparagraphs (a) through (h) and (j): if the Contractor, within a period of ten calendar days after receiving the notice described above, fails to correct the conditions of which complaint is made, the Department will, upon written certificate from the Engineer of the fact of such delay, neglect, or default and the Contractor's failure to correct such conditions, have full power and authority, without violating the Contract, to take the prosecution of the work out of the hands of the Contractor and to declare the Contractor in default.

If the Contractor, after having received a prior notice described above for any reason stated in subparagraph (b), (c), (d), (e), (f) or (h), commits a second or subsequent act of default for any reason covered by the same subparagraph (b), (c), (d), (e), (f) or (h) as stated in the prior notice, and regardless whether the specific reason is the same, then, regardless of whether the Contractor has cured the deficiency stated in that prior notice, the Department will, upon written certificate from the Engineer of the fact of such delay, neglect or default and the Contractor's failure to correct such conditions, have full power and authority, without any prior written notice to the Contractor and without violating the Contract, to take the prosecution of the work out of the hands of the Contractor and to declare the Contractor in default.

Regarding subparagraph (i), if the Contractor fails to comply with the Engineer's written suspension of work order within the time allowed for compliance and which time is stated in that suspension of work order, the Department will, upon written certificate from the Engineer of the fact of such delay and the Contractor's failure to correct that condition, have full power and authority, without violating the Contract, to immediately take the prosecution of the work out of the hands of the Contractor and to declare the Contractor in default.

Regarding subparagraph (k), if the Contractor fails to comply with 3-9, the Department will have full power and authority, without violating the Contract, to immediately take the prosecution of the work out of the hands of the Contractor and to declare the Contractor in default.

The Department has no liability for anticipated profits for unfinished work on a Contract that the Department has determined to be in default.

Notwithstanding the above, the Department shall have the right to declare the Contractor (or its "affiliate") in default and immediately terminate this Contract, without any prior notice to the Contractor, in the event the Contractor (or its "affiliate") is at any time "convicted" of a "contract crime," as these terms are defined in Section 337.165(1), Florida Statutes. The Department's right to default the Contractor (or its "affiliate") for "conviction" of a "contract crime" shall extend to and is expressly applicable to any and all Department Contracts that were either advertised for bid; for which requests for proposals or letters of interest were requested; for which an intent to award was posted or otherwise issued; or for which a Contract was entered into, after the date that the underlying or related criminal indictment, criminal information or other criminal charge was filed against the Contractor (or its "affiliate") that resulted in the "conviction." In the event the Department terminates this Contract for this reason, the Contractor shall hereby forfeit any claims for additional compensation, extra time, or anticipated profits. The Contractor shall only be paid for any completed work up to the date of termination. Further, the Contractor shall be liable for any and all additional costs and expenses the Department incurs in completing the Contract work after such termination.

8-9.2 Termination of Contract for Convenience: The Department may terminate the entire Contract or any portion thereof, if the Secretary determines that a termination is in the Department's interest. The Secretary will deliver to the Contractor a Written Notice of Termination specifying the extent of termination and the effective date.

When the Department terminates the entire Contract, or any portion thereof, before the Contractor completes all items of work in the Contract, the Department will make payment for the actual number of units or items of work that the Contractor has completed, at the Contract unit price, and according to the formulas and provisions set forth in 4-3.2 for items of work partially completed, and such payments will constitute full and complete compensation for such work or items. No payment of any kind or amount will be made for items of work not started. The Department will not consider any claim for loss of anticipated profits, or overhead of any kind (including home office and jobsite overhead or other indirect impacts) except as provided in 4-3.2 for partially completed work.

The Department will consider reimbursing the Contractor for actual cost of mobilization (when not otherwise included in the Contract) including moving equipment to the job where the volume of the work that the Contractor has completed is too small to compensate the Contractor for these expenses under the Contract unit prices.

The Department may purchase at actual cost acceptable materials and supplies procured for the work, that the Department has inspected, tested, and approved and that the Contractor has not incorporated in the work. Submit the proof of actual cost, as shown by receipted bills and actual cost records, at such points of delivery as the Engineer may designate.

Termination of a contract or a portion thereof, under the provisions of this Subarticle, does not relieve the Contractor or the surety of its responsibilities for the completed portion of the Contract or its obligations for and concerning any just claims arising out of the work performed.

All Contractor claims for additional payment, due to the Department's termination of the entire Contract or any portion thereof, must meet the requirements of 5-12.

8-9.3 Completion of Work by Department: Upon declaration of default, the Department will have full power to appropriate or use any or all suitable and acceptable materials and equipment on the site and may enter into an agreement with others to complete the work under the Contract, or may use other methods to complete the work in an acceptable manner. The Department will charge all costs that the Department incurs because of the Contractor's default, including the costs of completing the work under the Contract, against the Contractor. If the Department incurs such costs in an amount that is less than the sum that would have been payable under the Contract had the defaulting Contractor completed the work then the Department will pay the difference to the defaulting Contractor. If the Department incurs such costs in an amount that exceeds the sum that would have been payable under the Contract, then the Contractor and the surety shall be liable and shall pay the State the amount of the excess.

If, after the ten day notice period and prior to any action by the Department to otherwise complete the work under the Contract, the Contractor establishes his intent to prosecute the work in accordance with the Department's requirements, then the Department may allow the Contractor to resume the work, in which case the Department will deduct from any monies due or that may become due under the Contract, any costs to the Department incurred by the delay, or from any reason attributable to the delay.

8-10 Liquidated Damages for Failure to Complete the Work.

8-10.1 Highway Code Requirements Pertaining to Liquidated Damages: Section 337.18, paragraph (2) of the Florida Statutes, requires that the Department adopt regulations for the determination of default and provides that the Contractor pay liquidated damages to the Department for any failure of the Contractor to complete the Contract work within the Contract Time. These Code requirements govern, and are herewith made a part of the Contract.

8-10.2 Amount of Liquidated Damages: Applicable liquidated damages are the amounts established in the following schedule:

Original Contract Amount	Daily Charge Per Calendar Day
$50,000 and under	$278
Over $50,000 but less than $250,000	$388
$250,000 but less than $500,000	$566
$500,000 but less than $2,500,000	$1,148
$2,500,000 but less than $5,000,000	$1,914
$5,000,000 but less than $10,000,000	$2,514
$10,000,000 but less than $15,000,000	$3,300
$15,000,000 but less than $20,000,000	$3,782
$20,000,000 and over	$5,684 plus
	0.00005 of any amount over $20 million

8-10.3 Determination of Number of Days of Default: For all contracts, regardless of whether the Contract Time is stipulated in calendar days or working days, the Engineer will count default days in calendar days.

8-10.4 Conditions under which Liquidated Damages are Imposed: If the Contractor or, in case of his default, the surety fails to complete the work within the time stipulated in the Contract, or within such extra time that the Department may have granted then the Contractor or, in case of his default, the surety shall pay to the Department, not as a penalty, but as liquidated damages, the amount so due as determined by the Code requirements, as provided in 8-10.2.

8-10.5 Right of Collection: The Department has the right to apply, as payment on such liquidated damages, any money the Department owes the Contractor.

8-10.6 Allowing Contractor to Finish Work: The Department does not waive its right to liquidated damages due under the Contract by allowing the Contractor to continue and to finish the work, or any part of it, after the expiration of the Contract Time including granted time extensions.

8-10.7 Completion of Work by Department: In the case of a default of the Contract and the completion of the work by the Department, the Contractor and his surety are liable for the liquidated damages under the Contract, but the Department will not charge liquidated damages for any delay in the final completion of the Department's performance of the work due to any unreasonable action or delay on the part of the Department.

8-11 Release of Contractor's Responsibility.

The Department considers the Contract complete when the Contractor has completed all work and the Department has accepted the work. The Department will then release the Contractor from further obligation except as set forth in his bond, and except as provided in 5-13.

8-12 Recovery of Damages Suffered by Third Parties.

In addition to the damages provided for in 8-10.2 and pursuant to Section 337.18 of the Florida Statutes, when the Contractor fails to complete the work within the Contract Time or within such additional time that the Department may grant the Department may recover from the Contractor amounts that the Department pays for damages suffered by third parties unless the failure to timely complete the work was caused by the Department's act or omission.

SECTION 9
MEASUREMENT AND PAYMENT

9-1 Measurement of Quantities.

9-1.1 Measurement Standards: The Engineer will measure all work completed under the Contract in accordance with the United States Standard Measures.

9-1.2 Method of Measurements: The Engineer will take all measurements horizontally or vertically.

9-1.3 Determination of Pay Areas:

9-1.3.1 Final Calculation: When measuring items paid for on the basis of area of finished work, where the pay quantity is designated to be determined by calculation, the Engineer will use lengths and widths in the calculations based on the station to station dimensions shown on the plans; the station to station dimensions actually constructed within the limits designated by the Engineer; or the final dimensions measured along the surface of the completed work within the neat lines shown on the plans or designated by the Engineer. The Engineer will use the method or combination of methods of measurement that reflect, with reasonable accuracy, the actual surface area of the finished work as the Engineer determines.

9-1.3.2 Plan Quantity: When measuring items paid for on the basis of area of finished work, where the pay quantity is designated to be the plan quantity, the Engineer will determine the final pay quantity based on the plan quantity subject to the provisions of 9-3.2. Generally, the Engineer will calculate the plan quantity using lengths based on station to station dimensions and widths based on neat lines shown in the plans.

9-1.4 Construction Outside Authorized Limits: The Engineer will not pay for surfaces constructed over a greater area than authorized, or for material that the Contractor has moved from outside of slope stakes and lines shown on the plans, except where the Engineer provides written instruction for the Contractor to perform such work.

9-1.5 Truck Requirements: Provide all trucks with numbers and certify that all trucks used have a manufacturer's certification or permanent decal showing the truck capacity rounded to the nearest tenth of a cubic yard placed on both sides of the truck. This capacity will include the truck body only and any side boards added will not be included in the certified truck body capacity. Ensure the lettering and numbers are legible for identification purposes at all times.

9-1.6 Ladders and Instrument Stands for Bridge Projects: On bridge projects, in order to facilitate necessary measurements, provide substantial ladders to the tops of piers and bents, and place and move such ladders as the Engineer directs.

For bridge projects crossing water or marshy areas, supply fixed stands for instrument mounting and measurements, in accordance with the details stipulated in the Specifications for the project.

9-2 Scope of Payments.

9-2.1 Items Included in Payment: Accept the compensation as provided in the Contract as full payment for furnishing all materials and for performing all work contemplated and embraced under the Contract; also for all loss or damage arising out of the nature of the work or from the action of the elements, or from any unforeseen difficulties or obstructions which may arise or be encountered in the prosecution of the work until its final acceptance; also for all other costs incurred under the provisions of Division I.

For any item of work contained in the proposal, except as might be specifically provided otherwise in the basis of payment clause for the item, include in the Contract unit price (or lump sum price) for the pay item or items the cost of all labor, equipment, materials, tools and incidentals required for the complete item of work, including all requirements of the Section specifying such item of work, except as specifically excluded from such payments.

9-2.1.1 Fuels: The Department will, in the Contract Documents, provide an estimated quantity for fuel requirements for gasoline and diesel to cover the work specified in the Contract. Price adjustments will be made only for the amount of gasoline and diesel fuel estimated by the Department as required to complete the Contract. The requirement of each type of fuel for each pay item is estimated by multiplying the Department's standard fuel factor for that pay item by the quantity of that pay item. Price adjustments made for fuel used after expiration of the last allowable Contract Day (including any time extensions) will be limited to the increases or decreases dictated by the index in effect on the last allowable Contract Day. On Contracts with an original Contract Time in excess of 120 calendar days, the Department will make price adjustments on each applicable progress estimate to reflect increases or decreases in the price of gasoline and diesel from those in effect during the month in which bids were received. The Contractor will not be given the option of accepting or rejecting these adjustments. Price adjustments for these fuels will be made only when the current fuel price (CFP) varies by more than 5% from the price prevailing in the month when bids were received (BFP), and then only on the portion that exceeds 5%.

Price adjustments will be based on the monthly bulk average price for gas and diesel as derived by the Department. These average indexes shall be determined by averaging bulk fuel prices on the first day of each month as quoted by major oil companies that are reasonably expected to furnish fuel for projects in the State of Florida. Average price indices for gasoline and diesel will be available on the Construction Office website before the 15th of each month, at the following URL:
www.dot.state.fl.us/construction/fuel&Bit/Fuel&Bit.htm .

Payment will be based on the quantities shown on the progress estimate on all items for which established standard fuel factors are on a file maintained by the Department.

Price adjustments will not be made for Items of work added by contingency supplemental agreement, supplemental agreement, field supplemental agreement, or work orders.

Payment on progress estimates will be adjusted to reflect adjustments in the prices for gasoline and diesel in accordance with the following:

When fuel prices have decreased between month of bid and month of this progress estimate:

Ai = Fi (Pi - 95 Pb) during a period of decreasing prices.

Ai = Total dollar amount - positive or negative - of the cost adjustment for each kind of fuel used by the Contractor during the month "i."

Fi = Total gallons calculated as being used during the month.

Pi = Average price for fuel prevailing during month "i."

Pb = Average price for fuel prevailing during the month "b" when bids were received on this Contract.

When fuel prices have increased between month of bid and month of this progress estimate:

Ai = Fi (Pi - 1.05 Pb) during a period of increasing prices.

Ai = Total dollar amount - positive or negative - of the cost adjustment for each kind of fuel used by the Contractor during the month "i."

Fi = Total gallons calculated as being used during the month.

Pi = Average price for fuel prevailing during month "i."

Pb = Average price for fuel prevailing during the month "b" when bids were received on this Contract.

Payment will be made on the current progress estimate to reflect the index difference at the time work was performed.

Adjustments will be paid or charged to the Prime Contractor only. Any Contractor receiving an adjustment under this provision shall distribute the proper proportional part of such adjustment to subcontractors who perform applicable work.

9-2.1.2 Bituminous Material: On Contracts having an original Contract Time of more than 365 calendar days, or more than 5,000 tons of asphalt concrete, the Department will adjust the bid unit price for bituminous material, excluding cutback and emulsified asphalt to reflect increases or decreases in the Asphalt Price Index (API) of bituminous material from that in effect during the month in which bids were received. The Contractor will not be given the option of accepting or rejecting this adjustment. Bituminous adjustments will be made only when the current API (CAPI) varies by more than 5% of the API prevailing in the month when bids were received (BAPI), and then only on the portion that exceeds 5%.

The Department will determine the API for each month by averaging quotations in effect on the first day of the month at all terminals that could reasonably be expected to furnish bituminous material to projects in the State of Florida.

The API will be available on the Construction Office website before the 15th of each month at the following URL:
www.dot.state.fl.us/construction/fuel&Bit/Fuel&Bit.htm .

Payment on progress estimates will be adjusted to reflect adjustments in the prices for bituminous materials in accordance with the following:

$ Adjustment = (ID)(Gallons)

Where ID = Index Difference = [CAPI - 0.95(BAPI)] when the API has decreased between the month of bid and month of this progress estimate.

Where ID = Index Difference = [CAPI - 1.05(BAPI)] when the API has increased between the month of bid and month of this progress estimate.

Payment will be made on the current progress estimate to reflect the index difference at the time work was performed.

For asphalt concrete items payable by the ton, the number of gallons will be determined assuming a mix design with 6.25% liquid asphalt weighing 8.58 lb/gal.

Asphalt concrete items payable by the square yard will be converted to equivalent tons assuming a weight of 100 lb/yd^2 per inch.

9-2.2 Non-Duplication of Payment: In cases where the basis of payment clause in these Specifications relating to any unit price in the bid schedule requires that the unit price cover and be considered compensation for certain work or material essential to the item, the Department will not measure or pay for this same work or material under any other pay item that may appear elsewhere in these Specifications.

9-3 Compensation for Altered Quantities.

9-3.1 General: When alteration in plans or quantities of work not requiring a supplemental agreement as hereinbefore provided for are offered and performed, the Contractor shall accept payment in full at Contract unit bid prices for the actual quantities of work done, and no allowance will be made for increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor, resulting either directly from such alterations, or indirectly from unbalanced allocation among the Contract items of overhead expense on the part of the bidder and subsequent loss of expected reimbursement therefore, or from any other cause.

Compensation for alterations in plans or quantities of work requiring supplemental agreements shall be stipulated in such agreement, except when the Contractor proceeds with the work without change of price being agreed upon, the Contractor shall be paid for such increased or decreased quantities at the Contract unit prices bid in the Proposal for the items of work. If no Contract unit price is provided in the Contract, and the parties cannot agree as to a price for the work, the Contractor agrees to do the work in accordance with 4-3.2.

9-3.2 Payment Based on Plan Quantity:

9-3.2.1 Error in Plan Quantity: As used in this Article, the term "substantial error" is defined as the smaller of (a) or (b) below:

(a) a difference between the original plan quantity and final quantity of more than 5%,

(b) a change in quantity which causes a change in the amount payable of more than $5,000.

On multiple job Contracts, changes made to an individual pay item due to substantial errors will be based on the entire Contract quantity for that pay item.

Where the pay quantity for any item is designated to be the original plan quantity, the Department will revise such quantity only in the event that the

Department determines it is in substantial error. In general, the Department will determine such revisions by final measurement, plan calculations, or both, as additions to or deductions from plan quantities.

In the event that either the Department or the Contractor contends that the plan quantity for any item is in error and additional or less compensation is thereby due, the claimant shall submit, at their own expense, evidence of such in the form of acceptable and verifiable measurements or calculations. The Department will not revise the plan quantity solely on the basis of a particular method of construction that the Contractor selects. For earthwork items, the claimant must note any differences in the original ground surfaces from that shown in the original plan cross-sections that would result in a substantial error to the plan quantity, and must be properly documented by appropriate verifiable level notes, acceptable to both the Contractor and the Department, prior to disturbance of the original ground surface by construction operations. The claimant shall support any claim based upon a substantial error for differences in the original ground surface by documentation as provided above.

9-3.2.2 Authorized Changes in Limits of Work: Where the Department designates the pay quantity for any item to be the original plan quantity and authorizes a plan change which results in an increase or decrease in the quantity of that item, the Department will revise the plan quantity accordingly. In general, the Department will determine such revisions by final measurement, plan calculations or both.

9-3.2.3 Specified Adjustments to Pay Quantities: Do not apply the limitations specified in 9-3.2.1 and 9-3.2.2 to the following:

(1) Where these Specifications or Special Provisions provide that the Department determines the pay quantity for an item on the basis of area of finished work adjusted in accordance with the ratio of measured thickness to nominal thickness.

(2) Where these Specifications provide for a deduction due to test results falling outside of the allowable specified tolerances.

(3) To payment for extra length fence posts, as specified in 550-6.3.

9-3.3 Lump Sum Quantities:

9-3.3.1 Error in Lump Sum Quantity: Where the Department designates the pay quantity for an item to be a lump sum and the plans show an estimated quantity, the Department will adjust the lump sum compensation only in the event that either the Contractor submits satisfactory evidence or the Department determines and furnishes satisfactory evidence that the lump sum quantity shown is in substantial error as defined in 9-3.2.1.

9-3.3.2 Authorized Changes in Work: Where the Department designates the pay quantity for an item to be a lump sum and the plans show an estimated quantity, the Department will adjust compensation for that item proportionately when an authorized plan change is made which results in an increase or decrease in the quantity of that item. When the plans do not show an estimated plan quantity or the applicable specifications do not provide adjustments for contingencies, the Department will compensate for any authorized plan change resulting in an increase or decrease in the cost of

acceptably completing the item by establishing a new unit price through a supplemental agreement as provided in 4-3.2.

9-3.4 Deviation from Plan Dimensions: If the Contractor fails to construct any item to plan or to authorized dimensions within the specified tolerances, the Engineer, at his discretion will: require the Contractor to reconstruct the work to acceptable tolerances at no additional cost to the Department; accept the work and provide the Contractor no pay; or accept the work and provide the Contractor a reduced final pay quantity or reduced unit price. The Department will not make reductions to final pay quantities for those items designated to be paid on the basis of original plan quantity or a lump sum quantity under the provisions of this Article unless such reduction results in an aggregate monetary change per item of more than $100, except that for earthwork items, the aggregate change must exceed $5,000 or 5% of the original plan quantity, whichever is smaller. If, in the opinion of the Engineer, the Contractor has made a deliberate attempt to take advantage of the construction tolerances as defined in 120-12.1 to increase borrow excavation in fill sections or to decrease the required volume of roadway or lateral ditch excavation or embankment, the Department will take appropriate measurements and will apply reductions in pay quantities. The Department will not use the construction tolerance, as defined in 120-12.1, as a pay tolerance. The construction tolerance is not to be construed as defining a revised authorized template.

9-4 Deleted Work.

The Department will have the right to cancel the portions of the Contract relating to the construction of any acceptable item therein, by the payment to the Contractor of a fair and equitable amount covering all items of cost incurred prior to the date that the Engineer cancels the work.

9-5 Partial Payments.

9-5.1 General: The Engineer will make partial payments on monthly estimates based on the amount of work that the Contractor completes during the month (including delivery of certain materials, as specified herein below). The Engineer will make approximate monthly payments, and the Department will correct all partial estimates and payments in the subsequent estimates and in the final estimate and payment.

The Department will base the amount of such payments on the total value of the work that the Contractor has performed to the date of the estimate, based on the quantities completed and the Contract prices, less payments previously made and less any retainage withheld.

Retainage will not be withheld until the percent of allowable Contract time used exceeds 75%. From that time forward, the Department will withhold retainage of 10% of the amount due on the current estimate as retainage when the percent of allowable Contract time used exceeds the percent of Contract amount earned by more than 15%.

Contract amount is defined as the original Contract amount adjusted by approved supplemental agreements.

Contract time is defined as the original Contract time adjusted by approved Contract time extensions.

Retainage will be determined for each job on multiple job Contracts. The Department will not accept Securities, Certificates of Deposit or letters of credit as a replacement for retainage. Amounts withheld will not be released until payment of the final estimate.

9-5.2 Unsatisfactory Payment Record: In accordance with Sections 255.05 and 337.16 of the Florida Statutes, and the rules of the Department, the Department may disqualify the Contractor from bidding on future Department contracts if the Contractor's payment record in connection with contract work becomes unsatisfactory. The Department may also disqualify the surety from issuing bonds for future Department contracts if they similarly fail to perform under the terms of their bond.

9-5.3 Withholding Payment:

9-5.3.1 Withholding Payment for Defective Work: If the Department discovers any defective work or material prior to the final acceptance, or if the Department has a reasonable doubt as to the integrity of any part of the completed work prior to final acceptance, then the Department will not allow payment for such defective or questioned work until the Contractor has remedied the defect and removed any causes of doubt.

9-5.3.2 Withholding Payment for Failure to Comply: The Department will withhold progress payments from the Contractor if he fails to comply with any or all of the following within 60 days after beginning work:

(a) comply with and submit required paperwork relating to prevailing wage rate provisions, Equal Employment Opportunity, On-The-Job Training, and Affirmative Action;

(b) comply with the requirement to all necessary information, including actual payments to DBEs, all other subcontractors and major suppliers, through the Internet based Equal Opportunity Reporting System;

(c) comply with or make a good faith effort to ensure employment opportunity for minorities and females in accordance with the required contract provisions for Federal Aid Construction Contracts, and

(d) comply with or make a good faith effort to meet On-The-Job Training goals.

The Department will withhold progress payments until the Contractor has satisfied the above conditions.

9-5.4 Release of Retainage After Acceptance: When the Contractor has furnished the Department with all submittals required by the Contract, such as invoices, EEO reports, materials certifications, certification of materials procured, etc., (excluding Contractor's letter of acceptance of final amount due and Form 21-A release) and the Engineer has determined that the measurement and computation of pay quantities is correct, the Department may reduce the retainage to $1,000 plus any amount that the Department elects to deduct for defective work as provided in 9-5.3.

The Department will not allow a semifinal estimate under the provisions of the above paragraphs unless the time elapsing between (1) acceptance of the project and receipt of all test reports, invoices, etc., and (2) submission of the

final estimate to the Contractor for acceptance, exceeds or is expected to exceed ten days.

The Department may deduct from payment estimates any sums that the Contractor owes to the Department on any account. Where more than one project or job (separate job number) is included in the Contract, the Department will distribute the reduced retainage as provided in the first paragraph of this Subarticle to each separate project or job in the ratio that the Contract value of the work for the particular job bears to the total Contract amount.

9-5.5 Partial Payments for Delivery of Certain Materials:

9-5.5.1 General: The Department will allow partial payments for new materials that will be permanently incorporated into the project and are stockpiled in approved locations in the project vicinity. Stockpile materials so that they will not be damaged by the elements and in a manner that identifies the project on which they are to be used.

The following conditions apply to all payments for stockpiled materials:

(1) There must be reasonable assurance that the stockpiled material will be incorporated into the specific project on which partial payment is made.

(2) The stockpiled material must be approved as meeting applicable specifications.

(3) The total quantity for which partial payment is made shall not exceed the estimated total quantity required to complete the project.

(4) The Contractor shall furnish the Engineer with copies of certified invoices to document the value of the materials received. The amount of the partial payment will be determined from invoices for the material up to the unit price in the Contract.

(5) Delivery charges for materials delivered to the jobsite will be included in partial payments if properly documented.

(6) Partial payments will not be made for materials which were stockpiled prior to award of the Contract for a project.

9-5.5.2 Partial Payment Amounts: The following partial payment restrictions apply:

(1) Partial payments less than $5,000 for any one month will not be processed.

(2) Partial payments for structural steel and precast prestressed items will not exceed 85% of the bid price for the item. Partial payments for all other items will not exceed 75% of the bid price of the item in which the material is to be used.

(3) Partial payment will not be made for aggregate and base course material received after paving or base construction operations begin except when a construction sequence designated by the Department requires suspension of paving and base construction after the initial paving operations, partial payments will be reinstated until the paving and base construction resumes.

9-5.5.3 Off Site Storage: If the conditions of 9-5.5.1 are satisfied, partial payments will be allowed for materials stockpiled in approved in-state locations. Additionally, partial payments for materials stockpiled in approved out-of-state

locations will be allowed if the conditions of 9-5.5.1 and the following conditions are met:

(1) Furnish the Department a Materials Bond stating the supplier guarantees to furnish the material described in the Contract to the Contractor and Department. Under this bond, the Obligor shall be the material supplier and the Obligees shall be the Contractor and the Florida Department of Transportation. The bond shall be in the full dollar amount of the bid price for the materials described in the contract.

(2) The following clauses must be added to the construction Contract between the Contractor and the supplier of the stockpiled materials:

"Notwithstanding anything to the contrary, <supplier> will be liable to the Contractor and the Florida Department of Transportation should <supplier> default in the performance of this agreement."

"Notwithstanding anything to the contrary, this agreement, and the performance bond issued pursuant to this agreement, does not alter, modify, or otherwise change the Contractor's obligation to furnish the materials described in this agreement to the Florida Department of Transportation."

(3) The agreement between the Contractor and the supplier of the stockpiled materials must include provisions that the supplier will store the materials and that such materials are the property of the Contractor.

9-5.6 Certification of Payment to Subcontractors: The term "subcontractor," as used herein, includes persons or firms furnishing materials or equipment incorporated into the work or stockpiled for which the Department has made partial payment and firms working under equipment-rental agreements. The Contractor is required to pay all subcontractors for satisfactory performance of their Contracts before the Department will make a further progress (partial) payment. The Contractor shall also return all retainage withheld to the subcontractors within 30 days after the subcontractor's work is satisfactorily complete, as determined by the Department. Prior to receipt of any progress (partial) payment, the prime contractor shall certify that all subcontractors having an interest in the Contract were paid for satisfactory performance of their Contracts and that the retainage is returned to subcontractors within 30 days after satisfactory completion of the subcontractor's work. Provide this certification in the form designated by the Department.

Within 30 days of the Contractor's receipt of the final progress payment or any other payments thereafter, except the final payment, the Contractor shall pay all subcontractors and suppliers having an interest in the Contract for all work completed and materials furnished. The Department will honor an exception to the above when the Contractor demonstrates good cause for not making any required payment and furnishes written notification of any such good cause to both the Department and the affected subcontractors or suppliers within said 30 day period.

9-6 Record of Construction Materials.

9-6.1 General: For all construction materials used in the construction of the project, (except materials exempted by 9-6.2), preserve for the Department's inspection the invoices and records of the materials for a period of three years

from the date of completion of the project. Apply this requirement when subcontractors purchase materials, and obtain the invoices and other materials records from the subcontractors. By providing the materials, the Contractor certifies that all invoices will be maintained for the required period.

9-6.2 Non-Commercial Materials: The provisions of 9-6.1 do not apply to materials generally classed as non-commercial, such as fill materials, local sand, sand-clay, or local materials used as stabilizer.

9-7 Disputed Amounts Due the Contractor.

The Department reserves the right to withhold from the final estimate any disputed amounts between the Contractor and the Department. The Department will release all other amounts due, as provided in 9-8.

9-8 Acceptance and Final Payment.

9-8.1 Acceptance and Final Payment Documents: Whenever the Contractor has completely performed the work provided for under the Contract and the Engineer has performed a final inspection and made final acceptance (as provided in 5-10 and 5-11), and subject to the terms of 8-11, the Engineer will prepare a final estimate showing the value of the work as soon as the Engineer makes the necessary measurements and computations. The Engineer will correct all prior estimates and payments in the final estimate and payment. The Department will pay the estimate, less any sums that the Department may have deducted or retained under the provisions of the Contract, as soon as practicable after final acceptance of the work, along with all executed supplemental agreements received after final acceptance.

If the Contractor fails to furnish all required Contract Documents as listed in (a) through (g) below within 90 days of the Department's offer of final payment or request for refund of overpayment, the Department may suspend the Contractor's Certificate of Qualification under the provisions of Florida Administrative Code 14-22.

(a) The Contractor has agreed in writing to accept the balance due or refund the overpayment, as determined by the Department, as full settlement of his account under the Contract and of all claims in connection therewith, or the Contractor, has through the use of the Qualified Acceptance Letter, accepted the balance due or refunded the overpayment, as determined by the Department, with the stipulation that his acceptance of such payment or the making of such refund does not constitute any bar, admission, or estoppel, or have any effect as to those payments in dispute or the subject of a pending claim between the Contractor and the Department. To receive payment based on a Qualified Acceptance Letter, define in writing the dispute or pending claim with full particular of all items of all issues in dispute, including itemized amounts claimed for all particulars of all items, and submit it as part of the Qualified Acceptance Letter. The Contractor further agrees, by submitting a Qualified Acceptance Letter that any pending or future arbitration claim or suit is limited to those particulars, including the itemized amounts, defined in the original Qualified Acceptance Letter, and that he will commence with any such arbitration claim or suit within 820 calendar days from and after the time of final acceptance of the work and that his failure to

file a formal claim within this period constitutes his full acceptance of the Engineer's final estimate and payment. The overpayment refund check from the Contractor, if required, will be considered a part of any Acceptance Letter executed.

(b) The Contractor has properly maintained the project, as specified hereinbefore.

(c) The Contractor has furnished a sworn affidavit to the effect that the Contractor has paid all bills and no suits are pending (other than those exceptions listed, if any) in connection with work performed under the Contract and that the Contractor has not offered or made any gift or gratuity to, or made any financial transaction of any nature with, any employee of the Department in the performance of the Contract. Include with the listed tort liability exceptions, if any, evidence of adequate insurance coverage as required in 7-13.

(d) The surety on the Contract bond consents, by completion of their portion of the affidavit and surety release subsequent to the Contractor's completion of his portion, to final payment to the Contractor and agrees that the making of such payment does not relieve the surety of any of its obligations under the bond.

(e) The Contractor has complied with and settled all requirements pertaining to any wage-rate provisions.

(f) The Contractor has furnished all required mill tests and analysis reports to the Engineer.

(g) The Contractor has furnished the Construction Compliance with Specifications and Plans Certification. Provide the Engineer with a notarized final certification of compliance with the requirements of Section 105 to accompany the final estimate. Certification must be on a form provided by the Engineer.

9-8.2 Review of Engineer's Final Estimate: The Department may review the Engineer's final estimate and make changes as necessary. If changes are made, the Contractor will be so notified in writing in the "Notification of Findings Due to Additional Review". This notification letter will detail the changes made as a result of the review, and will stipulate the actions to be taken by the Department and those required by the Contractor. The issuance of a "Notification of Findings Due to Additional Review" will not impact the requirements of 9-8.1, above.

Complete the required actions and return the signed "Notification of Findings Due to Additional Review" to the Department within the timeframe specified in 9-8.1. If the "Notification of Findings Due to Additional Review" is received after the time has expired in 9-8.1, return to the Department within 30 days signifying agreement or disagreement with the findings. For disagreement items, provide a full explanation including the item(s) and amount. For any claim or part of a claim that pertains solely to the "Notification of Findings Due to Additional Review" disputes, submit full and complete claim documentation as described in 5-12.3 as to such claim dispute issues within 90 days of receipt of the notification. Failure to return the signed notification or to furnish such claim documentation within the time frames specified may result in suspension of the

Contractor's Certificate of Qualification under the provisions of Florida Administrative Code 14-22.

9-9 Interest Due on Delayed Payments.

The Department will determine and pay any interest due the Contractor for delays in final payment in accordance with Section 337.141 of the Florida Statutes.

9-10 Offsetting Payments.

Section 337.145 of the Florida Statutes, providing for offsetting payments to the Contractor, is hereby made a part of this Contract:

(1) After settlement, arbitration, or final adjudication of any claim of the Department for work done pursuant to a construction contract with any party, the Department may offset such amount from payments due for work done on any construction contract, excluding amounts owed to subcontractors, suppliers, and laborers, which it has with the party owing such amount if, upon demand, payment of the amount is not made within 60 days to the Department.

(2) Offsetting any amount pursuant to (1) above shall not be considered a breach of Contract by the Department.

DIVISION II
Construction Details

GENERAL CONSTRUCTION OPERATIONS

SECTION 100
CONSTRUCTION EQUIPMENT-GENERAL REQUIREMENTS

100-1 General.

Unless restricted to a specific type by the Contract Documents or the Engineer, the Contractor may perform the work using equipment, tools, machinery, etc., of his own choosing. Provide a unique alphanumeric identification number on all equipment (other than small tools) used on the project. This number shall be a minimum of 2 inches high and appear on both sides of the equipment. Place the number in such a manner so as to contrast sharply in color with the background on which it is placed. Ensure that the number, which may be painted or otherwise permanently affixed to the equipment, is clearly legible at all times. Provide, upon submittal of Notice of Intent to Claim or Preliminary Time Extension Request in accordance with 5-12.2, a list showing all equipment (other than small tools) for which the Contractor may request compensation, its identification number with serial number, manufacturer, year manufactured, model and description. Update this list to account for equipment moving to or from the project and provide certification weekly, by close of business on Friday, the equipment, its unique number and the dates and hours that the equipment was assigned to this project for the proceeding week. No compensation will be made for any equipment used during any time period when the said equipment is not listed in the weekly certification. Failure to provide this information in the time specified may result in the Engineer withholding all Contract Payments until receipt of such information. Note that facilities to be constructed under the Contract are adequate to support only their design loads in their completed construction stage. If the Contractor's equipment or procedures during construction damage any part of the facility, the Contractor will replace or repair it as directed by the Engineer at no expense to the Department.

100-2 Equipment Condition and Approval.

100-2.1 Approval: Provide onsite and in due time prior to its need, in working condition, all equipment to be used in construction of the project, subject to approval or disapproval by the Engineer. Use only factory recommended exhaust mufflers on internal combustion engines. Remove from the job, alter, or repair equipment which is disapproved by the Engineer. Ensure that the number of units, the sizes, etc., of the equipment on hand are adequate to complete the work within the Contract Time.

100-2.2 Maintenance: Consistent with public interest, safety, and good practice, maintain all equipment, tools, and machinery used in a satisfactory working condition throughout the period they are on the job site. Also, provide adequate equipment maintenance procedures to promote continuous satisfactory

working condition and minimize noise pollution caused by construction equipment.

100-2.3 Stationary Equipment: Screen all stationary equipment such as pumps, compressors, generators, etc., from noise sensitive receivers if that equipment is to operate beyond normal working hours. If it is feasible, screen this equipment during normal working hours to reduce noise impacts.

100-3 Experimental Equipment.

100-3.1 General: To encourage the development and use of new or improved equipment, the Engineer may grant the Contractor permission to use equipment other than that normally used and currently accepted, upon approval of the Contractor's written request for permission to use such equipment in place of the normally used equipment. The Engineer, before considering or granting such request, may require that the Contractor establish, at his own expense, satisfactory evidence that the proposed equipment will produce work equal in quality to that produced by the specified equipment, and meets any applicable local, state or federal noise abatement laws, by-laws, ordinances and regulation in effect.

100-3.2 Conditions of Approval: When the Engineer grants permission for the use of new or improved equipment, understand that the Engineer gives such permission for the purpose of testing the quality of work this equipment actually produces. The Engineer will maintain the right to retract permission for use of the equipment at any time that, in his opinion, the Contractor does not obtain results that are at least equal to the results obtainable with currently accepted equipment. Upon the Engineer's withdrawal of such permission for the use of the equipment, use the equipment currently accepted and normal for the work, and remove and dispose of, or otherwise remedy, at no expense to the Department, any work which the Engineer considers defective or unsatisfactory as a result of the use of such experimental equipment. If the Engineer approved the use of particular equipment on a particular project, the Engineer's approval does not extend to the use of the particular equipment on any other project. Furthermore, the Contractor is fully responsible for producing finished work of the quality required by the Contract Documents.

SECTION 101
MOBILIZATION

101-1 Description.

Perform preparatory work and operations in mobilizing for beginning work on the project, including, but not limited to, those operations necessary for the movement of personnel, equipment, supplies, and incidentals to the project site and for the establishment of temporary offices, buildings, safety equipment and first aid supplies, and sanitary and other facilities.

Include the costs of bonds and any required insurance and any other preconstruction expense necessary for the start of the work, excluding the cost of construction materials.

101-2 Basis of Payment.

101-2.1 When a Separate Item is Included in the Proposal: When the proposal includes a separate item of payment for this work, the work and incidental costs specified as being covered under this Section will be paid for at the Contract lump sum price for the item of Mobilization.

Payment will be made under:

Item No. 101- 1- Mobilization -lump sum.

101-2.2 Partial Payments: When the proposal includes a separate pay item for Mobilization and the Notice to Proceed has been issued, partial payments will be made in accordance with the following:

For contracts of 120 contract days duration or less, partial payment will be made at 50% of the bid price per month for the first two months. For contracts in excess of 120 contract days duration, partial payment will be made at 25% of the bid price per month for the first four months. In no event shall more than 50% of the bid price be paid prior to commencing construction on the project site.

Total partial payments for Mobilization on any project, including when more than one project or job is included in the Contract, will be limited to 10% of the original Contract amount for that project. Any remaining amount will be paid upon completion of all work on the Contract.

Retainage, as specified in 9-5, will be applied to all partial payments.

Partial payments made on this item will in no way act to preclude or limit any of the provisions for partial payments otherwise provided for by the Contract.

101-2.3 When No Separate Item is Included in the Proposal: When the proposal does not include a separate item for Mobilization, all work and incidental costs specified as being covered under this Section will be included for payment under the several scheduled items of the overall Contract, and no separate payment will be made therefore.

SECTION 102
MAINTENANCE OF TRAFFIC

102-1 Description.

Maintain traffic within the limits of the project for the duration of the construction period, including any temporary suspensions of the work. Construct and maintain detours. Provide facilities for access to residences, businesses, etc., along the project. Furnish, install and maintain traffic control and safety devices during construction. Furnish and install work zone pavement markings for maintenance of traffic in construction areas. Provide any other special requirements for safe and expeditious movement of traffic specified on the plans. Maintenance of Traffic includes all facilities, devices and operations as required for safety and convenience of the public within the work zone.

Do not maintain traffic over those portions of the project where no work is to be accomplished or where construction operations will not affect existing roads.

Do not obstruct or create a hazard to any traffic during the performance of the work, and repair any damage to existing pavement open to traffic.

Include the cost of any work that is necessary to meet the requirements of the Contract Documents under the MOT pay item, when there is not a pay item provided.

102-2 Materials.

Meet the following requirements:

Bituminous Adhesive .....Section 970
Work Zone Pavement Markings..... 971-1 and 971-3
Paint.....Section 971
Glass Spheres .....Section 971
Temporary Traffic Control Device Materials.....Section 990
Retroreflective and Nonreflective Sheeting for
Traffic Control Devices.....Section 994

102-2.1 Temporary Traffic Control Devices: Use only the materials meeting the requirements of Section 990, Design Standards and the MUTCD.

102-2.2 Detour: Provide all materials for the construction and maintenance of all detours.

102-2.3 Commercial Materials for Driveway Maintenance: Provide materials of the type typically used for base, including recycled asphalt pavement material, and having stability and drainage properties that will provide a firm surface under wet conditions.

102-3 Specific Requirements.

102-3.1 Beginning Date of Contractor's Responsibility:
Maintain traffic starting the day work begins on the project or on the first day Contract time is charged, whichever is earlier.

102-3.2 Worksite Traffic Supervisor: Provide a Worksite Traffic Supervisor in accordance with Section 105. Provide the Worksite Traffic Supervisor with all equipment and materials needed to set up, take down, maintain traffic control, and handle traffic-related situations.

Ensure that the Worksite Traffic Supervisor performs the following duties:

1. Performs on site direction of all traffic control on the project.
2. Is on site during all set up and take down, and performs a drive through inspection immediately after set up.
3. Is on site during all nighttime operations to ensure proper Maintenance of Traffic.
4. Immediately corrects all safety deficiencies and does not permit minor deficiencies that are not immediate safety hazards to remain uncorrected for more than 24 hours.
5. Is available on a 24-hour per day basis and present within 45 minutes after notification of an emergency situation and is prepared to positively respond to repair the work zone traffic control or to provide alternate traffic arrangements.

6. Conducts daily daytime and weekly nighttime inspections of projects with predominately daytime work activities, and daily nighttime and weekly daytime inspections of projects with predominantly nighttime work activities of all traffic control devices, traffic flow, pedestrian, bicyclist, and business accommodations.

Advise the project personnel of the schedule of these inspections and give them the opportunity to join in the inspection as is deemed necessary. Submit a comprehensive weekly report, using the Department's currently approved form, to the Engineer detailing the condition of all traffic control devices (including pavement markings) being used. Include assurances in the inspection report that pedestrians are accommodated with a safe travel path around work sites and safely separated from mainline traffic, that existing or detoured bicyclist paths are being maintained satisfactorily throughout the project limits, and that existing businesses in work areas are being provided with adequate entrances for vehicular and pedestrian traffic during business hours. Have the Worksite Traffic Supervisor sign the report and certify that all of the above issues are being handled in accordance with the Contract Documents. When deficiencies are found, the Worksite Traffic Supervisor is to note such deficiencies and include the proposed corrective actions, including the date corrected.

The Department may disqualify and remove from the project a Worksite Traffic Supervisor who fails to comply with the provisions of this Section. The Department may temporarily suspend all activities, except traffic, erosion control and such other activities that are necessary for project maintenance and safety, for failure to comply with these provisions.

102-4 Alternative Traffic Control Plan.

The Contractor may propose an alternative Traffic Control Plan (TCP) to the plan presented in the Contract Documents. Have the Contractor's Engineer of Record sign and seal the alternative plan. Prepare the TCP in conformance with and in the form outlined in the current version of the Roadway Plans Preparation Manual. Indicate in the plan a TCP for each phase of activities. Take responsibility for identifying and assessing any potential impacts to a utility that may be caused by the alternate TCP proposed by the Contractor, and notify the Department in writing of any such potential impacts to utilities.

Engineer's approval of the alternate TCP does not relieve the Contractor of sole responsibility for all utility impacts, costs, delays or damages, whether direct or indirect, resulting from Contractor initiated changes in the design or construction activities from those in the original Contract Specifications, design plans (including traffic control plans) or other Contract Documents and which effect a change in utility work different from that shown in the utility plans, joint project agreements or utility relocation schedules.

The Department reserves the right to reject any Alternative Traffic Control Plan. Obtain the Engineer's written approval before beginning work using an alternate TCP. The Engineer's written approval is required for all modifications to the TCP. The Engineer will only allow changes to the TCP in an emergency without the proper documentation.

102-5 Traffic Control.

102-5.1 Standards: FDOT Design Standards (DS) are the minimum standards for the use in the development of all traffic control plans. The MUTCD Part VI is the minimum national standard for traffic control for highway construction, maintenance, and utility operations. Follow the basic principles and minimum standards contained in these documents for the design, application, installation, maintenance, and removal of all traffic control devices, warning devices and barriers which are necessary to protect the public and workers from hazards within the project limits.

102-5.2 Maintenance of Roadway Surfaces: Maintain all lanes that are being used for the maintenance of traffic, including those on detours and temporary facilities, under all weather conditions. Keep the lanes reasonably free of dust, potholes and rutting. Provide the lanes with the drainage facilities necessary to maintain a smooth riding surface under all weather conditions.

102-5.3 Number of Traffic Lanes: Maintain one lane of traffic in each direction. Maintain two lanes of traffic in each direction at existing four (or more) lane cross roads, where necessary to avoid undue traffic congestion. Construct each lane used for maintenance of traffic at least as wide as the traffic lanes existing in the area before commencement of construction. Do not allow traffic control and warning devices to encroach on lanes used for maintenance of traffic.

The Engineer may allow the Contractor to restrict traffic to one-way operation for short periods of time provided that the Contractor employs adequate means of traffic control and does not unreasonably delay traffic. When a construction activity requires restricting traffic to one-way operations, locate the flaggers within view of each other when possible. When visual contact between flaggers is not possible, equip them with 2-way radios, official, or pilot vehicle(s), or use traffic signals.

102-5.4 Crossings and Intersections: Provide and maintain adequate accommodations for intersecting and crossing traffic. Do not block or unduly restrict any road or street crossing the project unless approved by the Engineer. Maintain all existing actuated or traffic responsive mode signal operations for main and side street movements for the duration of the Contract. Restore any loss of detection within 12 hours. Use only detection technology listed on the Department's Approved Products List (APL) and approved by the Engineer to restore detection capabilities.

Before beginning any construction, provide the Engineer a plan for maintaining detection devices for each intersection and the name(s) and phone numbers of persons that can be contacted when signal operation malfunctions.

102-5.5 Access for Residences and Businesses: Provide continuous access to all residences and all places of business.

102-5.6 Protection of the Work from Injury by Traffic: Where traffic would be injurious to a base, surface course, or structure constructed as a part of the work, maintain all traffic outside the limits of such areas until the potential for injury no longer exists.

102-5.7 Flagger: Provide trained flaggers in accordance with Section 105.

102-5.8 Conflicting Pavement Markings: Where the lane use or where normal vehicle paths are altered during construction, remove all pavement markings (paint, tape, thermoplastic, raised pavement markers, etc.) that will conflict with the adjusted vehicle paths. Use of paint to cover conflicting pavement markings is prohibited. Remove conflicting pavement markings using a method that will not damage the surface texture of the pavement and which will eliminate the previous marking pattern regardless of weather and light conditions.

Remove all pavement markings that will be in conflict with "next phase of operation" vehicle paths as described above, before opening to traffic.

Cost for removing conflicting pavement markings (paint, tape, thermoplastic, raised pavement markers, etc.) to be included in Maintenance of Traffic, Lump Sum.

102-5.9 Vehicle and Equipment Visibility: Equip all pickups and automobiles used on the project with a minimum of one Class 2 amber or white warning light that meets the Society of Automotive Engineers Recommended Practice SAE J845 dated March, 1992 or SAE J1318 dated April, 1986 and incorporated herein by reference, that is unobstructed by ancillary vehicle equipment such as ladders, racks or booms. If the light is obstructed, additional lights will be required. The lights shall be operating when a vehicle is in a work area where a potential hazard exists, when operating the vehicle at less than the average speed for the facility while performing work activities, making frequent stops or called for in the plans or Design Standards.

Equip all other vehicles and equipment with a minimum of 4 ft^2 of reflective sheeting or flashing lights.

To avoid distraction to motorists, do not operate the lights on the vehicles or equipment when the vehicles are outside the clear zone or behind a barrier.

102-5.10 No Waiver of Liability: Conduct operations in such a manner that no undue hazard results due to the requirements of this Article. The procedures and policies described herein in no way acts as a waiver of any terms of the liability of the Contractor or his surety.

102-6 Detours.

102-6.1 General: Construct and maintain detour facilities wherever it becomes necessary to divert traffic from any existing roadway or bridge, or wherever construction operations block the flow of traffic.

102-6.2 Construction: Plan, construct, and maintain detours for the safe passage of traffic in all conditions of weather. Provide the detour with all facilities necessary to meet this requirement.

Where the plans call for the Department to furnish detour bridge components, construct the pile bents in accordance with the plans, unless otherwise authorized by the Engineer.

Submit a letter with the following: company name, phone number, office address, project contact person, project number, detour bridge type, bridge length, span length, location and usage time frames, to the Engineer at least 30 calendar days before the intended pick-up date, to obtain the storage facility

location and list of components for the project. Upon receipt of letter, the Engineer will, within ten calendar days provide an approved material list to the Contractor and the appropriate Department storage yard.

Provide a letter with an original company seal, identifying the representative with authority to pick up components, to the Engineer at least ten calendar days before the proposed pick-up date. The Department is not obligated to load the bridge components without this notice. Take responsibility and sign for each item loaded at the time of issuance.

Provide timber dunnage, and transport the bridge components from the designated storage facility to the job site. Unload, erect, and maintain the bridge, then dismantle the bridge and load and return the components to the designated storage facility.

Notify the Engineer in writing at least ten calendar days before returning the components. Include in this notice the name of the Contractor's representative authorized to sign for return of the bridge components. The yard supervisor is not obligated to unload the bridge components without this notice.

The Department will provide equipment and an operator at the Department's storage facility to assist in loading and unloading the bridge components. Furnish all other labor and equipment required for loading and unloading the components.

The Departments representative will record all bridge components issued or returned on the Detour Bridge Issue and Credit Ticket. The Tickets must be signed by a Department and Contractor representative, after loading or unloading each truck to document the quantity and type of bridging issued or returned.

Bind together all bridge components to be returned in accordance with the instructions given by the storage facility. The yard supervisor will repack components that are not packed in compliance with these instructions. Upon request, written packing instructions will be made available to the Contractor, before dismantling of the bridge for return to the Department's storage facility.

Assume responsibility for any shortage or damage to the bridge components. Monies due the Contractor will be reduced at the rate of $35.00 per hour plus materials for repacking, repairs or replacement of bridge components.

The skid resistance of open steel grid decking on the detour bridge may decrease gradually after opening the bridge to traffic. The Department will furnish a pneumatic floor scabbler machine for roughening the roadway surface of the detour bridge decking. Provide an air compressor at the job site with 200 ft^3/minute capacity, 90 psi air pressure for the power supply of the machine, and an operator. Transport the scabbler machine to and from the Department's Structures Shop. Repair any damage to the scabbler machine caused by operations at no expense to the Department. Perform scabbling when determined necessary by the Engineer. The Department will pay for the cost of scabbling as Unforeseeable Work in accordance with 4-4.

Return the bridge components to the designated storage facility beginning no later than ten calendar days after the date the detour bridge is no longer needed, the date the new bridge is placed in service, or the date Contract Time expires, whichever is earliest. Return the detour bridging at an average of not less than 200 feet per week. Upon failure to return the bridge components to

the Department within the time specified, compensate the Department for the bridge components not returned at the rate of $5.00 per 10 feet, per day, per bridge, for single lane; and $10.00 per 10 feet, per day, per bridge, for dual lane until the bridge components are returned to the Department.

102-6.3 Construction Methods: Select and use construction methods and materials that provide a stable and safe detour facility. Construct the detour facility to have sufficient durability to remain in good condition, supplemented by maintenance, for the entire period that the detour is required.

102-6.4 Removal of Detours: Remove detours when they are no longer needed and before the Contract is completed. Take ownership of all materials from the detour and dispose of them, except for materials, which might be on loan from the Department with the stipulation that they are returned.

102-6.5 Detours Over Existing Roads and Streets: When the Department specifies that traffic be detoured over roads or streets outside the project area, do not maintain such roads or streets. However, maintain all signs and other devices placed for the purpose of the detour.

102-6.6 Operation of Existing Movable Bridges: The Department will maintain and operate existing moveable bridges that are to be removed by the Contractor until such time as they are closed to traffic. During this period, make immediate repairs of any damage to such structures caused by use or operations related to the work at no expense to the Department, but do not provide routine repairs or maintenance. In the event that use or operations result in damage to a bridge requiring repairs, give such repairs top priority to any equipment, material, or labor available.

102-7 Traffic Control Officer.

Provide uniformed law enforcement officers, including marked law enforcement vehicles, to assist in controlling and directing traffic in the work zone when the following types of work is necessary on projects:

1. Traffic control in a signalized intersection when signals are not in use.
2. When Standard Index No. 619 is used on Interstate at nighttime and required by the plans.
3. When pacing/rolling blockade specification is used.

102-8 Driveway Maintenance.

102-8.1 General: Ensure that each residence and or business has safe, stable, and reasonable access.

102-8.2 Construction Methods: Place, level, manipulate, compact, and maintain the material, to the extent appropriate for the intended use.

As permanent driveway construction is accomplished at a particular location, the Contractor may salvage and reuse previously placed materials that are suitable for reuse on other driveways.

102-9 Temporary Traffic Control Devices.

102-9.1 Installation and Maintenance: Install and maintain temporary traffic control devices as detailed in the plans, Index 600 of the Design Standards and when applicable, in accordance with the approved vendor drawings, as

provided on the QPL. Erect the required temporary traffic control devices to prevent any hazardous conditions and in conjunction with any necessary traffic re-routing to protect the traveling public, workers, and to safeguard the work area. Use only those devices that are on the Qualified Products List (QPL) or the Approved Products List (APL). Immediately remove or cover any devices that do not apply to existing conditions.

All temporary traffic control devices must meet the requirements of National Cooperative Highway Research Program Report 350 (NCHRP 350) and current FHWA directives. Manufacturers seeking evaluation must furnish certified test reports showing that their product meets all test requirements set forth by NCHRP 350. Manufacturers seeking evaluation of Category I devices for inclusion on the QPL shall include the manufacturer's self-certification letter. Manufacturer's seeking evaluation of Category II and III devices for inclusion on the QPL shall include the FHWA WZ numbered acceptance letter with attachments and vendor drawings of the device in sufficient detail to enable the Engineer to distinguish between this and similar devices. For devices requiring field assembly or special site preparation, vendor drawings shall include all field assembly details and technical information necessary for proper application and installation and must be signed and sealed by a Professional Engineer registered in the State of Florida. Manufacturers seeking evaluation of Category IV devices for inclusion on the QPL must comply with the requirements of Section 990 and include detailed vendor drawings of the device along with technical information necessary for proper application, field assembly and installation.

Ensure that the QPL number is permanently marked on the device at a readily visible location.

Notify the Engineer of any scheduled operation, which will affect traffic patterns or safety, sufficiently in advance of commencing such operation to permit his review of the plan for the proposed installation of temporary traffic control devices.

Ensure an employee is assigned the responsibility of maintaining the position and condition of all temporary traffic control devices throughout the duration of the Contract. Keep the Engineer advised at all times of the identification and means of contacting this employee on a 24-hour basis.

Keep temporary traffic control devices in the correct position, properly directed, clearly visible and clean, at all times. Ensure that all traffic control devices meet acceptable standards as outlined in American Traffic Safety Services Association (ATSSA's) "Quality Standards for Work Zone Traffic Control Devices". Immediately repair, replace or clean damaged, defaced or dirty devices.

102-9.2 Work Zone Signs: Provide signs in accordance with the plans and Design Standards. Meet the requirements of 700-2.6 and 700-5.5. Provide Federal Highway Administration's (FHWA) accepted sign substrate for use with accepted sign stands on the National Highway System (NHS) under the provisions of the National Cooperative Highway Research Program (NCHRP) Report 350 "Recommended Procedures for the Safety Performance Evaluation of Highway Features."

102-9.3 Business Signs: Provide and place signs in accordance with the plans and Design Standards. Meet the sign background sheeting requirements of Section 700. Furnish signs having a Type III reflectorized blue background with a 4 inches series B white legend and a white border. The maximum sign size is 24 by 36 inches.

Use signs with specific business names on each sign. Install logos provided by business owners and approved by the Engineer. Standard Business entrance signs meeting the requirements of Index 17355 without specific business names may be used only with the approval of the Engineer.

102-9.4 High Intensity Flashing Lights: Furnish Type B lights in accordance with the plans and Design Standards.

102-9.5 Warning/Channelizing Devices: Furnish warning/channelizing devices in accordance with the plans and Design Standards.

102-9.5.1 Reflective Collars for Traffic Cones: Use cone collars at night designed to properly fit the taper of the cone when installed. Place the upper 6 inches collar a uniform 3 1/2 inch distance from the top of the cone and the lower 4 inch collar a uniform 2 inch distance below the bottom of the upper 6 inch collar. Ensure that the collars are capable of being removed for temporary use or attached permanently to the cone in accordance with the manufacturer's recommendations. Provide a white sheeting having a smooth outer surface and that has the property of a retroreflector over its entire surface.

102-9.5.2 Barrier Wall (Temporary): Furnish, install, maintain, remove and relocate a temporary barrier wall in accordance with the plans. Ensure that temporary concrete barrier wall for use on roadway sections, complies with Section 521 and Index Nos. 412, 414 or 415 as specified in the plans. Ensure that temporary concrete barrier wall for use on bridge and wall sections, complies with Index No 414 as specified in the plans. Ensure that temporary water filled barrier wall used on roadway sections meets the NCHRP Report 350 criteria and is listed on the Qualified Products List (QPL). Barriers meeting the requirements of Index Nos. 412, 415 or temporary water filled barriers on the QPL will not be accepted as an alternate to barriers meeting the requirements of Index No. 414.

102-9.5.3 Glare Screen (Temporary): Furnish, install, maintain, remove and relocate glare screen systems in conjunction with temporary barrier wall at locations identified in the plans.

Ensure the anchorage of the glare screen to the barrier is capable of safely resisting an equivalent tensile load of 600 lb/ft of glare screen, with a requirement to use a minimum of three fasteners per barrier section.

When glare screen is utilized on temporary barrier wall, warning lights will not be required.

102-9.6 Temporary Vehicle Impact Attenuator (Crash Cushion) (Redirect/Inertia): Furnish, install, maintain and subsequently remove temporary vehicular impact attenuators in accordance with the details and notes shown in the plans, the Design Standards, and requirements of the pre-approved alternatives listed on the QPL. Maintain the attenuators until their authorized removal. Repair all attachment scars to permanent structures and pavements after attenuator removal. Make necessary repairs due to defective material, work, or

Contractor operations at no cost to the Department. Restore attenuators damaged by the traveling public within 24 hours after notification as authorized by the Engineer.

102-9.7 Guardrail (Temporary): Furnish guardrail (temporary) in accordance with the plans and Design Standards. Meet the requirements of Section 536.

102-9.8 Advance Warning Arrow Panel: Furnish advance warning panels that meet the requirements of Section 990 as required by the plans and Design Standards to advise approaching traffic of lane closures or shoulder work.

102-9.9 Portable Changeable (Variable) Message Sign (PCMS): Furnish changeable (variable) message signs that meet the requirements of Section 990 as required by the plans and Design Standards to supplement other temporary traffic control devices used in work zones.

A truck mounted PCMS may be used as a standalone maintenance of traffic device only when used for accident or incident management situations as defined in the MUTCD and is listed on the APL.

102-9.10 Portable Regulatory Signs (PRS): Furnish portable regulatory signs that meet the requirements of 990 as required by the plans and Design Standards.

Activate portable regulatory signs only during active work activities and deactivate when no work is being performed.

102-9.11 Radar Speed Display Unit (RSDU): Furnish radar speed display units that meet the requirements of Section 990 as required by the plans and Design Standards to inform motorists of the posted speed and their actual speed.

Activate the radar speed display unit only during active work activities and deactivate when no work is being performed.

102-9.12 Temporary Traffic Control Signals: Furnish, install and operate temporary traffic control signals as indicated in the plans. Temporary traffic control signals will consist of either portable or fixed traffic signals.

Provide portable traffic signals that meet the requirements of the Design Standards, 603-2 and are listed on the APL. The Engineer may approve used signal equipment if it is in acceptable condition.

102-9.13 Temporary Traffic Detection Technology: Furnish, install and operate Temporary Traffic Detection Technology listed on the Department's APL and approved by the Engineer to restore detection capabilities.

102-9.14 Trucks and Truck Mounted Impact Attenuators: Furnish, install and maintain only those attenuators that meet the requirements of NCHRP 350. Include the cost of trucks and truck mounted impact attenuators in MOT.

Use Truck Mounted Attenuators (TMA), when called for in the Design Standards. Limit TMA's to those items listed on the QPL.

Use truck mounted attenuator systems designed and installed in accordance with the manufactures recommendations.

Equip the TMA cartridge with lights and reflectors in compliance with applicable Florida motor vehicle laws, including turn signals, dual tail lights, and brake lights. Ensure that lights are visible in both the raised and lowered positions if the unit is capable of being raised.

Ensure that the complete unit is painted DOT yellow (Fed. Std. 595 b, No. 13538). Stripe the rear facing of the cartridge in the operating position with the alternating 6 inch white and 6 inch safety orange 45 degree striping to form an inverted "V" at the center of the unit and slope down and toward the outside of the unit, in both directions from the center. Ensure the bottom of the cartridge has the same pattern, covering the entire bottom, with 6 inch white and 6 inch safety orange stripes. Use Type III reflectorized sheeting for striping.

The trucks and truck mounted impact attenuators will not be paid for separately, but will be included in the cost of Maintenance of Traffic. Payment includes all costs, including furnishing, maintaining and removal when no longer required, and all materials, labor, tools, equipment and incidentals required for attenuator maintenance.

102-10 Work Zone Pavement Marking.

102-10.1 Description: Furnish and install Work Zone Pavement Markings for maintenance of traffic in construction areas and in close conformity with the lines and details shown on the plans. Meet the requirements of 710-4.3.

Use pavement marking materials that contain no lead or chromium compounds. Manufacturers seeking product approval must furnish certified test reports showing the Work Zone Pavement Marking material meets the requirements of this Section.

Centerlines, lane lines, edgelines, stop bars and turn arrows in work zones will be required in accordance with the MUTCD with the following additions:

(a) Install edgelines on paved shoulders.

(b) Place edgelines on all detours where vehicle paths are altered from normal operations and where a lane is narrowed from its normal width for any reason.

(c) Apply Work Zone Pavement Markings, including arrows and messages as determined by the Engineer to be required for the safe operation of the facility, before the end of the day if the highway is open to traffic. Channelizing devices may be used to direct traffic during the day before placing the Work Zone Pavement Markings.

(d) Work Zone Pavement Markings shall be water borne paint, unless otherwise identified in the plans or approved by the Engineer.

The most common types of Work Zone Pavement Markings are water borne paint and removable tape. Other types of Work Zone Pavement Markings may be identified in the plans.

102-10.2 Removable Tape:

102-10.2.1 General: Use removable tape listed on the Qualified Products List (QPL) and meeting the requirements of 990-5.

102-10.2.2 Application: Apply removable tape with a mechanical applicator to provide pavement lines that are neat, accurate and uniform. Equip the mechanical applicator with a film cut-off device and with measuring devices that automatically and accumulatively measure the length of each line placed within an accuracy tolerance of ±2%. Ensure removable tape adheres to the road

surface. Removable tape may be placed by hand on short sections 500 feet or less if it is done in a neat accurate manner.

102-10.2.3 Retroreflectivity: Apply white and yellow traffic stripes and markings that will attain an initial retroreflectivity of not less than 300 mcd/lx·m2 for white and contrast markings and not less than 250 mcd/lx·m2 for yellow markings. Black portions of contrast tapes and black masking tapes must be non-reflective and have a reflectance of less than 5 mcd/lx m2. The retroreflectance of the white, yellow and contrast pavement markings at the end of the six month service life shall not be less than 150 mcd/lx·m^2.

102-10.2.4 Removability: Provide removable tape capable of being removed from bituminous concrete and portland cement concrete pavement intact or in substantially large strips, either manually or by a mechanical roll-up device, at temperatures above 40ºF, without the use of heat, solvents, grinding or blasting. Ensure that the manufacturer shows documented reports that the removable tape meets this requirement after being in place for a minimum of 90 days and under an average daily traffic count per lane of at least 9,000 vehicles per day.

102-10.3 Work Zone Raised Pavement Markers (WZRPM's): Apply all markers in accordance with the Design Standards, Index No. 600.

102-10.4 Paint and Glass Beads: Meet the requirements of Section 710.

102-11 Method of Measurement.

102-11.1 General: Devices installed/used on the project on any calendar day or portion thereof, within the allowable Contract Time, including time extensions which may be granted, will be paid for at the Contract unit price for the applicable pay item, except those paid for as Lump Sum.

102-11.2 Traffic Control Officers: The quantity to be paid for will be at the Contract unit price per hour (4 hour minimum) for the actual number of officers certified to be on the project site, including any law enforcement vehicle(s) and all other direct and indirect costs. Payment will be made only for those traffic control officers specified in the Plans and authorized by the Engineer.

102-11.3 Special Detours: When a detour facility is specifically detailed in the plans, or is otherwise described or detailed as a special item, and an item for separate payment is included in the proposal, the work of constructing, maintaining, and subsequently removing such detour facilities will be paid for separately. Traffic control devices, warning devices, barriers, signing, and pavement markings for Special Detours will also be paid for separately.

When the plans show more than one detour, each detour will be paid for separately, at the Contract lump sum price for each.

Where a separate item for a specific detour facility is included in the proposal, payment will be made under Special Detour.

102-11.4 Commercial Material for Driveway Maintenance: The quantity to be paid for will be the certified volume, in cubic yards, of all materials authorized by the Engineer, acceptably placed and maintained for driveway maintenance. The volume, which is authorized to be reused, and which is acceptably salvaged, placed, and maintained in other designated driveways will be included again for payment.

102-11.5 Work Zone Signs: The number of signs (Temporary Regulatory, Warning and Guide) certified as installed/used on the project will be paid for at the Contract unit price for Work Zone Signs. When multiple signs are located on single or multiple post(s), each sign panel will be paid individually. Signs greater than 20 ft^2 and detailed in the plans will be paid for under Lump Sum MOT.

Portable signs (excluding Mesh signs and signs mounted with less than1 foot ground clearance) and Vehicular Mounted Signs will be included for payment under work zone signs, only if used in accordance with the Design Standards.

102-11.6. Business Signs: The number of business signs certified as installed/used on the project will be paid for at the Contract unit price for Business Signs.

102-11.7 High Intensity Flashing Lights: The number of high intensity flashing lights (Type B) certified as installed/used on the project will be paid for at the Contract unit price for High Intensity Flashing Lights (Temporary - Type B).

102-11.8 Warning/Channelizing Devices: The number of Type I, Type II, Type III, Vertical Panel and Drum Warning Devices certified as installed/used on the project meeting the requirements of Design Standards, Index No. 600 and have been properly maintained will be paid for at the Contract unit prices for Barricade (Temporary).

102-11.9 Barrier Wall (Temporary): The Contract unit price for Barrier Wall (Temporary) will be full compensation for furnishing, installing, maintaining, and removing the barrier wall. When called for, the Contract unit price for Barrier Wall (Temporary/Relocate) will be full compensation for relocating the barrier. The certified quantity to be paid for will be determined by the number of sections times the nominal length of each section.

102-11.10 Lights, Temporary, Barrier Wall Mount: The number of Type C Steady Burn lights, mounted on barrier wall, certified as installed/used on the project, meeting the requirements of the Design Standards and have been properly maintained will be paid for at the Contract unit price for Lights Temporary, Barrier Wall Mount.

102-11.11 Glare Screen (Temporary): The certified quantity to be paid for will be determined by the number of sections times the nominal length of each section.

102-11.12 Temporary Vehicular Impact Attenuator:

102-11.12.1 Redirective: The quantity to be paid for will be the number of Temporary Vehicular Impact Attenuators (Redirective) certified as installed/used and maintained on the project, including object marker.

102-11.12.2 Inertia: The quantity to be paid for will be the number of Temporary Vehicular Impact Attenuators (Inertia) complete arrays certified as installed/used and maintained in accordance with the plans and Design Standards, Index No. 417.

102-11.13 Temporary Guardrail: The quantity to be paid for will be the length, in feet, of temporary guardrail constructed and certified as installed/used on the project. The length of a run of guardrail will be determined as a multiple of the nominal panel lengths.

102-11.14 Advance Warning Arrow Panel: The quantity to be paid at the contract unit price will be for the number of advance warning arrow panels certified as installed/used on the project on any calendar day or portion thereof within the contract time.

102-11.15 Changeable (Variable) Message Sign: The quantity to be paid at the contract unit price will be for the number of changeable (variable) message signs certified as installed/used on the project on any calendar day or portion thereof within the contract time. Payment will be made for each Changeable (Variable) message sign that is used during the period beginning fourteen working days before Contract Time begins as authorized by the Engineer.

102-11.16 Portable Regulatory Signs: The quantity to be paid for will be the number of portable regulatory sign certified as installed/used on the project on any calendar day or portion thereof within the contract time, will be paid for the contract unit price for portable regulatory sign.

102-11.17 Radar Speed Display Unit: The quantity to be paid for will be the number of radar speed display units certified as installed/used on the project on any calendar day or portion thereof within the contract time, will be paid for the contract unit price for radar speed display unit.

102-11.18 Temporary Traffic Control Signals: The quantity of Temporary Traffic Control Signals to be paid for will be the number of completed installations (each signalized location) of portable traffic signals, or the number of fixed traffic signals in place and operating on the project, as authorized by the Engineer and certified as in place and in operation on the project.

102-11.19 Temporary Traffic Detection Technology: The quantity of Temporary Traffic Detection Technology to be paid for will be the number of completed and accepted intersections utilizing Temporary Traffic Detection Technology, authorized by the Engineer and certified as completed on the project. Compensation will begin the day Temporary Traffic Detection Technology is placed into operation and approved by the Engineer and will end the day the permanent detection is operational and approved by the Engineer.

102-11.20 Work Zone Pavement Markings: The quantities, furnished and installed, to be paid for will be the length of skip and solid pavement markings, and the area of pavement markings placed as follows:

(a) The total transverse distance, in feet, of skip pavement marking authorized and acceptably applied. The length of actual applied line will depend on the skip ratio of the material used. Measurement will be the distance from the beginning of the first stripe to the end of the last stripe with proper deductions made for unpainted intervals as determined by plan dimensions or stations, subject to 9-1.3.

(b) The net length, in feet, of solid pavement marking authorized and acceptably applied.

(c) The number of directional arrows or pavement messages authorized and acceptably applied.

(d) The number of WZRPM’s authorized and acceptably applied.

102-12 Submittals.

102-12.1 Submittal Instructions: Prepare a certification of quantities, using the Department's current approved form, for certified Maintenance of Traffic payment items for each project in the Contract. Submit the certification of quantities to the Engineer. The Department will not pay for any disputed items until the Engineer approves the certification of quantities.

102-12.2 Contractor's Certification of Quantities: Request payment by submitting a certification of quantities no later than Twelve O'clock noon Monday after the estimate cut-off date or as directed by the Engineer, based on the amount of work done or completed. Ensure the certification consists of the following:

(a) Contract Number, FPID Number, Certification Number, Certification Date and the period that the certification represents.

(b) The basis for arriving at the amount of the progress certification, less payments previously made and less an amount previously retained or withheld. The basis will include a detail breakdown provided on the certification of items of payment in accordance with 102-13. After the initial setup of the maintenance of traffic items and counts, the interval for recording the counts will be made weekly on the certification sheet unless there is a change. This change will be documented on the day of occurrence. Some items may necessitate a daily interval of recording the counts.

102-13 Basis of Payment.

102-13.1 Maintenance of Traffic (General Work): When an item of work is included in the proposal, price and payment will be full compensation for all work and costs specified under this Section except as may be specifically covered for payment under other items.

102-13.2 Traffic Control Officers: Price and payment will be full compensation for the services of the traffic control officers.

102-13.3 Special Detours: Price and payment will be full compensation for providing all detour facilities shown on the plans and all costs incurred in carrying out all requirements of this Section for general maintenance of traffic within the limits of the detour, as shown on the plans.

102-13.4 Commercial Materials for Driveway Maintenance: Price and payment will be full compensation for all work and materials specified for this item, including specifically all required shaping and maintaining of driveways.

102-13.5 Work Zone Signs: Price and payment will be full compensation for all work and materials for furnishing signs, supports and necessary hardware, installation, relocating, maintaining and removing signs.

102-13.6. Business Signs: Price and payment will be full compensation for all materials and labor required for furnishing, installing, relocating, maintaining, and removing the signs as well as the cost of installing any logos provided by business owners.

102-13.7 High Intensity Warning Lights: Price and payment will be full compensation for furnishing, installing, operating, relocating, maintaining and removing high intensity flashing lights (Type B).

102-13.8 Channelizing Devices: Prices and payment will be full compensation for furnishing, installing, relocating, maintaining and removing the warning devices, including the costs associated with attached warning lights as required.

102-13.9 Barrier Wall (Temporary): Price and payment will be full compensation for furnishing, installing, maintaining, and removing the barrier. When called for, Barrier Wall (Temporary) (Relocate) will be full compensation for relocating the barrier.

102-13.10 Lights, Temporary, Barrier Wall Mount: Price and payment will be full compensation for all work and materials for furnishing, installing and maintaining the warning lights mounted on barrier wall. Payment will not be made for lights that are improperly placed or are not working.

102-13.11 Glare Screen (Temporary): Price and payment will be full compensation for furnishing, installing, maintaining, and removing the glare screen certified as installed/used on the project. When called for, Glare Screen (Relocate) will be full compensation for relocating the glare screen.

102-13.12 Temporary Vehicular Impact Attenuator:

102-13.12.1 Redirective: Price and payment will be full compensation for furnishing, installing, maintaining and subsequently removing such attenuators. Payment for restoring damaged attenuators will be the manufacturer's/distributor's invoice price for the new materials/parts plus 20% markup. The 20% markup is compensation for all necessary work, including but not limited to labor, equipment, supplies and profit, as authorized by the Engineer. Additional MOT required for the repair of the attenuator will be paid for under the appropriate MOT pay item.

102-13.12.2 Inertia: Price and payment for the number of complete arrays will be full compensation for furnishing, installing, maintenance and removal at each specified location. In addition, payment will be made for new modules replaced due to damages, excluding damage caused by the Contractor's operations.

102-13.13 Temporary Guardrail: Price and payment will be full compensation for furnishing all materials required for a complete installation, including end anchorage assemblies and any end connections to other structures and for installing, maintaining and removing guardrail.

102-13.14 Advance Warning Arrow Panel: Price and payment will be full compensation for furnishing, installing, operating, relocating, maintaining and removing advance warning arrow panels.

102-13.15 Changeable (Variable) Message Sign: Price and payment will be full compensation for furnishing, installing, operating, relocating, maintaining and removing changeable message signs.

102-13.16 Portable Regulatory Signs: Price and payment will be full compensation for furnishing, installing, relocating, maintaining and removing a completely functioning system as described in these specifications portable regulatory signs. Price and payment will be full compensation for furnishing, installing, operating, relocating, maintaining and removing changeable message signs.

Payment will include all labor, materials, incidentals, repairs and any actions necessary to operate and maintain the unit at all times that work is being performed or traffic is being affected by construction and/or maintenance of traffic operations.

102-13.17 Radar Speed Display Unit: Price and payment will be made only for a completely functioning system as described in these specifications. Payment will include all labor, hardware, accessories, signs, and incidental items necessary for a complete system. Payment will include any measurements needed to insure that the unit conforms to all specification requirements.

Payment will include all labor, materials, incidentals, repairs and any actions necessary to operate and maintain the unit at all times that work is being performed or traffic is being affected by construction and/or maintenance of traffic operations. Price and payment will be full compensation for furnishing, installing, operating, relocating, maintaining and removing radar speed display unit.

102-13.18 Temporary Traffic Control Signals: Price and payment will constitute full compensation for furnishing, installing, operating, maintaining and removing temporary traffic control signals including all equipment and components necessary to provide an operable traffic signal.

102-13.19 Temporary Traffic Detection Technology: Price and payment of per intersection/per day will constitute full compensation for furnishing, installing, operating, maintaining and removing temporary traffic detection technology including all equipment and components necessary to provide an acceptable signalized intersection. Take ownership of all equipment and components.

102-13.20 Work Zone Pavement Markings: Prices and payments will be full compensation for all work specified in Section 710, including, all cleaning and preparing of surfaces, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment will be withheld until all deficiencies are corrected.

Removable Tape may be substituted for work zone paint at no additional cost to the Department.

Payment for Class A or B Raised Pavement Markers used to supplement line markings will be paid for under Item No. 102-78, Reflective Pavement Marker. Install these markers as detailed in the Design Standards.

102-13.21 Payment Items: Payment will be made under:

Item No. 102- 1-	Maintenance of Traffic - lump sum.
Item No. 102- 2-	Special Detour - lump sum.
Item No. 102- 3-	Commercial Materials for Driveway Maintenance - per cubic yard.
Item No. 102- 14-	Traffic Control Officers - per hour.
Item No. 102- 60-	Work Zone Signs - per each per day.
Item No. 102- 61-	Business Signs - each.
Item No. 102- 71-	Barrier Wall - per foot.
Item No. 102- 94-	Glare Screen - per foot.
Item No. 102- 73-	Guardrail (Temporary) - per foot.

Item No. 102- 74-	Barricade (Temporary) - per each per day.
Item No. 102- 76-	Advanced Warning Arrow Panel - per each per day.
Item No. 102- 77-	High Intensity Flashing Lights (Temporary - Type B) - per each per day.
Item No. 102- 78-	Reflective Pavement Markers - each.
Item No. 102- 79-	Lights, Temporary, Barrier Wall Mount - per each per day.
Item No. 102- 81-	Vehicular Impact Attenuator/Crash Cushion (Gating) (Temporary) –per location.
Item No. 102- 89-	Vehicular Impact Attenuator/Crash Cushion (Temporary) - per location.
Item No. 102- 99-	Changeable (Variable) Message Sign (Temporary) - per each per day.
Item No. 102-104-	Temporary Traffic Control Signals (Portable) - per each per day.
Item No. 102-104-	Temporary Traffic Control Signals (Fixed) - per each per day.
Item No. 102-107-	Temporary Traffic Detection - per day.
Item No. 102-150-	Portable Regulatory Signs - per each per day.
Item No. 102-150-	Radar Speed Display Unit - per each per day.
Item No. 102-911-	Removable Pavement Marking (White/Black) - per foot.
Item No. 102-912-	Removable Pavement Marking (Yellow) - per foot.
Item No. 710-	Reflective Paint.
Item No. 711-	Thermoplastic.

SECTION 103
TEMPORARY WORK STRUCTURES

103-1 Description.

103-1.1 Scope of Work: Construct temporary work structures used solely to support construction equipment. Temporary structures include but are not limited to work bridges, elevated platforms and rail systems. Items such as barges, mats, or items such as falsework or scaffolding are not included in this Section. If a temporary structure type other than the structure type shown in the plans is chosen, assume responsibility for obtaining all necessary permit revisions and the Engineer's approval. Conform to any limitations contained in the plans and permits. Do not place embankment outside the limits shown in the plans. The

cost of the embankment, placing, compaction, and removal will be included in the lump sum price for Temporary Work Structure.

103-1.2 Materials: Construct the temporary work structure using materials sufficient to handle the anticipated loads. Assume responsibility for the design of the temporary structure.

103-1.3 Navigation Requirements: Submit drawings showing the location of the temporary work structures relative to the navigable waterway to the Coast Guard at least 60 days prior to beginning construction of the structure, or as required by conditions of the permit. Provide adequate lighting of the structure during the duration of construction as required by the Coast Guard or local authorities.

103-2 Basis of Payment.

103-2.1 General: The unit price for the temporary work structure will include all costs associated with the design, materials, labor, installation, removal and disposal of the structure.

103-2.2 Partial Payments: When the plans include a separate pay item for Temporary Work Structure, 75% of the lump sum price will be paid upon completion of the temporary work structure, and 25% will be paid upon complete removal of the temporary work structure from the project site. When the project requires numerous structures or multiple setups (leap frog type) of the same system, the 75% will be split evenly between the various structures or setups. Partial payments for any project will be limited to 5% of the original Contract amount for that project. Any remaining amount will be paid upon completion of all work on the project.

When more than one project is included in the Contract, the above percentages will apply separately to each project which has a separate pay item for Temporary Work Structures.

Payment will be made under:

Item No. 103- 1-	Temporary Work Structures - lump sum.

SECTION 104
PREVENTION, CONTROL, AND ABATEMENT OF EROSION AND WATER POLLUTION

104-1 Description.

Provide erosion control measures on the project and in areas outside the right-of-way where work is accomplished in conjunction with the project, so as to prevent pollution of water, detrimental effects to public or private property adjacent to the project right-of-way and damage to work on the project. Construct and maintain temporary erosion control features or, where practical, construct and maintain permanent erosion control features as shown in the plans or as may be directed by the Engineer.

104-2 General.

Coordinate the installation of temporary erosion control features with the construction of the permanent erosion control features to the extent necessary to ensure economical, effective, and continuous control of erosion and water pollution throughout the life of the Contract.

Due to unanticipated conditions, the Engineer may direct the use of control features or methods other than those included in the original Contract. In such event, the Department will pay for this additional work as unforeseeable work.

104-3 Control of Contractor's Operations Which May Result in Water Pollution.

Prevent pollution of streams, canals, lakes, reservoirs, and other water impoundments with fuels, oils, bitumens, calcium chloride, or other harmful materials. Also, conduct and schedule operations to avoid or otherwise minimize pollution or siltation of such water impoundments, and to avoid interference with movement of migratory fish. Do not dump any residue from dust collectors or washers into any live stream.

Restrict construction operations in rivers, streams, lakes, tidal waters, reservoirs, canals, and other water impoundments to those areas where it is necessary to perform filling or excavation to accomplish the work shown in the plans and to those areas which must be entered to construct temporary or permanent structures. As soon as conditions permit, promptly clear rivers, streams, and impoundments of all obstructions placed therein or caused by construction operations.

Do not frequently ford live streams with construction equipment. Wherever an appreciable number of stream crossings are necessary at any one location, use a temporary bridge or other structure.

Except as necessary for construction, do not deposit excavated material in rivers, streams, canals, or impoundments, or in a position close enough thereto, to be washed away by high water or runoff.

Where pumps are used to remove highly turbid waters from enclosed construction areas such as cofferdams or forms, treat the water by one or more of the following methods prior to discharge into State waters: pumping into grassed swales or appropriate vegetated areas or sediment basins, or confined by an appropriate enclosure such as turbidity barriers when other methods are not considered appropriate.

Do not disturb lands or waters outside the limits of construction as staked, except as authorized by the Engineer.

Obtain the Engineer's approval for the location of, and method of operation in, borrow pits, material pits, and disposal areas furnished for waste material from the project (other than commercially operated sources) such that erosion during and after completion of the work will not result in probability of detrimental siltation or water pollution.

104-4 Materials for Temporary Erosion Control.

The Engineer will not require testing of materials used in construction of temporary erosion control features other than as provided for geotextile fabric in

985-3 unless such material is to be incorporated into the completed project. When no testing is required, the Engineer will base acceptance on visual inspection.

The Contractor may use new or used materials for the construction of temporary silt fence, staked turbidity barriers, and floating turbidity barrier not to be incorporated into the completed project, subject to the approval of the Engineer.

104-5 Preconstruction Requirements.

At the Preconstruction Conference, provide to the Department an Erosion Control Plan meeting the requirements or special conditions of all permits authorizing project construction. If no permits are required or the approved permits do not contain special conditions or specifically address erosion and water pollution, the project Erosion Control Plan will be governed by 7-1.1, 7-2.2, 7-8.1, 7-8.2, and Section 104.

When a DEP generic permit is issued, the Contractor's Erosion Control Plan shall be prepared to accompany the Department's Stormwater Pollution Prevention Plan (SWPPP). Ensure the Erosion Control Plan includes procedures to control off-site tracking of soil by vehicles and construction equipment and a procedure for cleanup and reporting of non-storm water discharges, such as contaminated groundwater or accidental spills. Do not begin any soil disturbing activities until Department approval of the Contractor's Erosion Control Plan, including required signed certification statements.

Failure to sign any required documents or certification statements will be considered a default of the Contract. Any soil disturbing activities performed without the required signed documents or certification statements may be considered a violation of the DEP Generic Permit.

When the SWPPP is required, prepare the Erosion Control Plan in accordance with the planned sequence of operations and present in a format acceptable to the Department. The Erosion Control Plan shall describe, but not be limited to, the following items or activities:

(1) For each phase of construction operations or activities, supply the following information:

(a) Locations of all erosion control devices

(b) Types of all erosion control devices

(c) Estimated time erosion control devices will be in operation

(d) Monitoring schedules for maintenance of erosion control devices

(e) Methods of maintaining erosion control devices

(f) Containment or removal methods for pollutants or hazardous wastes

(2) The name and telephone number of the person responsible for monitoring and maintaining the erosion control devices.

(3) Submit for approval the Erosion Control Plans meeting paragraphs 3a, 3b, or 3c below:

(a) Projects permitted by the Southwest Florida Water Management District (SWFWMD), require the following:

Submit a copy of the Erosion Control Plan to the Engineer for review and to the appropriate SWFWMD Office for review and approval. Include the SWFWMD permit number on all submitted data or correspondence.

The Contractor may schedule a meeting with the appropriate SWFWMD Office to discuss his Erosion Control Plan in detail, to expedite the review and approval process. Advise the Engineer of the time and place of any meetings scheduled with SWFWMD.

Do not begin construction activities until the Erosion Control Plan receives written approval from both SWFWMD and the Engineer.

(b) Projects permitted by the South Florida Water Management District or the St. Johns River Water Management District, require the following:

Obtain the Engineer's approval of the Erosion Control Plan.

Do not begin construction activities until the Erosion Control Plan receives written approval from the Engineer.

(c) Projects authorized by permitting agencies other than the Water Management Districts or projects for which no permits are required require the following:

The Engineer will review and approve the Contractor's Erosion Control Plan.

Do not begin construction activities until the Erosion Control Plan receives written approval from the Engineer.

Comply with the approved Erosion Control Plan.

104-6 Construction Requirements.

104-6.1 Limitation of Exposure of Erodible Earth: The Engineer may limit the surface areas of unprotected erodible earth exposed by the construction operation and may direct the Contractor to provide erosion or pollution control measures to prevent contamination of any river, stream, lake, tidal waters, reservoir, canal, or other water impoundments or to prevent detrimental effects on property outside the project right-of-way or damage to the project. Limit the area in which excavation and filling operations are being performed so that it does not exceed the capacity to keep the finish grading, turf, sod, and other such permanent erosion control measures current in accordance with the accepted schedule.

Do not allow the surface area of erodible earth that clearing and grubbing operations or excavation and filling operations expose to exceed 750,000 ft^2 without specific prior approval by the Engineer. This limitation applies separately to clearing and grubbing operations and excavation and filling operations.

The Engineer may increase or decrease the amount of surface area the Contractor may expose at any one time.

104-6.2 Incorporation of Erosion Control Features: Incorporate permanent erosion control features into the project at the earliest practical time. Use approved temporary erosion control features to correct conditions that develop during construction which were not foreseen at the time of design, to control erosion prior to the time it is practical to construct permanent control features, or to provide immediate temporary control of erosion that develops

during normal construction operations, which are not associated with permanent erosion control features on the project.

The Engineer may authorize temporary erosion control features when finished soil layer is specified in the Contract and the limited availability of that material from the grading operations will prevent scheduled progress of the work or damage the permanent erosion control features.

104-6.3 Scheduling of Successive Operations: Schedule operations such that the area of unprotected erodible earth exposed at any one time is not larger than the minimum area necessary for efficient construction operations, and the duration of exposure of uncompleted construction to the elements is as short as practicable.

Schedule and perform clearing and grubbing so that grading operations can follow immediately thereafter. Schedule and perform grading operations so that permanent erosion control features can follow immediately thereafter if conditions on the project permit.

104-6.4 Details for Temporary Erosion Control Features:

104-6.4.1 General: Use temporary erosion and water pollution control features that consist of, but are not limited to, temporary turf, sandbagging, slope drains, artificial coverings, sediment basins, sediment checks, berms, synthetic bales, floating turbidity barrier, staked turbidity barrier and silt fence. For design details for some of these items, refer to the Erosion Control and Water Quality Section of the Design Standards.

104-6.4.2 Temporary Turf: The Engineer may designate certain areas of turf or sod constructed in accordance with Section 570 as temporary erosion control features. For areas not defined as sod, constructing temporary turf by seeding only is not an option for temporary erosion control under this Section. The Engineer may waive the turf establishment requirements of Section 570 for areas with temporary turf that will not be a part of the permanent construction.

104-6.4.3 Sandbagging: Furnish and place sandbags in configurations to control erosion and siltation.

104-6.4.4 Slope Drains: Construct slope drains in accordance with the details shown in the plans, the Design Standards, or as may be approved as suitable to adequately perform the intended function.

104-6.4.5 Sediment Basins: Construct sediment basins in accordance with the details shown in the plans, the Design Standards, or as may be approved as suitable to adequately perform the intended function. Clean out sediment basins as necessary in accordance with the plans or as directed.

104-6.4.6 Berms: Construct temporary earth berms to divert the flow of water from an erodible surface.

104-6.4.7 Synthetic Bales: Provide synthetic bales and install synthetic bales according to details shown in the plans, as directed by the Engineer, or as shown in the Design Standards to protect against downstream accumulation of sediment. Synthetic bales should be interlocking, have pre-made stake holes, are made of synthetic fibers (polypropylene, nylon, polyester) that meet the Environmental Protection Agency's TCLP standards, and produced into a filter medium. Use synthetic bales listed on the QPL. Wash out and remove sediment deposits when the deposits reach 1/2 the height of the reusable synthetic bale or

as directed by the Engineer. Dispose of the washout in accordance with 104-3 or in an area approved by the Engineer. Synthetic bales that have had sediment deposits removed may be reinstalled on the project as approved by the Engineer.

104-6.4.8 Temporary Silt Fences:

104-6.4.8.1 General: Furnish, install, maintain, and remove temporary silt fences, in accordance with the manufacturer's directions, these Specifications, the details as shown on the plans, and the Design Standards.

104-6.4.8.2 Materials and Installation: Use a geotextile fabric made from woven or nonwoven fabric, meeting the physical requirements of Section 985 according to those applications for erosion control.

Choose the type and size of posts, wire mesh reinforcement (if required), and method of installation. Do not use products which have a separate layer of plastic mesh or netting. Provide a durable and effective temporary silt fence that controls sediment comparable to the Design Standards, Index No. 102.

Install all sediment control devices in a timely manner to ensure the control of sediment and the protection of lakes, streams, gulf or ocean waters, or any wetlands associated therewith and to any adjacent property outside the right-of-way as required.

At sites where exposure to such sensitive areas is prevalent, complete the installation of any sediment control device prior to the commencement of any earthwork.

After installation of sediment control devices, repair portions of any devices damaged at no expense to the Department.

Erect temporary silt fence at upland locations across ditchlines and at temporary locations shown on the plans or approved by the Engineer where continuous construction activities change the natural contour and drainage runoff. Do not attach temporary silt fence to existing trees unless approved by the Engineer.

104-6.4.8.3 Inspection and Maintenance: Inspect all temporary silt fences immediately after each rainfall and at least daily during prolonged rainfall. Immediately correct any deficiencies. In addition, make a daily review of the location of silt fences in areas where construction activities have changed the natural contour and drainage runoff to ensure that the silt fences are properly located for effectiveness. Where deficiencies exist, install additional silt fences as directed by the Engineer.

Remove sediment deposits when the deposit reaches approximately 1/2 of the volume capacity of the temporary silt fence or as directed by the Engineer. Dress any sediment deposits remaining in place after the temporary silt fence is no longer required to conform with the finished grade, and prepare and seed them in accordance with Section 570.

104-6.4.9 Floating Turbidity Barriers and Staked Turbidity Barriers: Install, maintain, and remove turbidity barriers to contain turbidity that may occur as the result of dredging, filling, or other construction activities which may cause turbidity to occur in the waters of the State. The Contractor may need to deploy turbidity barriers around isolated areas of concern such as seagrass beds, coral communities, etc. both within as well as outside the right-of-way limits. The Engineer will identify such areas. Place the barriers prior to the

commencement of any work that could impact the area of concern. Install the barriers in accordance with the details shown in the plans or as approved by the Engineer. Ensure that the type barrier used and the deployment and maintenance of the barrier will minimize dispersion of turbid waters from the construction site. The Engineer may approve alternate methods or materials.

Operate turbidity barriers in such a manner to avoid or minimize the degradation of the water quality of the surrounding waters and minimize damage to areas where floating barriers installed.

104-6.4.10 Rock Bags: Furnish and place rock bags to control erosion and siltation. Place the bags as shown in the plans, the Design Standards or as directed by the Engineer. Use a fabric material with openings that are clearly visible to minimize clogging yet small enough to prevent rock loss. Use material of sufficient strength to allow removing and relocating bags without breakage. The bag size when filled with rocks shall be approximately 12 by 12 by 4 inches. Use No. 4 or No. 5 coarse aggregate rock.

104-6.4.11 Artificial Coverings:

104-6.4.11.1 General: Install artificial coverings in locations where temporary protection from erosion is needed. Two situations occur that require artificial coverings. The two situations have differing material requirements, which are described below.

(1) Use artificial coverings composed of natural or synthetic fiber mats, plastic sheeting, or netting as protection against erosion, when directed by the Engineer, during temporary pauses in construction caused by inclement weather or other circumstances. Remove the material when construction resumes.

(2) Use artificial coverings as erosion control blankets, at locations shown in the plans, to facilitate plant growth while permanent grassing is being established. For the purpose described, use non-toxic, biodegradable, natural or synthetic woven fiber mats. Install erosion control blankets capable of sustaining a maximum design velocity of 6.5 ft/sec as determined from tests performed by Utah State University, Texas Transportation Institute or an independent testing laboratory approved by the Department. Furnish to the Engineer, two certified copies of manufacturers test reports showing that the erosion control blankets meet the requirements of this Specification. Certification must be attested, by a person having legal authority to bind the manufacturing company. Also, furnish two 4 by 8 inch samples for product identification. The manufacturers test records shall be made available to the Department upon request. Leave the material in place, as installed, to biodegrade.

104-6.5 Removal of Temporary Erosion Control Features: In general, remove or incorporate into the soil any temporary erosion control features existing at the time of construction of the permanent erosion control features in an area of the project in such a manner that no detrimental effect will result. The Engineer may direct that temporary features be left in place.

104-7 Maintenance of Erosion Control Features.

104-7.1 General: Provide routine maintenance of permanent and temporary erosion control features, at no expense to the Department, until the project is

complete and accepted. If reconstruction of such erosion control features is necessary due to the Contractor's negligence or carelessness or, in the case of temporary erosion control features, failure by the Contractor to install permanent erosion control features as scheduled, the Contractor shall replace such erosion control features at no expense to the Department. If reconstruction of permanent or temporary erosion control features is necessary due to factors beyond the control of the Contractor, the Department will pay for replacement under the appropriate Contract pay item or items.

Inspect all erosion control features at least once every seven calendar days and within 24 hours of the end of a storm of 0.50 inches or greater. Maintain all erosion control features as required in the Stormwater Pollution Prevention Plan, Contractor's Erosion Control plan and as specified in the State of Florida Department of Environmental Protection Generic Permit for Stormwater Discharge from Large and Small Construction Activities.

104-7.2 Mowing: The Engineer may direct mowing of designated areas within the project limits when neither the work of Sections 570 nor 580 is included in the Contract. Mow these designated areas within seven days of receiving such order. Remove and properly dispose of all litter and debris prior to the mowing operation. Use conventional and specialized equipment along with hand labor to mow the entire area including slopes, wet areas, intersections, overpasses and around all appurtenances. Mow all areas to obtain a uniform height of 6 inches, unless directed otherwise by the Engineer.

104-8 Protection During Suspension of Contract Time.

If it is necessary to suspend the construction operations for any appreciable length of time, shape the top of the earthwork in such a manner to permit runoff of rainwater, and construct earth berms along the top edges of embankments to intercept runoff water. Provide temporary slope drains to carry runoff from cuts and embankments that are in the vicinity of rivers, streams, canals, lakes, and impoundments. Locate slope drains at intervals of approximately 500 feet, and stabilize them by paving or by covering with waterproof materials. Should such preventive measures fail, immediately take such other action as necessary to effectively prevent erosion and siltation. The Engineer may direct the Contractor to perform, during such suspensions of operations, any other erosion control work deemed necessary.

104-9 Method of Measurement.

When separate items for temporary erosion control features are included in the Contract, the quantities to be paid for will be: (1) the areas, in square yards, of Artificial Coverings; (2) the area, in acres, of Mowing; including litter, debris removal and disposal, equipment, labor, materials and incidentals (when not included under Sections 570 or 580); (3) the volume, in cubic yards, of Sandbagging, measured in accordance with 530-4.1; (4) the length, in feet, of Slope Drains (Temporary), measured along the surface of the work constructed; (5) the number of Sediment Basins acceptably constructed; (6) the number of Sediment Basin Cleanouts acceptably accomplished; (7) the length, in feet, of synthetic bales; (8) the length, in feet, of Floating Turbidity Barrier; (9) the

length, in feet, of Staked Turbidity Barrier; (10) the length, in feet, of Staked Silt Fence and (11) the number of Rock Bags acceptably placed.

The quantity of floating turbidity barrier, relocated turbidity barrier, synthetic bales, staked turbidity barrier, and staked silt fence to be paid for will be the total length, in feet, furnished, installed, and accepted at a new location, regardless of whether materials are new or used or relocated from a previous installation on the project.

104-10 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including construction and routine maintenance of temporary erosion control features and for mowing.

Any additional costs resulting from compliance with the requirements of this Section, other than construction, routine maintenance, and removal of temporary erosion control features and mowing, will be included in the Contract unit prices for the item or items to which such costs are related. The work of Performance Turf designated as a temporary erosion control feature in accordance with 104-6.4.2 will be paid for under the appropriate pay items specified in Sections 570 and 580.

Separate payment will not be made for the cost of constructing temporary earth berms along the edges of the roadways to prevent erosion during grading and subsequent operations. The Contractor shall include these costs in the Contract prices for grading items.

Additional temporary erosion control features constructed as directed by the Engineer will be paid for as unforeseeable work.

In case of repeated failure on the part of the Contractor to control erosion, pollution, or siltation, the Engineer reserves the right to employ outside assistance or to use the Department's own forces to provide the necessary corrective measures. Any such costs incurred, including engineering costs, will be charged to the Contractor and appropriate deductions made from the monthly progress estimate.

Payment will be made under:

Item No. 104- 1-	Artificial Coverings - per square yard.
Item No. 104- 4-	Mowing - per acre.
Item No. 104- 5-	Sandbagging - per cubic yard.
Item No. 104- 6-	Slope Drains (Temporary) - per foot.
Item No. 104- 7-	Sediment Basins - each.
Item No. 104- 9-	Sediment Basin Cleanouts - each.
Item No. 104- 10-	Synthetic Bales – per foot
Item No. 104- 11-	Floating Turbidity Barrier - per foot.
Item No. 104- 12-	Staked Turbidity Barrier - per foot.
Item No. 104- 13-	Staked Silt Fence - per foot.
Item No. 104- 16-	Rock Bags - each.

SECTION 105
CONTRACTOR QUALITY CONTROL GENERAL REQUIREMENTS

105-1 General.

105-1.1 Quality Control Documentation.

105-1.1.1 Submission of Materials Certification and Reporting Test Results: Provide certifications prior to placement of materials. Report test results at completion of the test and meet the requirements of the applicable Specifications.

105-1.1.2 Database(s): Obtain access to the Department's databases prior to testing and/or material placement. Database access information is available through the Department's website. Enter all required and specified documentation and test results in the Department databases.

105-1.1.3 Worksheets: Make available to the Department, when requested, worksheets used for collecting test information. Ensure the worksheets at a minimum contain the following:

a. Project Identification Number,
b. Time and Date,
c. Laboratory Identification and Name,
d. Training Identification Numbers (TIN) and initials,
e. Record details as specified within the test method.

105-1.2 Inspections to Assure Compliance with Acceptance Criteria.

105-1.2.1 General: The Department is not obligated to make an inspection of materials at the source of supply, manufacture, or fabrication. Provide the Engineer with unrestricted entry at all times to such parts of the facilities that concern the manufacture, fabrication, or production of the ordered materials. Bear all costs incurred in determining whether the material meets the requirements of these Specifications.

105-1.2.2 Quality Control Inspection: Provide all necessary inspection to assure effective Quality Control of the operations related to materials acceptance. This includes but is not limited to sampling and testing, production, storage, delivery, construction and placement. Ensure that the equipment used in the production and testing of the materials provides accurate and precise measurements in accordance with the applicable Specifications. Maintain a record of all inspections, including but not limited to, date of inspection, results of inspection, and any subsequent corrective actions taken. Make available to the Department the inspection records, when requested.

105-1.2.3 Notification of Placing Order: Order materials sufficiently in advance of their incorporation in the work to allow time for sampling, testing and inspection. Notify the Engineer, prior to placing orders for materials.

Submit to the Engineer a fabrication schedule for all items requiring commercial inspection, before or at the preconstruction meeting. These items include, but are not limited to steel bridge components, overhead cantilevered sign supports with cantilevered arms exceeding 41 feet, moveable bridge components or any other item identified as an item requiring commercial inspection in the Contract Documents.

Notify the Engineer at least 30 days before beginning any production and include a production schedule.

105-2 Additional Requirements for Lump Sum Projects.

Prepare and submit to the Engineer a project-specific list of material items and quantities to be used on the project as a Job Guide Schedule in the same format as the current Sampling, Testing, and Reporting Guide 21 calendar days prior to commencement of construction. Provide up-to-date quantities for the items on the Job Guide Schedule to the Engineer with each monthly progress estimate. The Department may not authorize payment of any progress estimate not accompanied by updated Job Guide Schedule quantities. Maintain the Job Guide Schedule throughout the project including the quantity placed since the previous submittal, and total to date quantity and any additional materials placed. Do not commence work activities that require testing until the Job Guide Schedule has been reviewed and accepted by the Engineer. At final acceptance, submit a final Job Guide Schedule that includes all materials used on the project in the same format as the monthly reports.

105-3 Quality Control Program.

105-3.1 General: Certain operations require personnel with specific qualifications. Certain materials require production under an approved Quality Control (QC) Plan to ensure that these materials meet the requirements of the Contract Documents. Applicable materials include hot mix asphalt, Portland cement concrete (Structural), earthwork, cementitious materials, timber, steel and miscellaneous metals, galvanized metal products, prestressed and/or precast concrete products and drainage products. For all applicable materials included in the Contract, submit a QC Plan prepared in accordance with the requirements of this Section to the Engineer. Do not incorporate any of these materials into the project prior to the Engineer's approval of the QC Plan.

Steel and Miscellaneous Metal products, including aluminum, are defined as the metal components of bridges**,** including pedestrian and moveable bridges, overhead and cantilevered sign supports, ladders and platforms, bearings, end wall grates, roadway gratings, drainage items, expansion joints, roadway decking, shear connectors, handrails, galvanized products, fencing, guardrail, light poles, high mast light poles, standard mast arm assemblies and Monotube assemblies, stay in-place forms, casing pipe, strain poles, fasteners, connectors and other hardware.

Exceptions to these materials are the production of hot mix asphalt Traffic Levels A and B only when the Contractor has selected Option 2 Mixture Acceptance.

When accreditation or certification is required, make supporting documents from the two previous inspections performed by the accrediting or certifying agency available to the Department upon request.

Obtain Department approval prior to beginning production. Meet and maintain the approved Quality Control Program requirements at all times. Production and construction of these products without the Department's prior approval of a Quality Control Program may result in rejection of the products.

Continued approval will be subject to satisfactory results from Department evaluations, including the Independent Assurance program. In cases of non-compliance with the approved Quality Control Program, identify all affected material and do not incorporate or supply to the Department projects. The following conditions may result in suspension of a Quality Control Program:

a. Failure to timely supply information required.

b. Repeated failure of material to meet Standard Specification requirements.

c. Failure to take immediate corrective action relative to deficiencies in the performance of the Quality Control Program.

d. Certifying materials that are not produced under an approved Quality Control Program for use on Department projects.

e. Failure to correct any deficiencies related to any requirement of the Quality Control Program, having received notice from the Department, within the amount of time defined in the notice.

105-3.2 Compliance with the Materials Manual.

Producers of Flexible Pipe shall meet the requirements of Section 6.1, Volume II of the Department's Materials Manual, which may be viewed at the following URL:
www.dot.state.fl.us/specificationsestimates/materialsmanual/section61.pdf .

Producers of Precast Concrete Pipe shall meet the requirements of Section 6.2, Volume II of the Department's Materials Manual, which may be viewed at the following URL:
www.dot.state.fl.us/specificationsestimates/materialsmanual/section62.pdf .

Producers of Precast Concrete Drainage Structures shall meet the requirements of Section 6.3, Volume II of the Department's Materials Manual, which may be viewed at the following URL:
www.dot.state.fl.us/specificationsestimates/materialsmanual/section63.pdf .

Producers of Precast/Prestressed Concrete Products shall meet the requirements of Sections 8.1 and 8.3 of the Department's Materials Manual, which may be viewed at the following URLs:
www.dot.state.fl.us/specificationsestimates/materialsmanual/section81.pdf .
www.dot.state.fl.us/specificationsestimates/materialsmanual/section83.pdf .

Producers of Precast Prestressed Concrete Products using Self Consolidating Concrete shall meet the requirements of Section 8.4, Volume II of the Department's Materials Manual, which may be viewed at the following URL:
www.dot.state.fl.us/specificationsestimates/materialsmanual/section84.pdf

Producers of Incidental Precast/Prestressed Concrete Products shall meet the requirements of Section 8.2, Volume II of the Department's Materials Manual, which may be viewed at the following URL:
www.dot.state.fl.us/specificationsestimates/materialsmanual/section82.pdf .

Producers of Portland Cement Concrete shall meet the requirements of Section 9.2, Volume II of the Department's Materials Manual, which may be viewed at the following URL:
www.dot.state.fl.us/specificationsestimates/materialsmanual/section92.pdf .

Producers of Structural Steel and Miscellaneous Metal Components shall meet the requirements of Sections 11.1 and 11.2 of the Department's Materials Manual, which may be viewed at the following URLs:
www.dot.state.fl.us/specificationsestimates/materialsmanual/section111.pdf .
www.dot.state.fl.us/specificationsestimates/materialsmanual/section112.pdf .

105-3.3 Hot Mix Asphalt, Portland Cement Concrete (Structural), Earthwork, Cementitious Materials, Timber, Steel and Miscellaneous Metals, Galvanized Metal Products, Prestressed and/or Precast Concrete Products and Drainage Products Quality Control Program: Have an accepted Quality Control Program, developed in accordance with this Section, during the production of materials to be used on Department projects.

105-3.4 Prestressed Concrete Quality Control Program: Ensure that prestressed concrete plants participating in the Department's Acceptance Program are qualified.

Obtaining qualification requires a current certification from a Department approved precast prestressed concrete plant certification agency and a Department approved Quality Control Plan, meeting the requirements of this Section. The list of Department approved certification agencies is available on the website of the State Materials Office.

105-3.5 Steel and Miscellaneous Metals Quality Control Program: Ensure that the fabricators of Steel and miscellaneous metal products participating in the Department's Quality Control Acceptance Program are qualified. Obtaining qualification requires an accepted Quality Control Plan, developed in accordance with this Section. A current American Institute for Steel Construction (AISC) certification is a requirement for the Quality Control Acceptance Program of the steel and miscellaneous metal fabricators, provided that AISC certification program is available for the category of the fabrication products.

105-3.6 Producers Quality Control Plan Submittal: Depending on the type of products, **t**he producers shall submit their proposed Quality Control Plans to the State Materials Office or to the District Materials Office, as described below:

105-3.6.1 State Materials Office: Producers of cementitious materials, steel and miscellaneous metals, galvanized metal products, and aggregates must submit their proposed Quality Control Plan to the State Materials Office for review and acceptance.

105-3.6.2 District Materials Office: Producers of hot mix asphalt, Portland cement concrete (Structural), earthwork, timber, prestressed and/or precast concrete products and drainage products must submit their proposed Quality Control Plan to the local District Materials Office for acceptance. Producers located outside the State must contact the State Materials Office for address information of the District Materials Office responsible for the review of the proposed Quality Control Program.

105-3.7 Quality Control Plan Review and Acceptance: The Department will respond to the producer within 21 calendar days of receipt of the proposed Quality Control Program. The Department may perform evaluation activities to verify compliance with submitted documents prior to acceptance.

If the Quality Control Program must be revised for any reason, including non-compliance, submit the revision to the Department. The Department will respond to the producer within 7 calendar days of receipt of the revised Quality Control Program.

105-3.8 Contractor's Quality Control Plan: Have an approved Quality Control Plan meeting the requirements of this Section for the transportation, storage, placement, and other related construction operations required by the Contract Documents.

105-4 Contractor Certification of Compliance.

Provide the Engineer with a notarized monthly certification of compliance with the requirements of this Section, to accompany each progress estimate, on a form provided by the Engineer. The Department may not authorize payment of any progress estimate not accompanied by an executed certification document.

Final payment in accordance with 9-8 will not be made until a final notarized certification summarizing all QC exceptions has been submitted.

105-5 Guidelines for Development of the Quality Control Plan.

105-5.1 General: Use the following guidelines for developing the QC Plan. Provide detailed policies, methods and procedures to ensure the specified quality of all applicable materials and related production and field operations. Include other items in addition to these guidelines as necessary.

105-5.2 Personnel:

105-5.2.1 Qualifications: Submit the Training Identification Numbers (TIN) for all technicians performing sampling, testing and inspection for both field and laboratory tests. Include employed and subcontracted technicians.

105-5.2.2 Level of Responsibility: Identify the primary contact for the Department. Identify roles and responsibilities of various personnel involved in the QC process.

105-5.3 Raw Materials:

105-5.3.1 Source: Identify the sources of raw materials. Provide locations and plant or mine numbers when applicable.

105-5.3.2 Certification: Describe methods of verifying compliance of certification with the specifications.

105-5.3.3 Disposition of Failing Materials: Describe the system for controlling non-conforming materials, including procedures for identification, isolation and disposition.

105-5.4 Storage Facilities for Raw Materials: Describe measures and methods, including bedding details, for preventing segregation, contamination and degradation.

Describe methods of identifying individual materials. Where applicable, submit a site plan showing the locations of various materials.

105-5.5 Production Equipment: Describe calibration frequencies, maintenance schedule and procedures for production equipment.

105-5.6 Plant Requirements:

105-5.6.1 Plant Identification: For those facilities producing materials listed in Article105-3, provide the mailing address, physical address including

county and X-Y (Latitude and Longitude) coordinates of the plant, telephone and fax numbers, E-mail address, primary contact at the plant, responsible person in charge, facility number provided by the Department, Owner information and Vendor Number and other information as required.

105-5.6.2 Process Control System: Describe the methods and measures established to ensure Contract compliance for the produced materials that are supplemental to the QC sampling and testing program described in the Contract Documents. These methods and measures will include, but are not limited to, inspection schedule, additional sampling and testing, maintenance schedule, etc.

105-5.6.3 Loading and Shipping Control: Describe the methods and measures for preventing segregation, contamination and degradation during loading and shipping operations. Describe the methods established for materials to be in compliance with the specifications at the point of use.

105-5.6.4 Types of Products Generated: Describe the products the plant is approved to produce under Department guidelines.

105-5.7 Other Requirements:

105-5.7.1 Copy of Certification: Attach examples of certifications issued by the plant/Contractor for the products approved by the Department.

105-5.7.2 Statement of Compliance: Include a statement of compliance with all quality requirements set forth by the Department in the Contract Documents and Department manuals.

105-5.7.3 Information on Producers with Accepted Quality Control Programs: Identify the Producers of materials listed in 105-3.1 for the project. Include the Department's Facility Id number as part of the identification. All producers must have accepted QC Programs and be listed on the Department's List of Producers with Accepted QC Programs.

105-5.7.4 Describing Documentation Procedure: Identify location of document storage to enable Department review. Include QC charts, qualification/accreditation records, inspection reports, and other pertinent/supporting documents for an approved QC Plan.

105-5.8 Final Manufactured Product - Plant Operations: Describe inspection schedule and methods for identifying defects and non-compliance with the specifications. Describe corrective actions and methods to resolve them.

105-5.8.1 Storage: When storage of the produced materials is required and it is not defined in the Contract Documents, describe the methods and duration for storage. Include measures and methods for preventing segregation, contamination and degradation during storage.

105-5.8.2 Disposition of Failing Materials: When not described in the specifications, describe the methods and measures for identifying and controlling the failing materials. Include preventive and corrective measures. Describe disposition of failing materials.

105-5.9 Final Manufactured Product - Field Operations:

105-5.9.1 Transportation: Describe the method of delivery from the point of production/storage to the point of placement.

105-5.9.2 Storage: When storage of the produced materials is required and it is not defined in the Contract Documents, describe the methods and

duration for storage. Include measures and methods for preventing segregation, contamination and degradation during storage.

105-5.9.3 Placement: Describe the methods and identify the type of equipment used in incorporation of the materials into the project.

105-5.9.4 Disposition of Failing Materials: When not described in the specifications, describe the methods and measures for identifying and controlling the failing materials. Include preventive and corrective measures. Describe disposition of failing materials.

105-6 Lab Qualification Program.

Testing Laboratories participating in the Department's Acceptance Program must have current Department qualification when testing materials that are used on Department projects. In addition, they must have one of the following:

a. Current AASHTO (AAP) accreditation.

b. Inspected on a regular basis per ASTM D 3740 for earthwork, ASTM D 3666 for asphalt and ASTM C 1077 for concrete for test methods used in the Acceptance Program, with all deficiencies corrected, and under the supervision of a Specialty Engineer.

c. Current Construction Materials Engineering Council (CMEC) program accreditation or other independent inspection program accreditation acceptable to the Engineer and equivalent to a. or b. above.

After meeting the criteria described above, submit a Laboratory Qualification Application to the Department. The application is available from the Department's website. Obtain the Department's qualification prior to beginning testing. The Department may inspect the laboratory for compliance with the accreditation requirements prior to issuing qualification.

Meet and maintain the qualification requirements at all times. Testing without Department's qualification may result in a rejection of the test results. Continued qualifications are subject to satisfactory results from Department evaluations, including Independent Assurance evaluations. In case of suspension or disqualification, prior to resumption of testing, resolve the issues to the Department's satisfaction and obtain reinstatement of qualification. The following conditions may result in suspension of a laboratory's qualified status:

a. Failure to timely supply required information.
b. Loss of accredited status.
c. Failure to correct deficiencies in a timely manner.
d. Unsatisfactory performance.
e. Changing the laboratory's physical location.
f. Delays in reporting the test data in the Department's database.
g. Incomplete or inaccurate reporting.
h. Using unqualified technicians performing testing.

It is prohibited for any contract laboratory or staff to perform Contractor Quality Control testing and any other Acceptance Program testing on the same contract.

105-7 Quality Control Plan Submittal.

Submit the QC Plan to the Engineer for approval within 21 calendar days after the Contract Award. The Engineer will review the QC Plan and respond to the Contractor within 21 calendar days of receipt.

If at any time the Contractor is not in compliance with the approved QC Plan, or a part thereof, affected portions of the plan will be disapproved. Cease work in the affected operation(s) and submit a revision to the Engineer. If the QC Plan, or a part thereof, must be revised, submit the revision to the Engineer. The Engineer will review the revision and respond within seven calendar days of receipt.

Continue to work on operations that are still in compliance with the approved sections of the QC Plan.

105-8 Personnel Qualifications.

105-8.1 General: Provide qualified personnel for sampling, testing and inspection of materials and construction activities. Ensure that qualifications are maintained during the course of sampling, testing and inspection.

Construction operations that require a qualified technician must not begin until the Department verifies that the technician is on the CTQP list of qualified technicians. The CTQP lists are subject to satisfactory results from periodic Independent Assurance evaluations.

105-8.2 QC Manager: Designate a QC Manager who has full authority to act as the Contractor's agent to institute any and all actions necessary for the successful implementation of the QC Plan. The QC Manager must speak and understand English. The QC Manager must be on-site at the project on a daily basis or always available upon four hours notice to administer the QC Plan. This includes administering, implementing, monitoring, and as necessary, adjusting the processes to ensure compliance with the Contract Documents. Ensure that the QC Manager is qualified as such through the Construction Training/Qualification Program.

Under the direction of the QC Manager, and using Department's standard forms provided by the Engineer, summarize the daily QC activities including testing and material sampling. Since erasures are strictly prohibited on all reports and forms, use blue or colored ink. Do not use black ink. If manual corrections to original data are necessary, strike through, correct, and date the entry, including the initials of the person making the correction. Make copies of the completed forms available for the Department to review daily unless otherwise required in the specifications. Ensure that the QC test data is entered into the Department's database on a daily basis. Maintain all QC related reports and documentation for a period of three years from final acceptance of the project. Make copies available for review by the Department upon request.

105-8.3 Worksite Traffic Supervisor: Provide a Worksite Traffic Supervisor who is responsible for initiating, installing, and maintaining all traffic control devices as described in Section 102 and in the Contract Documents. Ensure that the Worksite Traffic Supervisor is certified in the advanced training category by a Department approved training Provider. Approved Providers will be posted on the Department's website at the following URL address:

www.dot.state.fl.us/rddesign/MOT/MOT.htm . Use approved alternate Worksite Traffic Supervisors when necessary.

105-8.4 Flagger: Provide trained flaggers to direct traffic where one-way operation in a single lane is in effect and in other situations as required. The Worksite Traffic Supervisor or others as approved by the Department will provide training for flaggers.

105-8.5 Earthwork Quality Control Personnel:

105-8.5.1 Earthwork Level I: Ensure the technician who samples soil and earthwork materials from the roadway project, takes earthwork moisture and density readings, and records those data in the Density Log Book holds a Construction Training and Qualification Program (CTQP) Earthwork Construction Inspection Level I qualification.

105-8.5.2 Earthwork Level II: Ensure the technician responsible for determining the disposition of soil and earthwork materials on the roadway, and for interpreting and meeting Contract Document requirements holds a CTQP Earthwork Construction Inspection Level II qualification.

105-8.6 Asphalt Quality Control Personnel:

105-8.6.1 Plant Technicians: For asphalt plant operations, provide a QC technician, qualified as a CTQP Asphalt Plant Level II technician, available at the asphalt plant at all times when producing mix for the Department. Perform all asphalt plant related testing with a CTQP Asphalt Plant Level I technician. When the Contractor has identified Option 2 Mixture Acceptance for Traffic Levels A and B, no qualified personnel are required at the plant.

105-8.6.2 Paving Technicians: For paving operations, keep a qualified CTQP Asphalt Paving Level II technician on the roadway at all times when placing asphalt mix for the Department, and perform all testing with a CTQP Asphalt Paving Level I technician. As an exception, measurements of cross-slope, temperature and yield (spread rate) can be performed by someone under the supervision of a CTQP Paving Level II technician.

105-8.6.3 Mix Designer: Ensure all mix designs are developed by individuals who are CTQP qualified as an Asphalt Hot Mix Designer.

105-8.6.4 Documentation: Document all QC procedures, inspection, and all test results and make them available for review by the Engineer throughout the life of the Contract. Identify in the asphalt producer's Quality Control Plan the Quality Control Manager(s) and/or Asphalt Plant Level II technician(s) responsible for the decision to resume production after a quality control failure.

105-8.7 Concrete QC Personnel:

105-8.7.1 Concrete Field Technician - Level I: Ensure technicians performing plastic property testing on concrete for materials acceptance are qualified CTQP Concrete Field Technicians Level I. Plastic property testing will include but not be limited to slump, temperature, air content, water-to-cementitious materials ratio calculation, and making and curing concrete cylinders. Duties will include initial sampling and testing to confirm specification compliance prior to beginning concrete placements, ensuring timely placement of initial cure and providing for the transport of compressive strength samples to the

designated laboratories. Technicians who test concrete properties or perform Verification testing for the Department must possess this qualification.

105-8.7.2 Concrete Field Technician - Level II: Ensure field technicians responsible for the quality of concrete being placed on major bridge projects are qualified CTQP Concrete Field Technicians Level II. A Level II Technician must be present on the jobsite during all concrete placements. Prior to the placement of concrete, the technician will inspect the element to be cast to ensure compliance with Contract Documents. A Level II Technician's duties may include ensuring that concrete testing, inspection, and curing in the field is performed in accordance with the Contract Documents. The QC Technician will inform the Verification Technician of anticipated concrete placements and LOT sizes.

105-8.7.3 Concrete Laboratory Technician - Level I: Ensure technicians testing cylinders and recording concrete strength for material acceptance are qualified CTQP Concrete Laboratory Technicians Level I. Duties include final curing, compressive strength testing, and the recording/reporting of all test data.

105-8.7.4 Concrete Production Facility Manager for Quality Control: Ensure each concrete production facility has a Facility Manager for QC with the following qualifications:

1. CTQP Concrete Laboratory Technician Level I, CTQP Concrete Field Technician-Level I, and CTQP Batch Plant Operator. As alternatives to these qualifications, the Department will accept Prestressed Concrete Institute (PCI) Level III or National Ready Mixed Concrete Association (NRMCA) Concrete Technologist Level II, as equivalent qualifications.
2. Three years of QC experience directly related to cement concrete production.
3. Demonstrated proficiency in implementing, supervising, and maintaining surveillance over a QC Program.
4. Experience and certification in performance of required QC tests and statistical evaluation of QC test results.

105-8.7.5 Concrete Mix Designer: Ensure all mix designs are developed by individuals who are qualified under one of the following:

1. CTQP Concrete Lab Technician Level II;
2. National Ready Mix Concrete Association Level 2 Production Control Technician Certification;
3. Precast Concrete Pipe, Box Culverts, Drainage Structures, and Incidental Precast Concrete Level II Quality Control Inspector meeting the requirements of 105-8.11; or
4. PCI Quality Control Level III certification.

105-8.8 Supervisory Personnel-Bridge Structures:

105-8.8.1 General: Provide supervisory personnel meeting the qualification requirements detailed in this Article. Submit qualifications to the Engineer at the pre-construction conference. Do not begin Construction until the qualifications of supervisory personnel have been approved by the Engineer.

105-8.8.2 Proof of License or Certification: Submit a copy of the Professional Engineer license current and in force issued by the state in which

registration is held. The license must be for the field of engineering that the construction work involves such as Civil, Electrical or Mechanical. Under certain circumstances Florida registration may be required.

Submit a copy of the license issued by the State of Florida for tradesmen that require a license indicating that the license is in force and is current. Submit a copy of the certification issued by the Instrumentation, Systems and Automation Society of America for each Certified Control Systems Technician.

105-8.8.3 Experience Record: Submit the following information for supervisory personnel to substantiate their experience record. The supervisor (project engineer, superintendent/manager or foreman) seeking approval must provide a notarized certification statement attesting to the completeness and accuracy of the information submitted. Provide the following experience information for each individual seeking approval as a supervisor:

Project owner's name and telephone number of an owner's representative, project identification number, state, city, county, highway number and feature intersected.

Provide a detailed description of each bridge construction experience, and the level of supervisory authority during that experience. Report the duration in weeks, as well as begin and end dates, for each experience period.

Provide the name, address and telephone number of an individual that can verify that the experience being reported is accurate. This individual should have been an immediate supervisor unless the supervisor cannot be contacted in which case another individual with direct knowledge of the experience is acceptable.

105-8.8.4 Concrete Post-Tensioned Segmental Box Girder Construction: Ensure the individuals filling the following positions meet the minimum requirements as follows:

105-8.8.4.1 Project Engineer-New Construction: Ensure the Project Engineer is a registered professional engineer with five years of bridge construction experience. Ensure a minimum of three years of experience is in Segmental Box Girder Construction Engineering and includes a minimum of one year in segmental casting yard operations and related surveying, one year in segment erection and related surveying, including post-tensioning and grouting of longitudinal tendons and a minimum of one year as the Project Engineer in responsible charge of Segmental Box Girder Construction Engineering.

105-8.8.4.2 Project Engineer-Repair and Rehabilitation: Ensure the Project Engineer is a registered Professional Engineer with five years of bridge construction experience. Ensure a minimum of three years of experience is in Segmental Box Girder Construction Engineering and includes one year of post-tensioning and grouting of longitudinal tendons and a minimum of one year as the Project Engineer in responsible charge of Segmental Box Girder rehabilitation engineering or Segmental Box Girder new construction engineering.

105-8.8.4.3 Project Superintendent/Manager-New Construction: Ensure the Project Superintendent/Manager has a minimum of ten years of bridge construction experience or is a registered professional engineer with five years of

bridge construction experience. Ensure that a minimum of three years of experience is in Segmental Box Girder construction operations and includes a minimum of one year in the casting yard operations and related surveying, one year in segment erection and related surveying including post-tensioning and grouting of longitudinal tendons and a minimum of one year as the Project Superintendent/Manager in responsible charge of Segmental Box Girder construction operations.

105-8.8.4.4 Project Superintendent/Manager-Repair and Rehabilitation: Ensure the Project Superintendent/Manager has a minimum of five years of bridge construction experience or is a registered professional engineer with three years of bridge construction experience. Ensure that a minimum of two years of experience is in Segmental Box Girder construction operations and includes a minimum of one year experience performing post-tensioning and grouting of longitudinal tendons and a minimum of one year as the Project Superintendent/Manager in responsible charge of Segmental Box Girder rehabilitation operations or Segmental Box Girder new construction operations.

105-8.8.4.5 Foreman-New Construction: Ensure that the Foreman has a minimum of five years of bridge construction experience with two years of experience in Segmental Box Girder Operations and a minimum of one year as the foreman in responsible charge of Segmental Box Girder new construction Operations.

105-8.8.4.6 Foreman-Repair and Rehabilitation: Ensure the Foremen has a minimum of five years of bridge construction experience with two years of experience in Segmental Box Girder Operations and a minimum of one year as the foreman in responsible charge of Segmental Box Girder rehabilitation operations or Segmental Box Girder new construction operations.

105-8.8.4.7 Geometry Control Engineer/Manager: Ensure that the Geometry Control Engineer/Manager for construction of cast-in-place box segments is a Registered Professional Engineer with one year of experience, a non-registered Engineer with three years of experience or a Registered Professional Land Surveyor with three years of experience in geometry control for casting and erection of cast-in-place box segments. Credit for experience in cast-in-place box girder geometry control will be given for experience in precast box girder geometry control but not vice versa.

Ensure that the Geometry Control Engineer/Manager for precast box segments is a Registered Professional Engineer with one year of experience or non-registered with three years of experience in casting yard geometry control of concrete box segments.

The Geometry Control Engineer/Manager must be responsible for and experienced at implementing the method for establishing and maintaining geometry control for segment casting yard operations and segment erection operations and must be experienced with the use of computer programs for monitoring and adjusting theoretical segment casting curves and geometry. This individual must be experienced at establishing procedures for assuring accurate segment form setup, post-tensioning duct and rebar alignment and effective

concrete placement and curing operations as well as for verifying that casting and erection field survey data has been properly gathered and recorded.

105-8.8.4.8 Surveyor: Ensure that the Surveyor in charge of geometry control surveying for box segment casting and/or box segment erection has a minimum of one year of bridge construction surveying experience.

105-8.8.5 Movable Bridge Construction: Ensure the individual filling the following positions meet the minimum requirements as follows:

105-8.8.5.1 Electrical Journeyman: Ensure the Electrical Journeyman holds, an active journeyman electrician's license and has at least five years experience in industrial electrical work, or is a Certified Control Systems Technician. A Certified Control Systems Technician will not be permitted to perform electrical power work including, but not limited to, conduit and wire-way installation or power conductor connection. Ensure the electrical journeyman has successfully completed the installation of one similar movable bridge electrical system during the last three years.

105-8.8.5.2 Control Systems Engineer and Mechanical Systems Engineer: Ensure the Control Systems Engineer and Mechanical Systems Engineer are both registered Professional Engineers with a minimum of 10 years supervisory experience each in movable bridge construction. Ensure the Engineers have working knowledge of the movable bridge leaf motion control techniques, mechanical equipment and arrangements specified for this project. Ensure that each Engineer has been in responsible control of the design and implementation of at least three movable bridge electrical control and machinery systems within the past 10 years of which, at least one of the three bridges was within the last three years. Ensure that a minimum of one of the three bridge designs incorporated the same type of leaf motion control and machinery systems specified for this project.

105-8.8.6 Concrete Post-Tensioned Other Than Segmental Box Girder Construction: Ensure the individual filling the following positions meet the minimum requirements as follows:

105-8.8.6.1 Project Engineer: Ensure the Project Engineer is a registered Professional Engineer with five years of bridge construction experience. Ensure that a minimum of three years of experience is in concrete post-tensioned construction. Ensure that the three years of experience includes experience in girder erection, safe use of cranes, stabilization of girders; design of false work for temporary girder support, post-tensioning and grouting operations, and a minimum of one year as the Project Engineer in responsible charge of post-tensioning related engineering responsibilities.

105-8.8.6.2 Project Superintendent/Manager: Ensure the Project Superintendent/Manager has a minimum of ten years of bridge construction experience or is a registered Professional Engineer with five years of bridge construction experience and has a minimum of three years of supervisory experience in girder erection, safe use of cranes, stabilization of girders; design of falsework for temporary girder support post-tensioning, grouting operations and a minimum of one year as the Project Superintendent/Manager in responsible charge of post-tensioning related operations.

105-8.8.6.3 Foreman: Ensure the Foremen has a minimum of five years of bridge construction experience with two years of experience in post-tensioning related operations and a minimum of one year as the foreman in responsible charge of post-tensioning related operations.

105-8.8.7 Post Tensioning: Perform all post-tensioning field operations under the direct supervision of a Level II Qualified Post-Tensioning and Grouting Technician qualified through the Department's Construction Training Qualification Program (CTQP). In addition, provide a minimum of two crewmembers that are CTQP Level I Qualified Post-Tensioning and Grouting Technicians. All personnel involved in grouting must attend a grouting training session provided by the Department not less than seven days prior to the start of the first stressing or grouting operation of the project.

Perform all vacuum grouting operations under the direct supervision of a crew foreman who has been trained and has experience in the use of vacuum grouting equipment and procedures. Submit the crew foreman's credentials to the Engineer prior to performing any vacuum grouting operations.

Conduct all stressing and grouting operations in the presence of the Engineer. Coordinate and schedule all post-tensioning activities to facilitate inspection by the Engineer.

105-8.8.8 Failure to Comply with Bridge Qualification Requirements: Make an immediate effort to reestablish compliance. If an immediate effort is not put forth as determined by the Engineer, payment for the bridge construction operations requiring supervisors to be qualified under this Specification will be withheld up to 60 days. Cease all bridge construction and related activities (casting yard, etc.) if compliance is not met within 60 days, regardless of how much effort is put forth. Resume bridge construction operations only after written approval from the Engineer stating that compliance is reestablished.

105-8.9 Prestressed Concrete Plant Quality Control Personnel: Ensure each prestressed concrete plant has an onsite production manager, an onsite Plant Quality Control Manager, a Plant engineer, and adequate onsite QC inspectors/technicians to provide complete QC inspections and testing.

Ensure the Plant Manager for QC has at least five years of related experience and a current PCI QC personnel Level III certification and a certificate of completion of Section 450 Specification examination. Ensure that the QC inspector/technician has current PCI QC Technician/Inspector Level II certification and a certificate of completion of Section 450 Specification examination.

Ensure that the batch plant operators of the ready mixed concrete batch plants meet the requirements of Section 9.2 of the Materials Manual. Ensure that the batch plant operators of the onsite centrally mixed concrete plants meet the requirements of 105-8.11.1.4.2.

105-8.10 Signal Installation Inspector: Provide an inspector trained and certified by the International Municipal Signal Association (IMSA) as a Traffic Signal Inspector to perform all signal installation inspections. Use only Department approved signal inspection report forms during the signal inspection activities. Ensure all equipment, materials, and hardware is in compliance with

Department Specifications and verify that all equipment requiring certification is listed on the Department's Approved Product List (APL). Provide the completed signal inspection report form(s), certified by the IMSA Traffic Signal Inspector to the Engineer.

The Department's approved inspection report forms are available at the following URL: www.dot.state.fl.us/trafficoperations/ .

105-8.11 Pipe and Precast Concrete Products Manufacturing Facilities Quality Control Personnel:

105-8.11.1 Precast Concrete Drainage Structures, Precast Concrete Box Culvert, Precast Concrete Pipe, and Flexible Pipe Manufacturing Facilities Quality Control Personnel:

105-8.11.1.1 Level I Quality Control Inspectors: Ensure that the Level I Inspectors have completed a minimum of a 12-hour, Department approved, Level I QC Inspector training course in the respective work area. As an exception to this, ensure Flexible Pipe Level I QC Inspectors have completed a minimum of an 8-hour, Department approved, Level I QC Flexible Pipe Inspector training course.

105-8.11.1.2 Level II Quality Control Inspectors: Ensure that Level II Inspectors have completed Department approved Level I QC Inspector training and a minimum of a 5-hour, Department approved, Level II QC Inspector training course in the respective work areas.

105-8.11.1.3 Plant Quality Control Manager: Ensure that QC Manager has completed Department approved Level II QC Inspector training and has a minimum of 2 years construction related experience in the specific work area.

105-8.11.1.4 Additional Requirements for Quality Control Personnel of Precast Concrete Drainage and Precast Concrete Box Culvert Manufacturing Facilities:

105-8.11.1.4.1 Testing Personnel: Ensure the personnel performing plastic property tests have ACI Concrete Field Testing Technician-Grade I certification. Ensure the personnel performing laboratory compressive strength testing have ACI Concrete Laboratory Testing Technician-Grade 1 certification or ACI Concrete Strength Testing Technician certification.

105-8.11.1.4.2: Batch Plant Operator: Ensure the concrete batch plant operator is qualified as a CTQP Concrete Batch Plant Operator. As an alternative to CTQP qualification, the Department will accept the completion of a minimum of a 6-hour, Department approved, Batch Plant Operator training course.

105-8.11.2 Quality Control Personnel of Incidental Precast Manufacturing Facilities:

105-8.11.2.1: Incidental Precast Concrete Plant Quality Control Inspectors: Ensure the QC Inspectors meet the requirements of 105-8.11.1.4.1 and are qualified as CTQP Concrete Field Technician Level I.

105-8.11.2.2: Incidental Precast Concrete Plant Quality Control Manager: Ensure the QC Manager meets the requirements of 105-8.11.2.1 and has at least two years of QC experience, directly related to cement concrete production.

105-8.11.2.3: Alternative Incidental Precast Concrete Personnel Qualification: As an alternative to CTQP qualifications and CTQP Batch Plant Operator, the Department will accept QC personnel meeting the qualification requirements of 105-8.11.1.

105-8.12 Structural Steel and Miscellaneous Metals Fabrication Facility Quality Control Personnel: Ensure each fabrication facility has an onsite production manager, an onsite facility manager for QC, a plant engineer, and on site QC inspectors/technicians to provide complete QC inspections and testing.

Ensure that the Facility Manager for QC and QC inspectors/technicians meet the certification requirements set forth in the latest version of AASHTO/NSBA Steel Bridge Collaboration S 4.1, Steel Bridge Fabrication QC/QA Guide Specification, including the years of experience required in Table 105-5 below. The Facility Manager for QC must meet the requirements of Table 105-5 for every Structural Steel Member Type produced by a plant with QC being managed by the Facility Manager for QC. The Facility Manager for QC will report directly to the plant manager or plant engineer and must not be the plant production manager nor report to or be the subordinate of the plant production manager. QC inspectors/technicians must be the employees of, and must report directly to the Facility Manager for QC.

TABLE 105-5
Experience Requirements for QC Inspectors/Technicians
And Facility Manager for Quality Control

Structural Steel Member Type	Minimum Years of Experience Required	
	QC Inspector/Technician	Facility Manager for QC
Rolled beam bridges	1 year	3 years
Welded plate girders (I sections, box sections, etc.)	2 years	4 years
Complex structures, such as trusses, arches, cable stayed bridges, and moveable bridges	3 years	5 years
Fracture critical (FC) members	3 years	5 years

SECTION 110
CLEARING AND GRUBBING

110-1 Description.

Clear and grub within the areas of the roadway right-of-way and of borrow pits, sand-clay base material pits, lateral ditches, and any other areas shown in the plans to be cleared and grubbed. Remove and dispose of all trees, stumps, roots and other such protruding objects, buildings, structures, appurtenances, existing flexible asphalt pavement, and other facilities necessary to prepare the area for the proposed construction. Remove and dispose of all product and debris not required to be salvaged or not required to complete the construction.

Also, perform certain miscellaneous work the Engineer considers necessary for the complete preparation of the overall project site, as follows:

(a) Plug any water wells that are encountered within the right-of-way and that are to be abandoned.

(b) Level the terrain outside the limits of construction for purposes of facilitating maintenance and other post-construction operations in accordance with 110-10.3.

(c) Trim trees and shrubs within the project right-of-way that are identified in the Contract Documents.

Meet the requirements for such miscellaneous work as specified in 110-10.

110-2 Standard Clearing and Grubbing.

110-2.1 Work Included: Completely remove and dispose of all buildings, timber, brush, stumps, roots, rubbish, debris, and all other obstructions resting on or protruding through the surface of the existing ground and the surface of excavated areas, and all other structures and obstructions necessary to be removed and for which other items of the Contract do not specify the removal thereof, including septic tanks, building foundations, and pipes.

Perform Standard Clearing and Grubbing within the following areas:

(a) All areas where excavation is to be done, including borrow pits, lateral ditches, right-of-way ditches, etc.

(b) All areas where roadway embankments will be constructed.

(c) All areas where structures will be constructed, including pipe culverts and other pipe lines.

110-2.2 Depths of Removal of Roots, Stumps, and Other Debris: In all areas where excavation is to be performed, or roadway embankments are to be constructed, remove roots and other debris to a depth of 12 inches below the ground surface. Remove roots and other debris from all excavated material to be used in the construction of roadway embankment or roadway base. Plow the surface to a depth of at least 6 inches, and remove all roots thereby exposed to a depth of at least 12 inches. Completely remove and dispose of all stumps within the roadway right-of-way.

Remove all roots, etc., protruding through or appearing on the surface of the completed excavation within the roadway area and for structures, to a depth of at least 12 inches below the finished excavation surface.

Remove or cut off all stumps, roots, etc., below the surface of the completed excavation in borrow pits, material pits, and lateral ditches.

In borrow and material pits, do not perform any clearing or grubbing within 3 feet inside the right-of-way line.

Within all other areas where Standard Clearing and Grubbing is to be performed remove roots and other debris projecting through or appearing on the surface of the original ground to a depth of 12 inches below the surface, but do not plow or harrow these areas.

110-2.3 Trees to Remain: As an exception to the above provisions, where so directed by the Engineer, trim, protect, and leave standing desirable trees within the roadway area. Trim branches of trees extending over the area occupied by the roadway as directed, to give a clear height of 16 feet above the roadway.

110-2.4 Boulders: Remove any boulders encountered in the roadway excavation (other than as permitted under the provisions of 120-7.2) or found on the surface of the ground. When approved by the Engineer place boulders in neat piles inside the right of way. The Contractor may stockpile boulders encountered in Department-furnished borrow areas, which are not suitable for use in the embankment construction, within the borrow area.

110-3 Selective Clearing and Grubbing.

The Contractor shall remove and dispose of all vegetation, obstructions, etc., as provided above except that, where so elected, the Contractor may cut roots, etc., flush with the ground surface. Completely remove and dispose of stumps. Entirely remove undergrowth except in specific areas designated by the Engineer to remain for aesthetic purposes. Trim, protect, and leave standing desirable trees, with the exception of such trees as the Engineer may designate to be removed in order to facilitate right-of-way maintenance. Remove undesirable or damaged trees as so designated by the Engineer. Perform Selective Clearing and Grubbing only in areas so designated in the plans.

110-4 Protection of Property Remaining in Place.

Protect and do not displace property obstructions which are to remain in place, such as buildings, sewers, drains, water or gas pipes, conduits, poles, walls, posts, bridges, etc.

110-5 Removal of Buildings.

110-5.1 Parts to be Removed: Completely remove all parts of the buildings, including utilities, plumbing, foundations, floors, basements, steps, connecting concrete sidewalks or other pavement, septic tanks, and any other appurtenances, by any practical manner which is not detrimental to other property and improvements. Remove utilities to the point of connection to the utility authority's cut-in. After removing the sewer connections to the point of cut-in, construct a concrete plug at the cut-in point, as directed by the Engineer, except where the utility owners may elect to perform their own plugging. Contact the

appropriate utility companies prior to removal of any part of the building to ensure disconnection of services.

110-5.2 Removal by Others: Where buildings within the area to be cleared and grubbed are so specified to be removed by others, remove and dispose of any foundations, curtain walls, concrete floors, basements or other foundation parts which might be left in place after such removal of buildings by others.

110-6 Removal of Existing Structures.

110-6.1 Structures to be Removed: Remove and dispose of the materials from existing structures. Remove the following: (1) those structures, or portions of structures, shown in the plans to be removed; (2) those structures, or portions of structures, found within the limits of the area to be cleared and grubbed, and directed by the Engineer to be removed; (3) those structures, or portion of structures, which are necessary to be removed in order to construct new structures; and (4) other appurtenances or obstructions which may be designated in the Contract Documents as to be included in an item of payment for the work under this Article.

Provide detailed schedule information to the Engineer 15 working days prior to the commencement of any demolition or renovation of any structures, even if asbestos is not found on the project, for the Engineer's use in notifying the Department of Environmental Protection (DEP) on DEP Form 62-257.900(1) "Notice of Asbestos Renovation or Demolition".

110-6.2 Method of Removal:

110-6.2.1 General: Remove the structures in such a way so as to leave no obstructions to any proposed new structures or to any waterways. Pull, cut off, or break off pilings to the requirements of the permit or other Contract Documents, whichever requires the deepest removal, but not less than 2 feet below the finish ground line. In the event that the plans indicate channel excavation to be done by others, consider the finish ground line as the limits of such excavation. For materials which are to remain the property of the Department or are to be salvaged for use in temporary structures, avoid damage to such materials, and entirely remove all bolts, nails, etc. from timbers to be so salvaged. Mark structural steel members for identification as directed.

110-6.2.2 Removal of Steel Members With Hazardous Coatings: Provide to the Engineer for approval, a copy of the "Contractor's Lead in Construction Compliance Program" from the firm actually removing and disposing of these steel members before any members are disturbed.

Vacuum power tool clean any coated steel member to bare metal as defined by SSPC-SP11 a minimum of 4 inches either side of any area to be heated (torch cutting, sawing, grinding, etc.) in accordance with 29 CFR 1926.354. Abrasive blasting is prohibited.

Provide air supplied respirators in accordance with 29 CFR 1926.62 and 29 CFR 1910.134.

110-6.3 Partial Removal of Bridges: On concrete bridges to be partially removed and widened, remove concrete by manually or mechanically operated pavement breakers, by concrete saws, by chipping hammers, or by hydro-demolition methods. Do not use explosives. Where concrete is to be removed to

neat lines, use concrete saws or hydro-demolition methods capable of providing a reasonably uniform cleavage face. If the equipment used will not provide a uniform cut without surface spalling, first score the outlines of the work with small trenches or grooves. For all demolition methods, submit for review and approval of the Engineer, a demolition plan that describes the method of removal, equipment to be used, types of rebar splices or couplers, and method of straightening or cutting rebars. In addition, for hydro-demolition, describe the method for control of water or slurry runoff and measures for safe containment of concrete fragments that are thrown out by the hydro-demolition machine.

110-6.4 Authority of U.S. Coast Guard: For structures in navigable waters, when constructing the project under authority of a U.S. Coast Guard permit, the U.S. Coast Guard may inspect and approve the work to remove any existing structures involved therein, prior to acceptance by the Department.

110-6.5 Asbestos Containing Materials (ACM) Not Identified Prior to the Work: When encountering or exposing any condition indicating the presence of asbestos, cease operations immediately in the vicinity and notify the Engineer.

Make every effort to minimize the disturbance of the ACM. Immediately provide for the health and safety of all workers at the job site and make provisions necessary for the health and safety of the public that may be exposed to any potentially hazardous conditions. Provisions shall meet all applicable laws, rules or regulations covering hazardous conditions and will be in a manner commensurate with the gravity of the conditions.

The Engineer will notify the District Contamination Assessment Coordinator who will coordinate selecting and tasking the Department's Asbestos Contractor or Contamination Assessment/Remediation Contractor (CAR). Provide access to the potential contamination area. Preliminary investigation by the Asbestos/CAR Contractor will determine the course of action necessary for site security and the steps necessary to resolve the contamination issue.

The Asbestos/CAR Contractor will delineate the contamination area(s), any staging or holding area required. Coordinate with the Asbestos/CAR Contractor and the Engineer to develop a work plan that will provide the Asbestos/CAR Contractor's operations schedule with projected completion dates for the final resolution of the contamination issue.

The Asbestos/CAR Contractor will maintain jurisdiction over activities inside any outlined contaminated areas and any associated staging holding areas. The Asbestos/CAR Contractor will be responsible for the health and safety of workers within the delineated areas. Provide continuous access to these areas for the Asbestos/CAR Contractor and representatives of regulatory or enforcement agencies having jurisdiction.

Both Contractors will use the schedule as a basis for planning the completion of both work efforts. The Engineer may grant the Contract Time extensions according to the provisions of 8-7.3.2.

Cooperate with the Asbestos/CAR Contractor to expedite integration of the Asbestos/CAR Contractor's operations into the construction project. The Prime Contractor is not expected to engage in routine construction activities involving asbestos containing materials. Adjustments to quantities or to Contract

unit prices will be made according to work additions or reductions on the part of the Prime Contractor in accordance with 4-3.

The Engineer will direct the Prime Contractor when operations may resume in the affected area.

110-7 Removal of Existing Pavement.

Remove and dispose of existing rigid portland cement concrete pavement, sidewalk, slope pavement, ditch pavement, curb, and curb and gutter etc., where shown in the plans or ordered by the Engineer to be removed or where required because of the construction operations. Retaining walls, drainage structures and flexible asphalt pavement are not included in the work under this Article.

110-8 Ownership of Materials.

Except as may be otherwise specified in the Contract Documents, the Contractor shall take ownership of all buildings, structures, appurtenances, and other materials removed by him and shall dispose of them in accordance with 110-9.

110-9 Disposal of Materials.

110-9.1 General: Either stack materials designated to remain the property of the Department in neat piles within the right-of-way or load onto the Department's vehicles.

Dispose of timber, stumps, brush, roots, rubbish, and other objectionable material resulting from clearing and grubbing in areas and by methods meeting the applicable requirements of all Local, State and Federal regulations. Do not block waterways by the disposal of debris.

110-9.2 Burning Debris: Where burning of such materials is permitted, perform all such burning in accordance with the applicable laws, ordinances, and regulations. Perform all burning at locations where trees and shrubs adjacent to the cleared area will not be harmed.

110-9.3 Timber and Crops: The Contractor may sell any merchantable timber, fruit trees, and crops that are cleared under the operations of clearing and grubbing for his own benefit, subject to the provisions of 7-1.2, which may require that the timber, fruit trees, or crops be burned at or near the site of their removal, as directed by the Engineer. The Contractor is liable for any claims which may arise pursuant to the provisions of this Subarticle.

110-9.4 Disposal of Treated Wood: Treated wood, including that which comes from bridge channel fender systems, must be handled and disposed of properly during removal. Treated wood should not be cut or otherwise mechanically altered in a manner that would generate dust or particles without proper respiratory and dermal protection. The treated wood must be disposed of in at least a lined solid waste facility or through recycling/reuse. Treated wood shall not be disposed by burning or placement in a construction and demolition (C&D) debris landfill. All compensation for the cost of removal and disposal of treated wood will be included in the Cost of Removal of Existing Structures.

110-9.5 Hazardous Materials/Waste: Handle, transport and dispose of hazardous materials in accordance with all Local, State and Federal requirements including the following:

a. SSPC Guide 7

b. Federal Water Pollution Control Act, and

c. Resource Conservation and Recover Act (RCRA).

Accept responsibility for the collection, sampling, classification, packaging, labeling, accumulation time, storage, manifesting, transportation, treatment and disposal of hazardous waste, both solid and liquid. Separate all solid and liquid waste and collect all liquids used at hygiene stations and handle as hazardous materials/waste. Obtain written approval from the Engineer for all hazardous materials/waste stabilization methods before implementation.

Obtain an EPA/FDEP Hazardous Waste Identification Number (EPA/FDEP ID Number) before transporting and/or disposal of any hazardous materials/waste.

List the Department as the generator of all hazardous materials/waste.

Submit the following for the Engineers' approval before transporting, treatment or disposal of any hazardous materials/waste:

a. Name, address and qualifications of the transporter,

b. Name, address and qualifications of the treatment facility,

c. Proposed treatment and/or disposal of all Hazardous Materials/Waste.

Transport all hazardous materials/waste in accordance with applicable 40 CFR 263 Standards. Provide a copy of all completed Hazardous Materials/Waste manifest/bills of lading to the Engineer within 21 days of each shipment.

110-9.5.1 Steel Members With Hazardous Coating: Dispose of steel members with hazardous coating in one of the following manners:

(a) Deliver the steel members and other hazardous waste to a licensed recycling or treatment facility capable of processing steel members with hazardous coating.

(b) Deliver the steel members with hazardous coating to a site designated by the Engineer for use as an offshore artificial reef. Deliver any other hazardous materials/waste to a licensed hazardous materials/waste recycling treatment facility.

Dismantle and/or cut steel members to meet the required dimensions of the recycling facility, treatment facility or offshore artificial reef agency.

All compensation for the cost of removal and disposal of hazardous materials/waste will be included in the Cost of Removal of Existing Structures.

110-9.5.2 Certification of Compliance: Furnish two copies of Certification of Compliance from the firm actually removing and disposing of the hazardous materials/waste stipulating, the hazardous materials/waste has been handled, transported and disposed of in accordance with this Specification. The Certification of Compliance shall be attested to by a person having legal authority to bind the company.

Maintain all records required by this Specification and ensure these records are available to the Department upon request.

110-10 Miscellaneous Operations.

110-10.1 Water Wells Required to be Plugged: Fill or plug all water wells within the right-of-way, including areas of borrow pits and lateral ditches, that are not to remain in service, in accordance with applicable Water Management District rules or the Department of Environmental Protection regulations.

Cut off the casing of cased wells at least 12 inches below the ground line or 12 inches below the elevation of the finished excavation surface, whichever is lower. Water wells, as referred to herein, are defined either as artesian or non-artesian, as follows:

(a) An artesian well is an artificial hole in the ground from which water supplies may be obtained and which penetrates any water-bearing rock, the water in which is raised to the surface by natural flow or which rises to an elevation above the top of the water-bearing bed. Artesian wells are further defined to include all holes drilled as a source of water that penetrate any water-bearing beds that are a part of the artesian water system of Florida, as determined by representatives of the applicable Water Management District.

(b) A non-artesian (water table) well is a well in which the source of water is an unconfined aquifer. The water in a non-artesian well does not rise above the source bed.

When the plans do not indicate whether a non-flowing well is artesian or non-artesian, obtain this information from the Engineer.

110-10.2 Landscape Areas: When certain areas of the right-of-way, outside of the limits of construction, are shown in the plans or designated by the Engineer to be landscaped, either under the construction Contract or at a later time, remove undesirable trees, stumps, undergrowth, and vegetation, as directed, and preserve and trim natural growth and trees as directed by the Engineer.

110-10.3 Leveling Terrain: Within the areas between the limits of construction and the outer limits of clearing and grubbing, fill all holes and other depressions, and cut down all mounds and ridges. Make the area of a sufficient uniform contour so that the Department's subsequent mowing and cutting operations are not hindered by irregularity of terrain. Perform this work regardless of whether the irregularities were the result of construction operations or existed originally.

110-10.4 Mailboxes: When the Contract Documents require furnishing and installing mailboxes, permit each owner to remove the existing mailbox. Work with the Local Postmaster to develop a method of temporary mail service for the period between removal and installation of the new mailboxes. Install the mailboxes in accordance with the Design Standards.

110-11 Method of Measurement.

110-11.1 Clearing and Grubbing: When direct payment is provided in the Contract, the quantity to be paid for will be the lump sum quantity.

110-11.2 Removal of Existing Structures: When direct payment is provided in the Contract, the quantity to be paid for will be the lump sum quantity or quantities for the specific structures removed, as designated.

110-11.3 Removal of Existing Pavement: Payment for removal of flexible asphalt pavement is included in the Lump Sum price for Clearing and Grubbing.

When a separate item for Removal of Existing Pavement is provided, the quantity to be paid for will be the number of square yards of existing pavement of the types listed in 110-7, acceptably removed and disposed of, as specified. The quantity will be determined by actual measurement along the surface of the pavement before its removal. Measurements for appurtenances which have irregular surface configurations, such as curb and gutter, steps, and ditch pavement, will be the area as projected to an approximate horizontal plane. Where the removal of pavement areas is necessary only for the construction of box culverts, pipe culverts, storm sewers, inlets, manholes, etc., these areas will not be included in the measurements.

110-11.4 Plugging Water Wells: When direct payment is provided in the Contract, the quantity to be paid for will be the number of water wells plugged, for each type of well (artesian or non-artesian).

110-11.5 Mailboxes: When direct payment is provided in the Contract, the quantity to be paid for will be the number of mailboxes acceptably furnished and installed.

110-11.6 Delivery of Salvageable Material to the Department When direct payment is provided in the Contract, the quantity to be paid for will be the Lump Sum quantity for delivery of salvageable materials to the Department as indicated in the plans.

110-11.7 General: In each case, except as provided below, where no item of separate payment for such work is included in the proposal, all costs of such work will be included in the various scheduled items in the Contract, or under specific items as specified herein below or elsewhere in the Contract.

110-12 Basis of Payment.

110-12.1 Clearing and Grubbing:

110-12.1.1 Lump Sum Payment: Price and payment will be full compensation for all clearing and grubbing required for the roadway right-of-way and for lateral ditches, channel changes, or other outfall areas, and any other clearing and grubbing indicated, or required for the construction of the entire project, including all necessary hauling, furnishing equipment, equipment operation, furnishing any areas required for disposal of debris, leveling of terrain and the landscaping work of trimming, etc., as specified herein, except for any areas designated to be paid for separately or to be specifically included in the costs of other work under the Contract.

Where construction easements are specified in the plans and the limits of clearing and grubbing for such easements are dependent upon the final construction requirements, no adjustment will be made in the lump sum price and payment, either over or under, for variations from the limits of the easement defined on the plans.

110-12.1.2 When No Direct Payment is Provided: When no item for clearing and grubbing is included in the proposal, the Contractor shall include the cost of any work of clearing and grubbing which is necessary for the proper construction of the project in the Contract price for the structure or other item of work for which such clearing and grubbing is required.

The Contractor shall include the cost of all clearing and grubbing which might be necessary in pits or areas from which base material is obtained in the Contract price for the base in which such material is used. The clearing and grubbing of areas for obtaining stabilizing materials, where required only for the purpose of obtaining materials for stabilizing, will not be paid for separately.

110-12.2 Removal of Existing Structures: Price and payment will be full compensation for all work of removal and disposal of the designated structures.

When direct payment for the removal of existing structures is not provided in the proposal, the Contractor shall include the cost of removing all structures in the Contract price for Clearing and Grubbing or, if no item of Clearing and Grubbing is included, in the compensation for the other items covering the new structure being constructed.

110-12.3 Removal of Existing Pavement: Price and payment will be full compensation for performing and completing all the work of removal and satisfactory disposal.

When no separate item for this work is provided and no applicable item of excavation or embankment covering such work (as provided in 120-13.1) is included, the Contractor shall include the costs of this work in the Contract price for the item of Clearing and Grubbing or for the pipe or other structure for which the pavement removal is required.

110-12.4 Plugging Water Wells: Price and payment will be full compensation for each type of well acceptably plugged.

If a water well requiring plugging is encountered and the Contract contains no price for plugging wells of that specific type, the plugging of such well will be paid for as unforeseeable work.

110-12.5 Mailboxes: Price and payment will be full compensation for all work and materials required, including supports and numbers.

110-12.6 Delivery of Salvageable Material to the Department: Price and payment will be full compensation for all work required for delivery of the materials to the Department.

110-12.7 Payment Items: Payment will be made under:

Item No. 110- 1-	Clearing and Grubbing - lump sum.
Item No. 110- 3-	Removal of Existing Structures - lump sum.
Item No. 110- 4-	Removal of Existing Pavement - per square yard.
Item No. 110- 5-	Plugging Water Wells (Artesian) - each.
Item No. 110- 6-	Plugging Water Wells (Non-Artesian) - each.
Item No. 110- 7-	Mailbox (Furnish and Install) - each.
Item No. 110- 86-	Delivery of Salvageable Material to FDOT - lump sum.

SECTION 120
EXCAVATION AND EMBANKMENT

120-1 Description.

120-1.1 General: Excavate and construct embankments as required for the roadway, ditches, channel changes and borrow material. Use suitable excavated material or authorized borrow to prepare subgrades and foundations. Construct embankments in accordance with Standard Index 505. Compact and dress excavated areas and embankments.

For excavation and backfilling of structures, comply with the requirements of Section 125. Excavate material for clearing and grubbing in accordance with the requirements of Section 110. Material displaced by the storm sewer or drainage structure system is not included in the earthwork quantities shown on the plans.

120-1.2 Unidentified Areas of Contamination: When encountering or exposing any abnormal condition indicating the presence of hazardous or toxic wastes, or contaminants, cease operations immediately in the vicinity and notify the Engineer. The presence of tanks or barrels; discolored earth, metal, wood, ground water, etc.; visible fumes; abnormal odors; excessively hot earth; smoke; or other conditions that appear abnormal may indicate hazardous or toxic wastes or contaminants and must be treated with extreme caution.

Make every effort to minimize the spread of contamination into uncontaminated areas. Immediately provide for the health and safety of all workers at the job site and make provisions necessary for the health and safety of the public that may be exposed to any potentially hazardous conditions. Ensure provisions adhere to all applicable laws, rules or regulations covering hazardous conditions and will be in a manner commensurate with the gravity of the conditions.

The Engineer will notify the District Contamination Assessment Coordinator who will coordinate selecting and tasking the Department's Contamination Assessment/Remediation Contractor (CAR). Provide access to the potential contamination area. Preliminary investigation by the CAR Contractor will determine the course of action necessary for site security and the steps necessary under applicable laws, rules, and regulations for additional assessment and/or remediation work to resolve the contamination issue.

The CAR Contractor will delineate the contamination area(s), any staging or holding area required, and, in cooperation with the Prime Contractor and Engineer, develop a work plan that will provide the CAR Contractor's operations schedule with projected completion dates for the final resolution of the contamination issue.

The CAR Contractor will maintain jurisdiction over activities inside any outlined contaminated areas and any associated staging holding areas. The CAR Contractor will be responsible for the health and safety of workers within the delineated areas. Provide continuous access to these areas for the CAR

Contractor and representatives of regulatory or enforcement agencies having jurisdiction.

Both Contractors will use the schedule as a basis for planning the completion of both work efforts. The Engineer may grant the Contract Time extensions according to the provisions of 8-7.3.2.

Cooperate with the CAR Contractor to expedite integration of the CAR Contractor's operations into the construction project. The Prime Contractor is not expected to engage in routine construction activities, such as excavating, grading, or any type of soil manipulation, or any construction processes required if handling of contaminated soil, surface water or ground water is involved. All routine construction activities will be by the CAR Contractor. Adjustments to quantities or to Contract unit prices will be made according to work additions or reductions on the part of the Prime Contractor in accordance with 4-3.

The Engineer will direct the Prime Contractor when operations may resume in the affected area.

120-2 Classifications of Excavation.

120-2.1 General: The Department may classify excavation specified under this Section for payment as any of the following: (1) Regular Excavation, (2) Subsoil Excavation, (3) Lateral Ditch Excavation, and (4) Channel Excavation.

If the proposal does not show Subsoil Excavation or Lateral Ditch Excavation as separate items of payment, include such excavation under the item of Regular Excavation.

If the proposal shows Lateral Ditch Excavation as a separate item of payment, but does not show Channel Excavation as a separate item of payment, include such excavation under the item of Lateral Ditch Excavation. Otherwise, include Channel Excavation under the item of Regular Excavation.

120-2.2 Regular Excavation: Regular Excavation includes roadway excavation and borrow excavation, as defined below for each.

120-2.2.1 Roadway Excavation: Roadway Excavation consists of the excavation and the utilization or disposal of all materials necessary for the construction of the roadway, ditches, channel changes, etc., except as may be specifically shown to be paid for separately and that portion of the lateral ditches within the limits of the roadway right-of-way as shown in the plans.

120-2.2.2 Borrow Excavation: Borrow Excavation consists of the excavation and utilization of material from authorized borrow pits, including only material that is suitable for the construction of roadway embankments or of other embankments covered by the Contract.

A Value Engineering Change Proposal (VECP) submittal based on using borrow material from within the project limits will not be considered.

120-2.3 Subsoil Excavation: Subsoil Excavation consists of the excavation and disposal of muck, clay, rock, or any other material that is unsuitable in its original position and that is excavated below the finished grading template. For stabilized bases and sand bituminous road mixes, consider the finished grading template as the top of the finished base, shoulders and slopes. For all other bases and rigid pavement, consider the finished grading template as the finished shoulder and slope lines and bottom of completed base or rigid pavement. For

pond and ditches that identify the placement of a blanket material, consider the finished grading template as the bottom of the blanket material. Subsoil Excavation also consists of the excavation of all suitable material within the above limits as necessary to excavate the unsuitable material. Consider the limits of Subsoil Excavation indicated on the plans as being particularly variable, in accordance with the field conditions actually encountered.

The quantity of material required to replace the excavated material and to raise the elevation of the roadway to the bottom of the template will be paid for under Embankment or Borrow Excavation (Truck Measure).

120-2.4 Lateral Ditch Excavation: Lateral Ditch Excavation consists of all excavation of inlet and outlet ditches to structures and roadway, changes in channels of streams, and ditches parallel to the roadway right-of-way. Dress lateral ditches to the grade and cross-section shown in the plans.

120-2.5 Channel Excavation: Channel Excavation consists of the excavation and satisfactory disposal of all materials from the limits of the channel as shown in the plans.

120-3 Preliminary Soils Investigations.

When the plans contain the results of a soil survey, do not assume such data is a guarantee of the depth, extent, or character of material present.

120-4 Removal of Unsuitable Materials and Existing Roads.

120-4.1 Subsoil Excavation: Where muck, rock, clay, or other material within the limits of the roadway is unsuitable in its original position, excavate such material to the cross-sections shown in the plans or indicated by the Engineer, and backfill with suitable material. Shape backfill material to the required cross-sections. Where the removal of plastic soils below the finished earthwork grade is required, meet a construction tolerance, from the lines shown in the plans as the removal limits, of ±0.2 feet in depth and ±6 inches (each side) in width.

120-4.2 Construction over Existing Old Road: Where a new roadway is to be constructed over an old one, plow or scarify the old road, and break it up full width, regardless of height of fill. If the plans provide that paving materials may be incorporated into the fill, distribute such material in a manner so as not to create voids. Recompact the old road meeting the requirements of 120-10.2.

120-4.3 Obliterating Old Road: Where the plans call for obliteration of portions of an old road outside of the proposed new roadway, obliterate such sections of the old road by grading to fill ditches and to restore approximately the original contour of the ground or a contour which produces a pleasing appearance.

120-5 Disposal of Surplus and Unsuitable Material.

120-5.1 Ownership of Excavated Materials: Dispose of surplus and excavated materials as shown in the plans or, if the plans do not indicate the method of disposal, take ownership of the materials and dispose of them outside the right-of-way.

120-5.2 Disposal of Muck on Side Slopes: As an exception to the provisions of 120-5. 1, when approved by the Engineer, in rural undeveloped areas, the Contractor may place muck (A-8 material) on the slopes, or store it alongside the roadway, provided there is a clear distance of at least 6 feet between the roadway grading limits and the muck, and the Contractor dresses the muck to present a neat appearance. In addition, the Contractor may also dispose of this material by placing it on the slopes in developed areas where, in the opinion of the Engineer, this will result in an aesthetically pleasing appearance and will have no detrimental effect on the adjacent developments. Where the Engineer permits the disposal of muck or other unsuitable material inside the right-of-way limits, do not place such material in a manner which will impede the inflow or outfall of any channel or side ditches. The Engineer will determine the limits adjacent to channels within which such materials may be disposed.

120-5.3 Disposal of Paving Materials: Unless otherwise noted, take ownership of paving materials, such as paving brick, asphalt block, concrete slab, sidewalk, curb and gutter, etc., excavated in the removal of existing pavements, and dispose of them outside the right-of-way. If the materials are to remain the property of the Department, place them in neat piles as directed. Existing limerock base that is removed may be incorporated in the stabilized portion of the subgrade. If the construction sequence will allow, incorporate all existing limerock base into the project as allowed by the Contract Documents.

120-5.4 Disposal Areas: Where the Contract Documents require disposal of excavated materials outside the right-of-way, and the disposal area is not indicated in the Contract Documents, furnish the disposal area without additional compensation.

Provide areas for disposal of removed paving materials out of sight of the project and at least 300 feet from the nearest roadway right-of-way line of any State-maintained road. If the materials are buried, disregard the 300 foot limitation.

120-6 Borrow.

120-6.1 Materials for Borrow: Do not open borrow pits until the Engineer has approved their location.

Do not provide borrow materials that are polluted as defined in Chapter 376 of the Florida Statutes (oil of any kind and in any form, gasoline, pesticides, ammonia, chlorine, and derivatives thereof, excluding liquefied petroleum gas) in concentrations above any local, State, or Federal standards.

Prior to placing any borrow material that is the product of soil incineration, provide the Engineer with a copy of the Certificate of Materials Recycling and Post Burn Analysis showing that the material is below all allowable pollutant concentrations.

120-6.2 Furnishing of Borrow Areas:

To obtain the Engineer's approval to use an off-site construction activity area that involves excavation such as a borrow pit or local aggregate pit, request in writing, a Cultural Resources Assessment. Send the request to the Division of Historical Resources, Department of State, State Historic Preservation Officer, Tallahassee, FL. As a minimum, include in the request the Project Identification

Number, the County, a description of the property with Township, Range, Section, etc., the dimensions of the area to be affected, and a location map. Do not start any work at the off-site construction activity area prior to receiving a clearance letter from the Division of Archives and written clearance from the Engineer concerning compliance with the Federal Endangered Species Act as specified in 7-1.4.

For certain locations, the Division of Archives will require a Cultural Resources Field Survey before approval can be granted. When this is required, secure professional archaeological services to make the survey and prepare a report. Submit the report to the Division of Archives with a copy to the Department. The Engineer will base final approval or rejection of the use of the off-site construction activity area on the report.

Before receiving approval or before use of borrow areas, obtain written clearance from the engineer concerning compliance with the Federal Endangered Species Act as specified in 7-1.4 and Section 4(f) of the USDOT Act as specified in 7-1.8.

The Department will adjust Contract Time in accordance with 8-7 for any suspension of operations required to comply with this Article. The Department will not accept any monetary claims due to delays or loss of off-site construction activity areas.

Except where the plans specifically call for the use of a particular borrow or dredging area, the Contractor may substitute borrow or dredging areas of his own choosing provided: (1) the Engineer determines the materials from such areas meet the Department's standards and other requirements for stability for use in the particular sections of the work in which it is to be placed, and (2) the Contractor absorbs any increase in hauling or other costs.

Before using any borrow material from any substitute areas, obtain the Engineer's approval, in writing, for the use of the particular areas, and, where applicable, ensure that the Engineer has cross-sectioned the surface. Upon such written approval by the Engineer, consider the substitute areas as designated borrow areas.

When furnishing the dredging or borrow areas, supply the Department with evidence that the necessary permits, rights, or waivers for the use of such areas have been secured.

Do not excavate any part of a Contractor furnished borrow area which is less than 300 feet from the right-of-way of the project or any State Road until the Engineer has approved a plan for landscaping and restoring the disturbed area. Perform this landscaping and land restoration at no expense to the Department, prior to final acceptance of the project. Do not provide a borrow area closer than 25 feet to the right-of-way of any state road. In Department furnished borrow pits, do not excavate material within 5 feet of adjacent property lines.

Upon completion of excavation, neatly shape, dress, grass, vegetate, landscape, and drain all exposed areas including haul roads, as necessary so as not to present an objectionable appearance.

Meet the requirements of Section 104 when furnishing borrow areas, regardless of location.

120-6.3 Borrow Material for Shoulder Build-up: When so indicated in the plans, furnish borrow material with a specific minimum bearing value, for building up of existing shoulders. Blend materials as necessary to achieve this specified minimum bearing value prior to placing the materials on the shoulders. Take samples of this borrow material at the pit or blended stockpile. Include all costs of providing a material with the required bearing value in the Contract unit price for borrow material.

120-6.4 Haul Routes for Borrow Pits: Provide and maintain, at no expense to the Department, all necessary roads for hauling the borrow material. Where borrow area haul roads or trails are used by others, do not cause such roads or trails to deteriorate in condition.

Arrange for the use of all non-public haul routes crossing the property of any railroad. Incur any expense for the use of such haul routes. Establish haul routes which will direct construction vehicles away from developed areas when feasible, and keep noise from hauling operations to a minimum. Advise the Engineer in writing of all proposed haul routes.

120-6.5 Authorization for Use of Borrow: When the item of Borrow Excavation is included in the Contract, use borrow only when sufficient quantities of suitable material are not available from roadway and drainage excavation, to properly construct the embankment, subgrade, and shoulders, and to complete the backfilling of structures. Do not use borrow material until so ordered by the Engineer, and then only use material from approved borrow pits.

120-7 Materials for Embankment.

120-7.1 Use of Materials Excavated From the Roadway and Appurtenances: Assume responsibility for determining the suitability of excavated material for use on the project in accordance with the applicable Contract Documents. Consider the sequence of work and maintenance of traffic phasing in the determination of the availability of this material.

120-7.2 General Requirements for Embankment Materials: Construct embankments of acceptable material including reclaimed asphalt pavement (RAP), reclaimed concrete aggregate (RCA) and portland cement concrete rubble, but containing no muck, stumps, roots, brush, vegetable matter, rubbish, reinforcement bar or other material that does not compact into a suitable and enduring roadbed. Do not use RAP or RCA in the top 3 feet of slopes and shoulders that are to be grassed or have other type of vegetation established.

Remove all waste material designated as undesirable. Use material in embankment construction in accordance with plan details or as the Engineer directs.

Complete the embankment using maximum particle sizes (in any dimension) as follows:

In top 12 inches: 3 1/2 inches (in any dimension).

12 to 24 inches: 6 inches (in any dimension).

In the depth below 24 inches: not to exceed 12 inches (in any dimension) or the compacted thickness of the layer being placed, whichever is less.

Spread all material so that the larger particles are separated from each other to minimize voids between them during compaction. Compact around these rocks in accordance with 120-9.2.

When and where approved by the Engineer, the Contractor may place larger rocks (not to exceed 18 inches in any dimension) outside the one to two slope and at least 4 feet or more below the bottom of the base. Compact around these rocks to a firmness equal to that of the supporting soil. Construct grassed embankment areas in accordance with 120-9.2.6. Where constructing embankments adjacent to bridge end bents or abutments, do not place rock larger than 3 1/2 inches in diameter within 3 feet of the location of any end-bent piling.

120-7.3 Materials Used at Pipes, Culverts, etc.: Construct embankments over and around pipes, culverts, and bridge foundations with selected materials.

120-8 Embankment Construction.

120-8.1 General: Construct embankments in sections of not less than 300 feet in length or for the full length of the embankment. Perform work in accordance with an approved Quality Control Plan meeting the requirements of 105-3.

For construction of mainline pavement lanes, turn lanes, ramps, parking lots, concrete box culverts and retaining wall systems, a LOT is defined as a single lift of finished embankment not to exceed 500 feet.

For construction of shoulder-only areas, bike/shared use paths, and sidewalks areas, a LOT is defined as 2,000 feet or one Day's Production, whichever is greater.

Isolated compaction operations will be considered as separate LOTS. For multiple phase construction, a LOT shall not extend beyond the limits of the phase.

120-8.2 Dry Fill Method:

120-8.2.1 General: Construct embankments to meet compaction requirements in Article 120-9 and in accordance with the acceptance program requirements in 120-10. Restrict the compacted thickness of the last embankment lift to 6 inches maximum.

120-8.2.1.1 For A-3, and A-2-4 Materials with up to 15% fines: Construct the embankment in successive layers with lifts up to a maximum compacted thickness of 12 inches. Ensure the percentage of fines passing the No. 200 US Standard sieve in the A-2-4 material does not exceed 15%.

120-8.2.1.2 For A-1, Plastic materials (As designated in Design Standard Index 505) and A-2-4 Materials with greater than 15% fines: Construct the embankment in successive layers with lifts up to a maximum compacted thickness of 6 inches.

Alternately, for A-1, Plastic material and A-2-4 Materials with greater than 15% fines, construct embankments using thick lift construction in successive layers of not more than 12 inches compacted thickness, after having demonstrated with a successful test section, the possession and control of compacting equipment sufficient to achieve density required by 120-10.2 for the full depth of a thicker lift, and if the Engineer approves the compaction effort. Notify the Engineer prior to beginning construction of a test section. Construct a

test section of the length of one full LOT. Perform five QC tests at random locations within the test section. All five QC tests and a Department Verification test must meet the density required by 120-10.2. Identify the test section with the compaction effort and soil classification in the Density Log Book. In case of a change in compaction effort or soil classification, failing QC test or when the QC tests cannot be verified, construct a new test section. The Contractor may elect to place material in 6 inches compacted thickness at any time. Construct all layers approximately parallel to the centerline profile of the road.

The Engineer reserves the right to terminate the Contractor's use of thick lift construction. Whenever the Engineer determines that the Contractor is not achieving satisfactory results, revert to the 6 inch compacted lifts.

As far as practicable, distribute traffic over the work during the construction of embankments so as to cover the maximum area of the surface of each layer.

Construct embankment in the dry whenever normal dewatering equipment and methods can accomplish the needed dewatering.

120-8.2.1.3 Equipment and Methods: Provide normal dewatering equipment including, but not limited to, surface pumps, sump pumps and trenching/digging machinery. Provide normal dewatering methods including, but not limited to, constructing shallow surface drainage trenches/ditches, using sand blankets, sumps and siphons.

When normal dewatering does not adequately remove the water, the Engineer may require the embankment material to be placed in the water or on low swampy ground in accordance with 120-9.2.3.

120-8.2.2 Placing in Unstable Areas: Where depositing the material in water, or on low swampy ground that will not support the weight of hauling equipment, construct the embankment by dumping successive loads in a uniformly distributed layer of a thickness not greater than necessary to support the hauling equipment while placing subsequent layers. Once sufficient material has been placed so that the hauling equipment can be supported, construct the remaining portion of the embankment in layers in accordance with the applicable provisions of 120-9.2.2 and 120-9.2.4.

120-8.2.3 Placing on Steep Slopes: When constructing an embankment on a hillside sloping more than 20 degrees from the horizontal, before starting the fill, deeply plow or cut into steps the surface of the original ground on which the embankment is to be placed.

120-8.2.4 Placing Outside Standard Minimum Slope: Where material that is unsuitable for normal embankment construction is to be used in the embankment outside the standard minimum slope (approximately one to two), place such material in layers of not more than 18 inches in thickness, measured loose. The Contractor may also place material which is suitable for normal embankment, outside such standard minimum slope, in 18 inch layers. Maintain a constant thickness for suitable material placed within and outside the standard minimum slope, unless placing in a separate operation.

120-8.3 Hydraulic Method:

120-8.3.1 Method of Placing: When the hydraulic method is used, as far as practicable, place all dredged material in its final position in the embankment

by such method. Place and compact any dredged material that is rehandled, or moved and placed in its final position by any other method, as specified in 120-9.2. The Contractor may use baffles or any form of construction he may select provided the slopes of the embankments are not steeper than indicated in the plans. Remove all timber used for temporary bulkheads or baffles from the embankment, and fill and thoroughly compact the holes thus formed. When placing fill on submerged land, construct dikes prior to beginning of dredging, and maintain the dikes throughout the dredging operation.

120-8.3.2 Excess Material: Do not use excess material placed outside the prescribed slopes, below the normal high-water level, to raise the fill. Remove only the portion of this material required for dressing the slopes.

120-8.3.3 Protection of Openings in Embankment: Leave openings in the embankments at the bridge sites. Remove any material which invades these openings or existing channels without additional compensation to provide the same depth of channel as existed before the construction of the embankment. Do not excavate or dredge any material within 200 feet of the toe of the proposed embankment.

120-8.4 Reclaimed Asphalt Pavement (RAP) Method:

120-8.4.1 General: Use only RAP material: 1) stored at facilities with an approved Florida Department of Environmental Protection Stormwater permit; or, 2) transferred directly from a milling project to the Department project. Certify the source if RAP material is from an identifiable Department project. Do not use RAP material in the following areas: 1) Construction areas that are below the seasonal high groundwater table elevation; or 2) MSE Wall backfill.

Prior to placement, submit documentation to the Engineer for his approval, outlining the proposed location of the RAP material.

120-8.4.2 Soil and RAP Mixture: Place the RAP material at the location and spread uniformly**,** using approved methods to obtain a maximum layer thickness of 4 inches. Mix this 4 inches maximum layer of RAP with a loose soil layer of 8 to 10 inches thickness. After mixing, meet all Embankment Utilization requirements of Index 505 for the location used. Do not mix RAP in the uppermost 12 inches in order to comply with 120-8.2.1. The total RAP and other embankment material shall not exceed 12 inches per lift after mixing and compaction if the contractor can demonstrate that the density of the mixture can be achieved. Perform mixing using rotary tillers or other equipment meeting the approval of the Engineer. The Engineer will determine the order in which to spread the two materials. Mix both materials to the full depth. Ensure that the finished layer will have the thickness and shape required by the typical section. Demonstrate the feasibility of this construction method by successfully completing a 500-foot-long test section. For embankment construction, meet the requirements of 120-8. For compaction requirements of the soil and RAP mixture, meet the requirements of 120-9.

120-8.4.3 Alternate Soil and RAP Layer Construction: As an alternate to 120-8.4.2, construct soil and RAP in alternate layers. Use soil with a minimum LBR value of 40 to prevent failure during compaction of the overlying RAP layer. Alternate compacted lifts of RAP layer and soil layer, each with a six-inch-maximum thickness. Demonstrate this construction method by successfully

completing a 500-foot-long test section. For compaction requirements of both soil and RAP, meet the requirements of 120-9.120-9 Compaction Requirements.

120-9 Compaction Requirements.

120-9.1 Moisture Content: Compact the materials at a moisture content such that the specified density can be attained. If necessary to attain the specified density, add water to the material, or lower the moisture content by manipulating the material or allowing it to dry, as is appropriate.

120-9.2 Compaction of Embankments:

120-9.2.1 General: Uniformly compact each layer, using equipment that will achieve the required density, and as compaction operations progress, shape and manipulate each layer as necessary to ensure uniform density throughout the embankment.

120-9.2.2 Compaction Over Unstable Foundations: Where the embankment material is deposited in water or on low swampy ground, and in a layer thicker than 12 inches (as provided in 120-8.2.2), compact the top 6 inches (compacted thickness) of such layer to the density as specified in 120-10.2.

120-9.2.3 Compaction Where Plastic Material Has Been Removed: Where unsuitable material is removed and the remaining surface is of the A-4, A-5, A-6, or A-7 Soil Groups (see AASHTO M-145), as determined by the Engineer, compact the surface of the excavated area by rolling with a sheepsfoot roller exerting a compression of at least 250 psi on the tamper feet, for the full width of the roadbed (subgrade and shoulders). Perform rolling before beginning any backfill, and continue until the roller feet do not penetrate the surface more than 1 inch. Do not perform such rolling where the remaining surface is below the normal water table and covered with water. Vary the procedure and equipment required for this operation at the discretion of the Engineer.

120-9.2.4 Compaction of Material To Be Used In Base, Pavement, or Stabilized Areas: Do not compact embankment material which will be incorporated into a pavement, base course, or stabilized subgrade, to be constructed as a part of the same Contract.

120-9.2.5 Compaction of Grassed Shoulder Areas: For the upper 6-inch layer of all shoulders which are to be grassed, since no specific density is required, compact only to the extent directed.

120-9.2.6 Compaction of Grassed Embankment Areas: For the outer layer of all embankments where plant growth will be established, do not compact. Leave this layer in a loose condition to a minimum depth of 6 inches for the subsequent seeding or planting operations.

120-9.3 Compaction for Pipes, Culverts, etc.: Compact the backfill of trenches to the densities specified for embankment or subgrade, as applicable, and in accordance with the requirements of 125-9.2.

Thoroughly compact embankments over and around pipes, culverts, and bridges in a manner which will not place undue stress on the structures, and in accordance with the requirements of 125-9.2.

120-9.4 Compaction of Subgrade: If the plans do not provide for stabilizing, compact the subgrade (as defined in 1-3) in both cuts and fills, to the density specified in 120-10.2. For undisturbed soils, do not apply density

requirements where constructing narrow widening strips or paved shoulders 5 feet or less in width.

Where trenches for widening strips are not of sufficient width to permit the use of standard compaction equipment, perform compaction using vibratory rollers, trench rollers, or other type compaction equipment approved by the Engineer.

Maintain the required density until the base or pavement is placed on the subgrade.

120-10 Acceptance Program.

120-10.1 General Requirements:

120-10.1.1 Initial Equipment Comparison: Before initial production, perform a comparison test using the Quality Control, Verifications and Independent Assurance gauges. Unless the Engineer instructs, do not perform the initial equipment comparison more than once per project. When comparing the computed dry density of one nuclear gauge to a second gauge, ensure that the difference between the two computed dry densities does not exceed 2 lb/ft^3 between gauges from the same manufacturer, and 3 lb/ft^3 between gauges from different manufacturers. Repair or replace any Quality Control gauge that does not compare favorably with the IA gauge.

Perform a comparison analysis between the Quality Control nuclear gauge and the Verification nuclear gauge any time a nuclear gauge or repaired nuclear gauge is first brought to the project. Repair and replace any Quality Control gauge that does not compare favorably with the Verification gauge at any time during the remainder of the project. Calibrate all Quality Control gauges annually.

120-10.1.2 Initial Production Lot: Before construction of any other LOT, prepare a 500-foot initial control section consisting of one full LOT in accordance with the approved Quality Control Plan for the project. Notify the Engineer at least 24 hours prior to production of the initial control section. Perform all QC tests required in 120-10.1.4. When the initial Quality Control test results pass specifications, the Engineer will perform a Verification test to verify compliance with the specifications. Do not begin constructing another LOT until successfully completing the initial production LOT. The Engineer will notify the Contractor of the initial production lot approval within three working days after receiving the Contractor's Quality Control data when test results meet the following conditions:

Quality Control tests must meet the specifications.

Verification test must meet the specifications.

Difference between Quality Control and Verification computed Dry Density results shall meet the requirements of 120-10.1.1.

If Verification test result fails the density requirements of 120-10.2, correct the areas of non-compliance. The Quality Control and Verification tests will then be repeated. The Engineer will reject the Contractor's Quality Control Plan after three unsuccessful Verification attempts. Submit a revised Quality Control Plan to the Engineer for approval.

120-10.1.3 Density over 105%: When a QC computed dry density results in a value greater than 105% of the applicable Proctor maximum dry density, the Engineer will perform an Independent Verification density test within 5 feet. If the Independent Verification density results in a value greater than 105%, the Engineer will investigate the compaction methods, examine the applicable Standard Proctor Maximum Density and material description. The Engineer may collect and test an Independent Verification Standard Proctor Maximum Density sample for acceptance in accordance with the criteria of 120-10.2.

120-10.1.4 Quality Control Tests:

120-10.1.4.1 Standard Proctor Maximum Density Determination: Determine the Quality Control standard Proctor maximum density and optimum moisture content by sampling and testing the material in accordance with the specified test method listed in 120-10.2.

120-10.1.4.2 Density Testing Requirements: Ensure compliance to the requirements of 120-10.2 by Nuclear Density testing in accordance with FM 1-T 238. Determine the in-place moisture content for each density test. Use Florida Method FM 1-T 238, FM 5-507 (Determination of Moisture Content by Means of a Calcium Carbide Gas Pressure Moisture Tester), or ASTM D-4643 (Laboratory Determination of Moisture Content of Granular Soils By Use of a Microwave Oven) for moisture determination.

120-10.1.4.3 Soil Classification: Perform soil classification tests on the sample collected in 120-10.1.4.1, in accordance with AASHTO T-88. Classify soils in accordance with AASHTO M–145 in order to determine compliance with embankment utilization requirements. Unless required by the Engineer, do not test or classify materials for stabilized subgrade or base.

120-10.1.5 Department Verification: The Engineer will conduct a Verification test(s) in order to accept all materials and work associated with 120-10.1.4. The Engineer will verify the Quality Control results if they meet the Verification Comparison Criteria, otherwise the Engineer will implement Resolution procedures.

The Engineer will select test locations, including Station, Offset, and Lift, using a Random Number generator based on the Lots under consideration. Each Verification test evaluates all work represented by the Quality Control testing completed in those LOTs.

In addition to the Verification testing, the Engineer may perform additional Independent Verification (IV) testing. The Engineer will evaluate and act upon the IV test results in the same manner as Verification test results.

When the project requires less than four Quality Control tests per material type, the Engineer reserves the right to accept the materials and work through visual inspection.

120-10.1.6 Reduced Testing Frequency: When no Resolution testing is required for 12 consecutive verified LOTs, or if required, the QC test data was upheld, reduce the QC density testing to one test every two LOTs by identifying the substantiating tests in the Density Log Book and notifying the Engineer in writing prior to starting reduced frequency of testing. Generate random numbers based on the two LOTs under consideration. When Quality Control test

frequency is reduced to one every two LOTs, obtain the Engineer's approval to place more than one LOT over an untested LOT. Assure similar compaction efforts for the untested LOTs. If the Verification test fails, and Quality Control test data is not upheld by Resolution testing, the Quality Control testing will revert to the original frequency of one Quality Control test per LOT. Do not apply reduced testing frequency in construction of shoulder-only areas, bike/shared use paths and sidewalks.

120-10.2 Acceptance Criteria: Obtain a minimum Quality Control (QC) density of 100% of the standard Proctor maximum density as determined by AASHTO T-99, Method C, with the following exceptions: 1) embankment constructed by the hydraulic method as specified in 120-8.3; 2) material placed outside the standard minimum slope as specified in 120-8.2.4; and 3) other areas specifically excluded herein.

120-10.3 Additional Requirements:

120-10.3.1 Frequency: Conduct QC sampling and testing at a minimum frequency listed in the table below. The Engineer will perform Verification sampling and tests at a minimum frequency listed in the table below.

120-10.3.2 Test Selection and Reporting: Determine test locations including Stations and offsets, using the random number generator approved by the Engineer. Do not use note pads or work sheets to record data for later transfer to the Density Log Book. Notify the Engineer upon successful completion of Quality Control testing on each LOT.

120-10.4 Verification Comparison Criteria and Resolution Procedures:

120-10.4.1 Standard Proctor Maximum Density Determination: The Engineer will verify the Quality Control results if the results compare within 4.5 lb/ft^3 of the Verification test result. Otherwise, the Engineer will take one additional sample of material from the soil type in question. The State Materials Office or an AASHTO accredited laboratory designated by the State Materials Office will perform Resolution testing. The material will be sampled and tested in accordance with AASHTO T-99, Method C.

The Engineer will compare the Resolution Test results with the Quality Control test results. If all Resolution Test results are within 4.5 lb/ft^3 of the corresponding Quality Control test results, the Engineer will use the Quality Control test results for material acceptance purposes for each LOT with that soil type. If the Resolution Test result is not within 4.5 lb/ft^3 of the Contractor's Quality Control test, the Verification Test result will be used for material acceptance purposes.

120-10.4.2 Density Testing: When a Verification or Independent Verification density test fails the Acceptance Criteria, retest the site within a 5 feet radius and the following actions will be taken:

1. If the Quality Control retest meets the Acceptance Criteria and meets the 120-10.1.1 criteria when compared with the Verification or Independent Verification test, the Engineer will accept those LOTs.

2. If the Quality Control retest does not meet the Acceptance Criteria and compares favorably with the Verification or Independent Verification test, rework and retest the LOT. The Engineer will re-verify those LOTs.

3. If the Quality Control retest and the Verification or Independent Verification test do not compare favorably, complete a new comparison analysis as defined in 120-10.1.1. Once acceptable comparison is achieved, retest the LOTs. The Engineer will perform new verification testing. Acceptance testing will not begin on a new LOT until the Contractor has a gauge that meets the comparison requirements.

Record Quality Control test results in the density log book on approved Department forms provided by the Engineer. Submit the original, completed density log book to the Engineer at final acceptance.

120-10.4.3 Soil Classification: The Engineer will verify the Quality Control results if the Verification results identify matching soil classifications. Otherwise, the Engineer will take one additional sample of material from the soil type in question. The State Materials Office or an AASHTO accredited laboratory designated by the State Materials Office will perform Resolution testing. The material will be sampled and tested in accordance with AASHTO T-88.

The Engineer will compare the Resolution Test results with the Quality Control test results. If the Resolution test matches the Quality Control classification, the Engineer will use the Quality Control classification for material acceptance purposes. If the Resolution Test result does not match the Contractor's Quality Control classification, the Verification Test result will be used for material acceptance purposes.

120-11 Maintenance and Protection of Work.

While construction is in progress, maintain adequate drainage for the roadbed at all times. Maintain a shoulder at least 3 feet wide adjacent to all pavement or base construction in order to provide support for the edges.

Maintain all earthwork construction throughout the life of the Contract, and take all reasonable precautions to prevent loss of material from the roadway due to the action of wind or water. Repair, at no expense to the Department except as otherwise provided herein, any slides, washouts, settlement, subsidence, or other mishap which may occur prior to final acceptance of the work. Perform maintenance and protection of earthwork construction in accordance with Section 104.

Maintain all channels excavated as a part of the Contract work against natural shoaling or other encroachments to the lines, grades, and cross-sections shown in the plans, until final acceptance of the project.

120-12 Construction.

120-12.1 Construction Tolerances: Shape the surface of the earthwork to conform to the lines, grades, and cross-sections shown in the plans. In final shaping of the surface of earthwork, maintain a tolerance of 0.3 foot above or below the plan cross-section with the following exceptions:

1. Shape the surface of shoulders to within 0.1 foot of the plan cross-section.

2. Shape the earthwork to match adjacent pavement, curb, sidewalk, structures, etc.

3. Shape the bottom of ditches so that the ditch impounds no water.

4. When the work does not include construction of base or pavement, shape the entire roadbed (shoulder point to shoulder point) to within 0.1 foot above or below the plan cross-section.

Ensure that the shoulder lines do not vary horizontally more than 0.3 foot from the true lines shown in the plans.

120-12.2 Operations Adjacent to Pavement: Carefully dress areas adjacent to pavement areas to avoid damage to such pavement. Complete grassing of shoulder areas prior to placing the final wearing course. Do not manipulate any embankment material on a pavement surface.

When shoulder dressing is underway adjacent to a pavement lane being used to maintain traffic, exercise extreme care to avoid interference with the safe movement of traffic.

120-13 Method of Measurement.

120-13.1 General: When payment for excavation is on a volumetric basis, the quantity to be paid for will be the volume, in cubic yards, calculated by the method of average end areas, unless the Engineer determines that another method of calculation will provide a more accurate result. The material will be measured in its original position by field survey or by photogrammetric means as designated by the Engineer, unless otherwise specified under the provisions for individual items.

Where Subsoil Excavation extends outside the lines shown in the plans or authorized by the Engineer including allowable tolerances, and the space is backfilled with material obtained in additional authorized roadway or borrow excavation, the net fill, plus shrinkage allowance, will be deducted from the quantity of Roadway Excavation or Borrow Excavation to be paid for, as applicable.

The quantity of all material washed, blown, or placed beyond the authorized roadway cross-section will be determined by the Engineer and will be deducted from the quantity of Roadway Excavation or Borrow Excavation to be paid for, as applicable.

Subsoil Excavation that extends outside the lines shown in the plans or authorized by the Engineer including allowable tolerances will be deducted from the quantity to be paid for as Subsoil Excavation.

120-13.2 Roadway Excavation: The measurement will include only the net volume of material excavated between the original ground surface and the surface of the completed earthwork, except that the measurement will also include all unavoidable slides which may occur in connection with excavation classified as Roadway Excavation.

The pay quantity will be the plan quantity provided that the excavation was accomplished in substantial compliance with the plan dimensions and subject to the provisions of 9-3.2 and 9-3.4. On designated 3-R Projects, Regular Excavation will be paid for at the Contract lump sum price provided that the excavation was accomplished in substantial compliance with the plan dimension.

120-13.3 Borrow Excavation: Measurement will be made on a loose volume basis, as measured in trucks or other hauling equipment at the point of

dumping on the road. If measurement is made in vehicles, level the material to facilitate accurate measurement.

Unsuitable material excavated from borrow pits where truck measurement is provided for and from any borrow pits furnished by the Contractor, will not be included in the quantity of excavation to be paid for.

120-13.4 Lateral Ditch Excavation: The measurement will include only material excavated within the lines and grades indicated in the plans or as directed by the Engineer. The measurement will include the full station-to-station length shown in the plans or directed by the Engineer and acceptably completed. Excavation included for payment under Section 125 will not be included in this measurement.

The pay quantity will be the plan quantity provided that the excavation was accomplished in substantial compliance with the plan dimensions and subject to the provisions of 9-3.2 and 9-3.4.

120-13.5 Channel Excavation: The measurement will include only material excavated within the lines and grades indicated in the plans or in accordance with authorized plan changes. The measurement will include the full station-to-station length shown in the plans including any authorized changes thereto.

If shoaling occurs subsequent to excavation of a channel and the Engineer authorized the shoaled material to remain in place, the volume of any such material remaining within the limits of channel excavation shown in the plans will be deducted from the measured quantity of Channel Excavation.

120-13.6 Subsoil Excavation: The measurement will include only material excavated within the lines and grades indicated in the plans (including the tolerance permitted therefore) or as directed by the Engineer.

When no item for Subsoil Excavation is shown in the proposal but Subsoil Excavation is subsequently determined to be necessary, such unanticipated Subsoil Excavation will be paid for as provided in 4-4.

120-13.7 Embankment: The quantity will be at the plan quantity.

Where payment for embankment is not to be included in the payment for the excavation, and is to be paid for on a cubic yard basis for the item of Embankment, the plan quantities to be paid for will be calculated by the method of average end areas unless the Engineer determines that another method of calculation will provide a more accurate result. The measurement will include only material actually placed above the original ground line, within the lines and grades indicated in the plans or directed by the Engineer. The length used in the computations will be the station-to-station length actually constructed. The original ground line used in the computations will be as determined prior to placing of embankment subject to the provisions of 9-3.2, and no allowance will be made for subsidence of material below the surface of the original ground.

If there are authorized changes in plan dimensions or if errors in plan quantities are detected, plan quantity will be adjusted as provided in 9-3.2.

Where the work includes excavation of unsuitable material below the finished grading template or original ground line, whichever is lower as defined in 120-3.3, the original ground line is defined as the surface prior to beginning excavation, except that this surface is not outside the permissible tolerance of lines and grades for Subsoil Excavation as indicated in the plans or as directed by

the Engineer. Any overrun or underrun of plan quantity for Subsoil Excavation which results in a corresponding increase or decrease in embankment will be considered as an authorized plan change for adjustment purposes as defined in 9-3.2.2.

No payment will be made for embankment material used to replace unsuitable material excavated beyond the lines and grades shown in the plans or ordered by the Engineer.

In no case will payment be made for material allowed to run out of the embankment on a flatter slope than indicated on the cross-section. The Contractor shall make his own estimate on the volume of material actually required to obtain the pay section.

120-14 Basis of Payment.

120-14.1 General: Prices and payments for the various work items included in this Section will be full compensation for all work described herein, including excavating, dredging, hauling, placing, and compacting; dressing the surface of the earthwork; maintaining and protecting the complete earthwork; and hauling.

The Department will not allow extra compensation for any rehandling of materials.

The Department will compensate for the cost of grassing or other permanent erosion control measures directed by the Engineer as provided in the Contract for similar items of roadway work.

120-14.2 Excavation:

120-14.2.1 Items of Payment: When no classification of material is indicated in the plans, and bids are taken only on Regular Excavation, the total quantity of all excavation specified under this Section will be paid for at the Contract unit price for Regular Excavation.

When separate classifications of excavation are shown in the proposal, the quantities of each of the various classes of materials so shown will be paid for at the Contract unit prices per cubic yard for Regular Excavation, Lateral Ditch Excavation, Subsoil Excavation, and Channel Excavation, as applicable, and any of such classifications not so shown will be included under the item of Regular Excavation (except that if there is a classification for Lateral Ditch Excavation shown and there is no classification for Channel Excavation, any channel excavation will be included under the item of Lateral Ditch Excavation). As an exception, on designated Projects, Regular Excavation will be paid for at the Contract lump sum price.

120-14.2.2 Basic Work Included in Payments: Prices and payments will be full compensation for all work described under this Section, except for any excavation, or embankment which is specified to be included for payment under other items. Such prices and payments will include hauling; any rehandling that may be necessary to accomplish final disposal as shown in the plans; the dressing of shoulders, ditches and slopes; removal of trash, vegetation, etc., from the previously graded roadway where no item for clearing and grubbing is shown in the plans; and compacting as required.

120-14.2.3 Additional Depth of Subsoil Excavation: Where Subsoil Excavation is made to a depth of 0 to 5 feet below the depth shown on the Contract plans, such excavation will be paid for at the unit price bid.

Where Subsoil Excavation is made to a depth greater than 5 feet, and up to 15 feet, deeper than the depth shown on the Contract plans, such excavation will be paid for at the unit price bid plus 25% of such unit price. Additional extra depth, more than 15 feet below such plan depth, will be considered as a change in the character of the work and will be paid for as Unforeseeable Work.

Where no subsoil excavation is shown in a particular location on the original plans, payment for extra depth of subsoil will begin 5 feet below the lowest elevation on the grading template.

120-14.2.4 Borrow Excavation: When the item of Borrow Excavation is included in the Contract, price and payment will also include the cost of furnishing the borrow areas and any necessary clearing and grubbing thereof, the removal of unsuitable material that it is necessary to excavate in order to obtain suitable borrow material, and also the costs incurred in complying with the provisions of 120-6.3.

120-14.2.5 Materials Excluded from Payment for the Excavation: No payment as excavation will be made for any excavation covered for payment under the item of Embankment.

No payment will be made for the excavation of any materials which are used for purposes other than those shown in the plans or designated by the Engineer. No payment will be made for materials excavated outside the lines and grades given by the Engineer, unless specifically authorized by the Engineer; except that, in the operations of roadway excavation, all slides and falls of insecure masses of material beyond the regular slopes and not due to lack of precaution on the part of the Contractor will be paid for at the Contract unit price for the material involved. The removal of slides and falls of material classified as Lateral Ditch Excavation or as Subsoil Excavation will not be paid for separately, but will be included in the Contract unit price for the pay quantity of these materials, measured as provided in 120-14.

120-14.3 Embankment:

120-14.3.1 General: Price and payment will be full compensation for all work specified in this Section, including all material for constructing the embankment; all excavating, dredging, pumping, placing and compacting of material for constructing the embankment complete; dressing of the surface of the roadway, maintenance and protection of the completed earthwork, and the removal of rubbish, vegetation, etc., from the roadway, where no clearing and grubbing of the area is specified in the plans. Also, such price and payment, in each case, will specifically include all costs of any roadway, lateral ditch, or channel excavation, unless such excavation is specifically shown to be paid for separately, regardless of whether the materials are utilized in the embankment.

120-14.3.2 Excluded Material: No payment will be made for the removal of muck or overburden from the dredging or borrow areas. No payment will be made for embankment material used to replace muck or other unsuitable material excavated beyond the lines and grades shown in the plans or ordered by the Engineer.

120-14.3.3 Clearing and Grubbing: No payment will be made for any clearing and grubbing of the borrow or dredging areas. Where no clearing and grubbing of such areas is specified in the plans, the cost of any necessary clearing and grubbing will be included in the Contract unit or lump sum price for Embankment.

120-14.3.4 Cost of Permits, Rights, and Waivers: Where the Contractor provides borrow or dredging areas of his own choosing, the cost of securing the necessary permits, rights or waivers will be included in the Contract price for Embankment.

120-14.4 Payment Items: Payment will be made under:

Item No. 120- 1-	Regular Excavation - per cubic yard.
Item No. 120- 2-	Borrow Excavation - per cubic yard.
Item No. 120- 3-	Lateral Ditch Excavation - per cubic yard.
Item No. 120- 4-	Subsoil Excavation - per cubic yard.
Item No. 120- 5-	Channel Excavation - per cubic yard.
Item No. 120- 6-	Embankment - per cubic yard.
Item No. 120- 71-	Regular Excavation (3-R Projects) - lump sum.

SECTION 121
FLOWABLE FILL

121-1 Description.

Furnish and place Flowable Fill as an alternative to compacted soil as approved by the Engineer. Applications for this material include, beddings, encasements, closures for tanks, pipes, and general backfill for trenches.

121-2 Materials.

Meet the following requirements:

Fine Aggregate*.....Section 902
Portland Cement (Types I, II, or III).....Section 921
Water.....Section 923
Air Entraining Admixtures** .....Section 924
Fly Ash, Slag and other Pozzolanic Materials.....Section 929

*Any clean fine aggregate with 100% passing a 3/8 inch mesh sieve and not more than 15% passing a No. 200 sieve may be used.

**High air generators or foaming agents may be used in lieu of conventional air entraining admixtures and may be added at jobsite and mixed in accordance with manufacturer's recommendation.

121-3 Mix Design.

Flowable Fill is a mixture of portland cement, fly ash, fine aggregate, air entraining admixture and water. Flowable fill contains a low cementitious content for reduced strength development.

Submit mix designs to the Engineer for approval. The following are suggested mix guides for excavatable and non-excavatable flowable fill:

	Excavatable	Non-Excavatable
Cement Type 1	75-100 lb/yd^3	75-150 lb/yd^3
Fly Ash	None	150-600 lb/yd^3
Water	*	*
Air**	5-35%	5-15%
28 Day Compressive Strength**	Maximum 100 psi	Minimum 125 psi
Unit Weight (Wet)**	90-110 lb/ft^3	100-125 lb/ft^3
*Mix designs shall produce a consistency that will result in a flowable self-leveling product at time of placement. **The requirements for percent air, compressive strength and unit weight are for laboratory designs only and are not intended for jobsite acceptance requirements. Fine Aggregate shall be proportioned to yield 1 yd3.		

121-4 Production and Placing.

Use flowable fill manufactured at a production facility that meets the requirements of 347-3.

Deliver flowable fill using concrete construction equipment. Revolution counter are waived. Place flowable fill by chute, pumping or other methods approved by the Engineer. Tremie flowable fill through water.

121-5 Construction Requirements.

Use straps, soil anchors or other approved means of restraint to ensure correct alignment when flowable fill is used as backfill for pipe or where flotation or misalignment may occur.

Protect flowable fill from freezing for a period of 36 hours after placement.

Place flowable fill to the designated fill line without vibration or other means of compaction. Do not place flowable fill during inclement weather, e.g. rain or ambient temperatures below 40ºF. Take all necessary precautions to prevent any damages caused by the hydraulic pressure of the fill during placement prior to hardening. Provide the means to confine the material within the designated space.

121-6 Acceptance.

Acceptance of flowable fill will be based on the following documentation and a minimum temperature of flowable fill at the point of delivery of 50ºF.

Furnish a delivery ticket to the Engineer for each load of flowable fill delivered to the worksite. Ensure that each ticket contains the following information:

(1) Project designation,
(2) Date,
(3) Time,
(4) Class and quantity of flowable fill,
(5) Actual batch proportions,
(6) Free moisture content of aggregates,
(7) Quantity of water withheld.

Leave the fill undisturbed until the material obtains sufficient strength. Sufficient strength is 35 psi penetration resistance as measured using a hand held penetrometer in accordance with ASTM C-403. Provide a hand held penetrometer to measure the penetration resistance of the hardened flowable fill.

121-7 Basis of Payment.

When the item of flowable fill is included in the Contract, payment will be made at the Contract unit price per cubic yard. Such price and payment will include all cost of the mixture, in place and accepted, determined as specified above. No measurement and payment will be made for material placed outside the neat line limits or outside the adjusted limits, or for unused or wasted material.

Payment will be made under:

Item No. 121- 70- Flowable Fill - per cubic yard.

SECTION 125
EXCAVATION FOR STRUCTURES AND PIPE

125-1 Description.

Excavate for bridge foundations, box culverts, pipe culverts, storm sewers and all other pipe lines, retaining walls, headwalls for pipe culverts and drains, catch basins, drop inlets, manholes, and similar structures. Construct and remove cofferdams, sheeting, bracing, etc.; pump or otherwise dewater foundations; remove and dispose of any existing structures or portions of structures not covered by other items in the Contract, including foundations, abutments, piers, wings, and all other materials, obstructions, etc., found necessary to clear the site for the proposed work; backfill, dispose of surplus material, and perform final cleaning, as may be necessary for the proper execution of the work. This Section does not include excavation for bases or pavements, curbs, curb and gutter, valley gutter, ditch pavement, or rubble gutter. Perform work in accordance with an approved Quality Control Plan meeting the requirements of 105-3.

125-1.1 Trench Excavation Safety System and Shoring, Special (Trench Excavation): When performing trench excavation in excess of 5 feet in depth, comply with the Occupational Safety and Health Administration's (OSHA) trench safety standards, 29 C.F.R., s. 1926.650, Subpart P, and all subsequent revisions or updates adopted by the Department of Labor and Employment Security. Ensure that trench boxes are wide enough to accommodate compaction and density testing.

Submission of bid and subsequent execution of the Contract will serve as certification that all trench excavation in excess of 5 feet in depth will be in compliance with Section 553.62, Florida Statutes.

Consider all available geotechnical information available when designing the trench excavation safety system.

Consider these and any more stringent trench safety standards as minimum Contract requirements.

125-2 Classification.

Consider all materials excavated as unclassified and as excavation regardless of the material encountered.

125-3 Cofferdams.

125-3.1 Construction:

125-3.1.1 Methods: Construct all foundations by open excavation, and shore, brace, or protect the foundation openings with cofferdams. Provide cofferdams or cribs for foundation construction below the bottom of the footings. Provide sufficient clearance in the cofferdam interiors to permit construction of forms and inspection of their exteriors, and for pumping equipment.

125-3.1.2 Protection of Concrete: Construct cofferdams to protect green concrete against damage from a sudden rising of the water and to prevent damage by erosion. Do not leave timber or bracing in cofferdams or cribs that extend into the substructure masonry except where permitted in writing by the Engineer.

125-3.1.3 Placing in the Dry: For placing footings in the dry, the Engineer may require cofferdam sheeting to be driven to an elevation 6 feet below the elevation of the bottom of the footings and require sufficient pumping equipment to dewater and maintain the cofferdam in a comparatively dry condition.

125-3.1.4 Working Drawings: For substructure work, submit drawings showing the proposed method of cofferdam construction and other details left to choice or not fully shown on the plans. Obtain the Engineer's approval of the type and clearance of cofferdams, insofar as such details affect the character of the finished work. For other details of design that do not affect the character of the finished work, assume responsibility for the successful construction of the work. Retain a Professional Engineer, registered in the State of Florida, to prepare the above construction drawing, and keep a signed and sealed copy on hand at the site at all times. On completion of the work, furnish the Department with as-built drawings on permanent reproducible material as noted in 5-1.4.1.

125-3.2 Removal: Unless otherwise provided, remove cofferdams or cribs, with all sheeting and bracing, after completion of the substructure without disturbing or marring the finished masonry.

125-4 Excavation.

125-4.1 Requirements for all Excavation: Excavate foundation pits to permit the placing of the full widths and lengths of footings shown in the plans, with full horizontal beds. Do not round or undercut corners or edges of footings. Perform all excavation to foundation materials, satisfactory to the Engineer, regardless of the elevation shown on the plans. Perform all excavation in stream beds to a depth at least 4 feet below the permanent bed of the stream, unless a firm footing can be established on solid rock before such depth is reached, and excavate to such additional depth as may be necessary to eliminate any danger of undermining. Wherever rock bottom is secured, excavate in such manner as to allow the solid rock to be exposed and prepared in horizontal beds for receiving the masonry. Remove all loose and disintegrated rock or thin strata. Have the

Engineer inspect and approve all foundation excavations prior to placing masonry.

125-4.2 Earth Excavation:

125-4.2.1 Foundation Material other than the Rock: When masonry is to rest on an excavated surface other than rock, take special care to avoid disturbing the bottom of the excavation, and do not remove the final foundation material to grade until just before placing the masonry. In case the foundation material is soft or mucky, the Engineer may require excavation to a greater depth and to backfill to grade with approved material.

125-4.2.2 Foundation Piles: Where foundation piles are used, complete the excavation of each pit before driving the piles. After the driving is completed, remove all loose and displaced material, leaving a smooth, solid, and level bed to receive the masonry.

125-4.2.3 Removal of Obstructions: Remove boulders, logs, or any unforeseen obstacles encountered in excavating. Compensation will be in accordance with the requirements of 4-3.4.

125-4.3 Rock Excavation: Clean all rock and other hard foundation material, remove all loose material, and cut all rock to a firm surface. Either level, step vertically and horizontally, or serrate the rock, as may be directed by the Engineer. Clean out all seams, and fill them with concrete or mortar.

125-4.4 Pipe Trench Excavation: : Excavate trenches for pipe culverts and storm sewers to the elevation of the bottom of the pipe and to a width sufficient to provide adequate working room. Remove soil not meeting the classification specified as suitable backfill material in 125-8.3.2.2, to a depth of 4 inches below the bottom of the pipe elevation. Remove rock, boulders or other hard lumpy or unyielding material to a depth of 12 inches below the bottom of the pipe elevation. Remove muck or other soft material to a depth necessary to establish a firm foundation. Where the soils permit, ensure that the trench sides are vertical up to at least the mid-point of the pipe.

For pipe lines placed above the natural ground line, place and compact the embankment, prior to excavation of the trench, to an elevation at least 2 feet above the top of the pipe and to a width equal to four pipe diameters, and then excavate the trench to the required grade.

For pipe trenches utilizing trench boxes, ensure that the trench box used is of sufficient width to permit thorough tamping of bedding material under and around the pipes as specified in 125-8.1.6.

Do not disturb the installed pipe and its embedment when moving trench boxes. Move the trench box carefully to avoid excavated wall displacement or damage. As the trench box is moved, fill any voids left by the trench box and continuously place and compact the backfill material adjacent to and all along the side of the trench box walls to fill any voids created by the trench box.

125-5 Preservation of Channel.

125-5.1 General: Unless shown on the plans, do not excavate outside of caissons, cribs, cofferdams, or sheet piling, and do not disturb the natural stream bed adjacent to the structure. If excavating or dredging at the site of the structure before sinking caissons, cribs, or cofferdams, complete the foundation and

backfill all such excavations to the original ground surface or other required elevation, with material satisfactory to the Engineer.

125-5.2 Removal of Excavated Materials: Do not allow materials that are deposited adjacent to the stream area to infiltrate the water areas. Leave the stream in its original condition.

125-6 Disposal of Surplus.

Use suitable excavated materials for backfilling over or around the structure. Dispose of unsuitable materials. Meet the disposal requirements pertaining to water pollution contained in Section 104 and in 7-1.1.

125-7 Pumping.

Pump from the interior of any foundation enclosure in such manner as to preclude the possibility of any portion of the concrete materials being carried away. Do not pump while placing concrete, or for a period of at least 24 hours thereafter, unless using a suitable pump separated from the concrete work by a watertight wall.

125-8 Backfilling.

125-8.1 General Requirements for Structures and Pipe:

125-8.1.1 General: Backfill in the dry whenever normal dewatering equipment and methods can accomplish the needed dewatering. A LOT is defined as one lift of backfill material placement, not to exceed 500 feet in length or a single run of pipe connecting two successive structures, whichever is less. Backfill around structures compacted separately from the pipe will be considered as separate LOTs. Backfill on each side of the pipe for the first lift will be considered a separate LOT. Backfill on opposite sides of the pipe for the remaining lifts will be considered separate LOTs, unless the same compactive effort is applied. Same compactive effort is defined as the same type of equipment (make and model) making the same number of passes on both sides of the pipe. For multiple phase backfill, a LOT shall not extend beyond the limits of the phase.

When placing backfill within trench box each lift of backfill is considered a LOT. Placement of backfill within trench box limits will be considered a complete operation before trench box is moved for next backfill operation. When the trench box is moved for next backfill operation this will start new LOTs for each lift. Follow the density testing frequency in 125-9.3.1.

125-8.1.2 Equipment and Methods: Provide normal dewatering equipment including, but not limited to, surface pumps, sump pumps, wellpoints and header pipe and trenching/digging machinery. Provide normal dewatering methods including, but not limited to, constructing shallow surface drainage trenches/ditches, using sand blankets, perforated pipe drains, sumps and siphons.

125-8.1.3 Backfill Materials: Backfill to the original ground surface or subgrade surface of openings made for structures, with a sufficient allowance for settlement. The Engineer may require that the material used for this backfill be obtained from a source entirely apart from the structure. Use only material accepted by the Engineer.

Do not allow heavy construction equipment to cross over culvert or storm sewer pipes until placing and compacting backfill material to the finished earthwork grade or to an elevation at least 4 feet above the crown of the pipe.

125-8.1.4 Use of A-7 Material: In the backfilling of trenches, A-7 material may be used from a point 12 inches above the top of the pipe up to the elevation shown on the Design Standards as the elevation for undercutting of A-7 material.

125-8.1.5 Time of Placing Backfill: Do not place backfill against any masonry or concrete abutment, wingwall, or culvert until the Engineer has given permission to do so, and in no case until the masonry or concrete has been in place seven days or until the specified 28-day compressive strength occurs.

125-8.1.6 Placement and Compaction: Place the material in horizontal layers not exceeding 6 inches compacted thickness, in depth above water level, behind abutments, wingwalls and end bents or end rest piers, under the haunches of the pipes and around box culverts and all structures including pipe culverts. When the backfill material is deposited in water, compact as specified in 125-8.2.5 and 125-8.3.4.

The Contractor may elect to place material in thicker lifts of no more than 12 inches compacted thickness above the Soil Envelope if he can demonstrate with a successful test section that density can be achieved. Notify the Engineer prior to beginning construction of a test section. Construct a test section of the length of one LOT. Perform five QC tests at random locations within the test section. All five tests must meet the density required by 125-9.2 and be verified by the Department. Identify the test section with the compaction effort and soil classification in the Logbook. In case of a change in compaction effort or soil classification, construct a new test section. When a QC test fails the requirements of 125-9.2 or when the QC tests cannot be verified, construct a new test section. The Contractor may elect to place material in 6 inches compacted thickness at any time.

125-8.2 Additional Requirements for Structures Other than Pipe:

125-8.2.1 Density: Where the backfill material is deposited in water, obtain a 12 inch layer of comparatively dry material, thoroughly compacted by tamping, before verifying the layer and density requirements. Meet the requirements of 125-9.2.

125-8.2.2 Box Culverts: For box culverts over which pavement is to be constructed, compact around the structure to an elevation not less than 12 inches above the top of the structure, using rapid-striking mechanical tampers.

125-8.2.3 Other Limited Areas: Compact in other limited areas using mechanical tampers or approved hand tampers, until the cover over the structure is at least 12 inches thick. When hand tampers are used, deposit the materials in layers not more than 4 inches thick using hand tampers suitable for this purpose with a face area of not more than 100 in^2. Take special precautions to prevent any wedging action against the masonry, and step or terrace the slope bounding the excavation for abutments and wingwalls if required by the Engineer.

125-8.2.4 Culverts and Piers: Backfill around culverts and piers on both sides simultaneously to approximately the same elevation.

125-8.2.5 Compaction Under Wet Conditions: Where wet conditions do not permit the use of mechanical tampers, compact using hand tampers. Use only A-3 material for the hand tamped portions of the backfill. When the backfill has reached an elevation and condition such as to make the use of the mechanical tampers practical, perform mechanical tamping in such manner and to such extent as to transfer the compaction force into the sections previously tamped by hand.

125-8.3 Additional Requirements for Pipe 15 Inches Inside Diameter or Greater:

125-8.3.1 General: Trenches for pipe may have up to four zones that must be backfilled.

Lowest Zone: The lowest zone is backfilled for deep undercuts up to within 4 inches of the bottom of the pipe.

Bedding Zone: The zone above the Lowest Zone is the Bedding Zone. Usually it will be the backfill which is the 4 inches of soil below the bottom of the pipe. When rock or other hard material has been removed to place the pipe, the Bedding Zone will be the 12 inches of soil below the bottom of the pipe.

Cover Zone: The next zone is backfill that is placed after the pipe has been laid and will be called the Cover Zone. This zone extends to 12 inches above the top of the pipe. The Cover Zone and the Bedding Zone are considered the Soil Envelope for the pipe.

Top Zone: The Top Zone extends from 12 inches above the top of the pipe to the base or final grade.

125-8.3.2 Material:

125-8.3.2.1 Lowest Zone: Backfill areas undercut below the Bedding Zone of a pipe with coarse sand, or other suitable granular material, obtained from the grading operations on the project, or a commercial material if no suitable material is available.

125-8.3.2.2 Soil Envelope: In both the Bedding Zone and the Cover Zone of the pipe, backfill with materials classified as A-1, A-2, or A-3. Material classified as A-4 may be used if the pipe is concrete pipe.

125-8.3.2.3 Top Zone: Backfill the area of the trench above the soil envelope of the pipe with materials allowed on Design Standard, Index No. 505.

125-8.3.3 Compaction:

125-8.3.3.1 Lowest Zone: Compact the soil in the Lowest Zone to approximately match the density of the soil in which the trench was cut.

125-8.3.3.2 Bedding Zone: If the trench was not undercut below the bottom of the pipe, loosen the soil in the bottom of the trench immediately below the approximate middle third of the outside diameter of the pipe.

If the trench was undercut, place the bedding material and leave it in a loose condition below the middle third of the outside diameter of the pipe. Compact the outer portions to meet the density requirements of the Acceptance Criteria. Place the material in lifts no greater than 6 inches (compacted thickness).

125-8.3.3.3 Cover Zone: Before placing the Cover Zone material, lay pipe according to Section 430. Excavate for pipe bells before laying pipe.

Place the material in 6 inches layers (compacted thickness), evenly deposited on both sides of the pipe, and compact with mechanical tampers suitable for this purpose. Hand tamp material below the pipe haunch that cannot be reached by mechanical tampers. Meet the requirements of in 125-9.2.

125-8.3.3.4 Top Zone: Place the material in layers not to exceed 12 inches in compacted thickness. Meet the requirements of the density Acceptance Criteria.

125-8.3.4 Backfill Under Wet Conditions: Where wet conditions are such that dewatering by normal pumping methods would not be effective, the procedure outlined below may be used when specifically authorized by the Engineer in writing. The Department will pay for any select material which is not available from the grading as Unforeseeable Work. The Department will not pay for select material that might be used by the Contractor for his own convenience instead of dewatering.

The Department will permit the use of granular material below the elevation at which mechanical tampers would be effective, but only material classified as A-3. Place and compact the material using timbers or hand tampers until the backfill reaches an elevation such that its moisture content will permit the use of mechanical tampers. When the backfill has reached such elevation, use normally acceptable backfill material. Compact the material using mechanical tampers in such manner and to such extent as to transfer the compacting force into the material previously tamped by hand.

The Department will permit the use of coarse aggregate below the elevation at which mechanical tampers would be effective. Use coarse aggregate as specified in Section 901 for Aggregate Size Number 89, 8, 78, 7, 68, 6, or 57. Place the coarse aggregate such that it will be stable and firm. Fully wrap the aggregate with a layer of Type D-4 filter fabric, as specified on Design Standard, Index No. 199. Do not place coarse aggregate within 4 feet of the ends of the trench or ditch. Use normally accepted backfill material at the ends.

125-9 Acceptance Program.

125-9.1 General Requirements: Meet the requirements of 120-10, except replace the requirements of 120-10.2 with 125-9.2.

125-9.1.1 Reduced Testing Frequency: When no Resolution testing is required for 6 consecutive LOTs, or if required, the Quality Control test data was upheld, reduce the Quality Control density testing to one test every two Lots by identifying the substantiating tests in the Density Log Book and notifying the Engineer in writing prior to starting reduced frequency of testing. Generate random numbers based on the two LOTs under consideration. When Quality Control test frequency is reduced to one every two LOTs, obtain the Engineer's approval to place more than one LOT over an untested LOT. Assure similar compaction efforts for the untested sections. If the Verification test fails, and Quality Control test data is not upheld by Resolution testing the Quality Control testing will revert to the original frequency.

125-9.2 Acceptance Criteria:

125-9.2.1 Density: Obtain a minimum Quality Control (QC) density in any LOT of 100% of the Standard Proctor maximum density as determined by

AASHTO T-99, Method C, or the requirements of 125-8.3.3.1 when applicable. For metal and plastic pipe, compact the backfill in the cover zone to a density of at least 95% of the Standard Proctor maximum density as determined by AASHTO T-99, Method C.

125-9.2.2 Exceptions to Structures and Pipe Density Requirements: Compact the backfill to a firmness approximately equal to that of the soil next to the pipe trench in locations outside the plane described by a two (horizontal) to one (vertical) slope downward from the roadway shoulder line or the back of curb as applicable. Apply 125-9.2.1 when compacting side-drain pipe backfill under driveways serving a property that is not a single residential lot.

125-9.3 Additional Requirements:

125-9.3.1 Frequency: Conduct QC Standard Proctor maximum density sampling and testing at a minimum frequency of one test per soil type. The Verification test will be at a minimum of one test per soil type:

Test Name	Quality Control	Verification
Standard Proctor Maximum Density	One per soil type	One per soil type
Density	One per LOT	One per four consecutive LOTs and for wet conditions, the first lift not affected by water
Soil Classification	One per Standard Proctor Maximum density	One per Standard Proctor Maximum density

125-10 Verification Comparison Criteria and Resolution Procedures.

125-10.1 Standard Proctor Maximum Density Determination: The Engineer will verify the Quality Control results if the results compare within 4.5 PCF of the Verification test result. Otherwise, the Engineer will take one additional sample of material from the soil type in question. The State Materials Office or an AASHTO accredited laboratory designated by the State Materials Office will perform Resolution testing. The material will be sampled and tested in accordance with AASHTO T-99, Method C.

The Engineer will compare the Resolution test result with the Quality Control test results. If the Resolution test result is within 4.5 PCF of the corresponding Quality Control test results, the Engineer will use the Quality Control test results for material acceptance purposes for each LOT with that soil type. If the Resolution Test result is not within 4.5 PCF of the Contractor's Quality Control test, the Verification Test result will be used for material acceptance purposes.

125-10.2 Density Testing: When a Verification or Independent Verification density test fails the Acceptance Criteria, retest the site within a 5 feet radius and the following actions will be taken:

1. If the Quality Control retest meets the Acceptance Criteria and compares favorably with the Verification or Independent Verification test, the Engineer will accept those LOTs.

2. If the Quality Control retest does not meet the Acceptance Criteria and compares favorably with the Verification or Independent Verification test, rework and retest the LOT. The Engineer will re-verify those LOTs.

3. If the Quality Control retest and the Verification or Independent Verification test do not compare favorably, complete a new equipment-comparison analysis as defined in 120-10.1.2. Once acceptable comparison is achieved, retest the LOTs. The Engineer will perform new verification testing. Acceptance testing will not begin on a new LOT until the Contractor has a gauge that meets the comparison requirements.

125-10.3 Soil Classification: Meet the requirements of 120-10.4.3.

125-11 Site Restoration.

Wherever the existing site is disturbed solely for the purpose of constructing or removing box culverts, pipe culverts, storm sewers, inlets, manholes, etc., completely replace and restore the site to the Engineer's satisfaction, without additional compensation.

125-12 Cleaning Up.

Upon completion of the work, leave the structure and all adjacent areas in a neat and presentable condition, clear up all temporary structures, rubbish and surplus materials and leave the space under the structure unobstructed and in such shape that drift will not collect nor scour or be induced. Pile all material from existing structures that have been removed neatly on the bank, unless otherwise directed by the Engineer. Pull false work piling unless the Engineer permits it to be cut or broken off in which case it will be cut or broken off at least 2 feet below the ground line or stream bed.

125-13 Method of Measurement.

When direct payment for Excavation for Structures is provided in the proposal, and such payment is on a unit basis, such excavation will be measured in its original position by the cross-section method to determine the amount of material. The cubic yard volume of excavation used as a basis of payment will then be that material actually removed below the original ground line or stream bed, but not including that shown on the plans to be paid for either as Regular Excavation, Subsoil Excavation, Lateral Ditch Excavation or Channel Excavation, or which is included in the item for Grading, and except that no payment will be made for material removed in excavating for footings or foundations outside of an area which is bounded by vertical planes 12 inches outside of the limits of the footing and parallel thereto. For pipe trenches the width used to be in the calculation shall be the diameter of the pipe, plus 24 inches.

125-14 Basis of Payment.

125-14.1 When No Direct Payment Provided: When direct payment for Excavation for Structures is not provided for in the proposal, all work specified in this Section, other than as specified in 125-14.3 through 125-14.7, shall be included in the Contract price for the concrete or for other items covering the applicable structure.

125-14.2 Direct Payment: When direct payment for work under this Section is provided, the Contract price per cubic yard (measured as provided in 125-13), as shown in the proposal, shall be full compensation for all the work specified in this Section, except such work as is specifically stipulated to be paid for separately, in 125-14.3 through 125-14.7.

125-14.3 Excavation Below Plan Grade: When excavation of material below plan grade is called for in the plans or authorized by the Engineer, and payment for Excavation for Structures is on a cubic yard basis, the material excavated below plan grade will be included in the measurement for this item.

Payment for the material used for the backfill will be made as specified in 125-14.7.

125-14.4 Strengthening Foundations: The work of strengthening the foundations (as provided in 125-4.2) shall be paid for as provided in 4-4, unless such work is covered by a bid item.

125-14.5 Backfilling for Additional Support: The work of providing additional support by backfilling with sand or other satisfactory material, where called for by the Engineer (as specified in 125-8), shall be paid for as provided in 4-4.

125-14.6 Removal and Replacement of Existing Pavement: For pavement, curb, etc., which is removed only in order to construct pipe culverts or storm sewers, as specified in 125-11, all costs of such removal and replacement shall be included in the costs of the pipe or other structure for which it is removed, unless otherwise provided for in the contract.

125-14.7 Removal and Replacement of Material Unsuitable for Backfill: When it cannot reasonably be anticipated from information contained in the plans, that material excavated for the structure will be unsuitable for use as backfill, and such material proves to be unsuitable for this use, the work of disposing of such material away from the site will be paid for as unforeseeable work, and the work of bringing in substitute material for the backfill will be paid for as specified for the particular case shown below:

(a) No additional payment will be made for backfill materials obtained from surplus material available from the normal excavation or grading operations.

(b) When the necessary material is not available from the normal excavation or grading operations, and the Contract includes an item for Borrow Excavation, backfill material authorized to be obtained from designated borrow areas will be included in the volume of Borrow Excavation to be paid for.

(c) When the necessary material is not available from the normal excavation or grading operations and no separate item for Borrow Excavation is included in the Contract, any backfill material obtained by increasing the volume of excavation within the roadway right of way will be measured and paid for as regular excavation subject to the provisions of 9-3.2.2.

(d) When authorization is given for obtaining the material from outside the right of way and from other than designated borrow areas, such excavation will be paid for as unforeseeable work.

(e) Where pipe bedding is provided, as specified in 125-8, by the use of select granular material, the quantity of such select material obtained either as

commercial material or from material from the grading operations other than in the immediate vicinity of the pipe to be bedded, as authorized by the Engineer, will be paid for at the Contract price per cubic yard for Select Bedding Material. No payment for this material will be made for material available from the excavation for the pipe culvert or from other material available from the grading operations at a location not sufficiently remote as to require loading on trucks.

125-14.8 Pay Items: Payment for the work under this Section, when provided for directly, shall be made under:

Item No.	125- 1-	Excavation for Structures - per cubic yard.
Item No.	125- 3-	Select Bedding Material - per cubic yard.

SECTION 145
GEOSYNTHETIC REINFORCEMENT

145-1 Description.

This Section specifies the construction requirements for geosynthetics used in: (1) geosynthetic reinforced soil slopes, and (2) geosynthetic reinforced foundations constructed on soft in-situ soils. Furnish and place geosynthetics and any associated facing material or drainage blankets.

145-2 Responsibility.

Construct the geosynthetic reinforced feature, including materials, method, and installation based on information provided in the Contract Documents and the geosynthetic supplier's recommendations. Provide shop drawings depicting the details and distribution of the selected geosynthetics which are required to meet the design shown in the plans and in accordance with the requirements contained in the Department's Plans Preparation Manual and Design Standards, Index No. 501 for these items. Alternate designs optimizing the selected geosynthetic materials may be submitted.

For alternate designs, provide complete design calculations and details which include: plan view, elevation view, and details in accordance with the Contract Documents. These shall show the extent, number of layers of geosynthetic reinforcement, minimum properties of each geosynthetic reinforcement layer, vertical spacing of geosynthetic reinforcement, orientation of geosynthetic facing details, details at special structures or obstructions, typical construction sequence, and top and bottom elevations of the geosynthetic reinforcement. Calculations shall be submitted to substantiate the design meets the requirements of Chapter 31 of the Department's Plans Preparation Manual and in accordance with the Contract Plans. As a minimum these shall clearly show the derivation of reinforcement requirements (i.e., type, spacing, length, etc.) and determination of all design parameters and factors. All plans and calculations are to be signed and sealed by a Professional Engineer registered in the State of Florida.

145-3 Materials.

145-3.1 Geosynthetic Materials: Use primary and secondary reinforcing elements consisting of a regular array of tensile elements that have sufficient reinforcement strength to perform the prime functions of reinforcement and which are listed on Design Standards, Index No. 501.

Deliver geosynthetic materials (including facing and drainage elements) to the job site in unopened shipping packages labeled with the supplier's name and product name. During shipping and storage, protect the geosynthetic from physical damage, debris and from temperatures greater than 140ºF. Follow the supplier's recommendations regarding protection from direct sunlight. At the time of installation, the Engineer will reject the material if it has defects, tears, punctures, flaws, deterioration, or other damage. However, if approved by the Engineer, the Contractor may repair torn or punctured sections by placing a patch over the damaged area. Replace or repair any rejected geosynthetic at no additional expense to the Department.

145-3.2 Backfill Materials: : Use only free draining backfill material in the reinforced volume as shown in the plans meeting the following gradation limits as determined in accordance with AASHTO T-27 and FM 1 T-011:

Sieve Size	Percent Passing
3 1/2 inches	100
3/4 inch	70 to 100
No. 4	30 to 100
No. 40	15 to 100
No. 100	5 to 65
No. 200	0 to 15

Do not use backfill material containing more than 2.0% by weight of organic material, as determined by FM 1-T 267 and by averaging the test results for three randomly selected samples from each stratum or stockpile of a particular material. Consider the stratum or stockpile unsuitable for construction of the reinforced volume if an individual test value exceeds 3.0%.

Use backfill with a maximum plasticity index of six as determined by AASHTO T-90, and a maximum liquid limit of 15 as determined by AASHTO T-89. Use backfill materials with a pH between 4.5 and 10.0. When metal pipes or other metal items are embedded in the backfill, use backfill with a pH between 6.0 and 10.0. Do not use soil cement or lime stabilized backfill unless approved by the Engineer.

Submit a copy of certified test results and a certificate of compliance certifying that the fill material meets the above requirements to the Engineer for review and approval prior to delivering the backfill to the site. Use a Department-approved testing laboratory for all testing. Submit an alternate design, prepared in accordance with 145-2, when backfill meeting alternate gradation limits is proposed.

145-4 Construction.

145-4.1 General: Obtain from the geosynthetic supplier, technical instructions, guidance in preconstruction activities, and on-site technical assistance during construction. Submit a copy of any instructions provided by the supplier to the Engineer prior to beginning installation.

145-4.2 Reinforced Soil Slopes:

145-4.2.1 Preparation: Remove all existing vegetation and all unsuitable foundation materials. Prepare the foundation in accordance with Section 110, except as noted herein.

Proof roll the graded area with a vibratory roller weighing a minimum of 8 tons or a sheepsfoot roller, where appropriate, exerting a compression of at least 250 pounds psi on the tamper foot for at least five passes in the presence of the Engineer or as directed by the Engineer. Remove and replace any soft or loose foundation subsoils that are, in the opinion of the Engineer, incapable of sustaining the required proof rolling, in accordance with Section 125.

Provide proof rolled ground surfaces which are uniform, smooth, and free of abrupt changes in slope, debris, and irregularities that might damage the reinforcement. Promptly repair and restore to their original condition any areas outside the limits of disturbance shown on the plans which are damaged as part of this work at no expense to the Department. Make every possible effort to avoid such damage.

145-4.2.2 Geosynthetic Placement: Place the geosynthetics at the proper elevation, location and orientation as shown on the plans. In general, place the geosynthetics used for slope stabilization such that its primary direction of tensile strength is perpendicular to the plan face of the slope. Pull the geosynthetic material tight, and secure it as necessary to lay flat against the soil prior to fill placement.

Place adjacent rolls of geosynthetic to maintain 100% horizontal coverage. Do not allow less than 50% horizontal coverage or an unreinforced horizontal spacing greater than 3 feet. Do not allow vertical spacing of the geosynthetic layers to exceed the spacing shown on the shop drawings.

Do not make any splices or seams in the primary direction of tensile strength in the geosynthetic without approval of the Engineer. When splices in the primary direction are approved, make splices full width of the geosynthetic strip by using a similar material with similar strength. Use a splice mechanism that allows a minimum of 95% load transfer from piece to piece of geosynthetic. Make only one splice per length of geosynthetic. Do not place splices within 6 feet of the slope face, within 6 feet below top of slope, or horizontally adjacent to another splice.

Place only that amount of geosynthetic material, including facing and drainage material, which will be covered in a single days production.

Do not operate equipment directly on the geosynthetics. Operate equipment such that no turning movements occur on the areas where geosynthetic is in place with less than 12 inches of fill cover. Fill and compact ruts of more than 3 inches in depth as they develop.

145-4.2.3 Backfill Placement: Maintain uniform moisture content of the backfill material prior to and during compaction throughout each layer of material. Use backfill material having a placement moisture content within 2% on the dry side of optimum. Do not place wet backfill with moisture content greater than optimum in the fill. Spread backfill material over the geosynthetic in the direction of geosynthetic overlaps. Do not stockpile backfill materials on the installed geosynthetics. Avoid construction procedures or equipment which, in the opinion of the Engineer, cause excessive mudwaving.

Compact the backfill using either smooth wheel or rubber tire rollers. Do not use sheepsfoot, grid rollers, or other types of equipment employing a foot. At the end of each day's operation, slope the backfill surface in order to permit runoff of rainwater away from the slope face, or provide some other positive drainage.

Place and compact the backfill material in accordance with Section 120 to obtain a density in each soil layer of at least 95% of the maximum density as determined by AASHTO T-180.

145-4.2.4 Repairs: Replace geosynthetic reinforcement damaged during or after installation at no expense to the Department. Repair geosynthetics damaged during or after installation only after the supplier establishes that the interior and exterior stability is not affected and after obtaining the Engineer's approval. Make such repairs as follows:

Remove all backfill material from the damaged area of the reinforcement geosynthetic plus an additional 4 feet in all directions beyond the limits of damage. Place a patch consisting of the same material as the reinforcement geosynthetic over the damaged area. Overlap the undamaged reinforcement geosynthetic with the patch a minimum of 3 feet in all directions. Then replace and compact backfill material in accordance with 145-4.2.3.

145-4.3 Reinforced Foundations Constructed on Soft In-Situ Soils:

145-4.3.1 Preparation: For some applications involving reinforcement of soft insitu soils, the Engineer may require that some vegetation be left in place. If directed in the plans or by the Engineer, cut trees to within 6 inches of the ground line, and leave the stumps in place. Remove fallen trunks, limbs, etc. greater than 3 inches in diameter.

145-4.3.2 Backfill Placement: Meet the requirements of 145-4.2.3.

145-4.3.3 Geosynthetic Placement: Position and orient the geosynthetics over prepared surfaces. Place a geotextile filter of a type recommended by the designer of the geosynthetic system under the reinforcement geosynthetic. Cut and overlap geosynthetics as necessary to accommodate curves. Overlap or join ends and sides of adjacent geosynthetic courses as shown on the plans and in accordance with 145-4.2.2. Make any overlaps in geosynthetics in the same direction that covering embankment will be spread. Take care to ensure that the geosynthetic sections do not separate at overlaps during construction. Pull the geosynthetic material tight by hand to a tension that removes all slack.

145-4.3.4 Repairs: Meet the requirements of 145-4.2.4.

145-5 Certification.

Furnish certification from the supplier, at least ten days prior to placement, that the products used are the same products listed on Design Standards, Index No. 501, are in accordance with the project design requirements and is recommended by the supplier for use at this location.

Acceptance of furnished material will be based on the suppliers certification and visual inspection by the Engineer.

145-6 Method of Measurement.

145-6.1 Geosynthetic Reinforced Soil Slopes: The quantity to be paid for will be the plan area, in square feet, of the projected vertical height of the slope face, measured from the top of slope to the proposed final ground line at the toe of slope and from the beginning to end limits as shown on the plans, regardless of the length or number of layers of geosynthetic within the reinforced volume and including any reinforcement required below the toe of slope elevation.

145-6.2 Geosynthetic Reinforced Foundations over Soft Soils: The quantity to be paid for will be the plan area, in square yards, of the embankment to be reinforced as shown on the plans, regardless of the length or number of layers of geosynthetic within the reinforced soil volume, and including any reinforcement required below the original ground elevation.

145-7 Basis of Payment.

145-7.1 Geosynthetic Reinforced Soil Slopes: Price and payment will be full compensation for all work, materials, and services specified in this Section, including design and shop drawings, geosynthetic materials, facing materials and/or treatment, installation, testing, and required submittals. The cost and placement of all backfill material will be included in the pay quantity for embankment or borrow excavation, as applicable.

145-7.2 Geosynthetic Reinforced Foundations over Soft Soils: Price and payment will be full compensation for all work, materials, and services specified in this Section, including geosynthetic materials, geotextile filter materials, facing materials, drainage materials, installation, testing, and required submittals. The cost and placement of all backfill will be included in the pay quantity for embankment or borrow excavation, as applicable.

145-7.3 Payment Items: Payment will be made under:

Item No. 145- 1-	Geosynthetic Reinforced Soil Slopes - per square foot.
Item No. 145- 2-	Geosynthetic Reinforced Foundations over Soft Soils - per square yard.

SECTION 160
STABILIZING

160-1 Description.

Stabilize designated portions of the roadbed to provide a firm and unyielding subgrade, having the required bearing value specified in the plans. Perform work

in accordance with an approved Quality Control Plan meeting the requirements of Section 105.

160-2 Materials.

160-2.1 Commercial Material: Meet the requirements of Section 914.

160-2.2 Local Material: Meet the requirements of Section 914.Test material from each source, or if authorized by the Engineer, test blended materials. Submit test results to the Engineer at least 14 days prior to the stabilization operation.

160-2.3 Existing Base: When the material from an existing base is used as all, or a portion, of the stabilizing additives, no further testing is required unless directed by the Engineer.

160-2.4 Granular Subbase: The Engineer may allow, at no additional cost to the Department, the substitution of 6 inches of Granular Subbase meeting the requirements of 290-2 and 290-3, when 12 inches of Stabilization requiring a Limerock Bearing Ratio (LBR) value of 40 is specified.

160-3 Construction Methods.

160-3.1 General: Prior to the beginning of stabilizing operations, construct the area to be stabilized to an elevation such that, upon completion of stabilizing operations, the completed stabilized subgrade will conform to the lines, grades, and cross-section shown in the plans. Prior to spreading any additive stabilizing material, bring the surface of the roadbed to a plane approximately parallel to the plane of the proposed finished surface.

Construct mainline pavement lanes, turn lanes, ramps, parking lots, concrete box culverts and retaining wall systems meeting the requirements of 120-8.1, except replace “Embankment” with “Subgrade”.

Construct shoulder-only areas, sidewalk, and bike/shared use path areas meeting the requirements of 120-8.1 except replace “Embankment” with “Subgrade” and meet the acceptance criteria of 160-4.2.

Isolated mixing operations will be considered as separate LOTs. Curbpads and shoulders compacted separately shall be considered separate LOTs. Isolated compaction operations will be considered as separate LOTs. For multiple phase construction, a LOT shall not extend beyond the limits of the phase.

160-3.2 Application of Stabilizing Material: After substantially completing the roadbed grading operations, determine the type and quantity (if any) of stabilizing material necessary for compliance with the bearing value requirements. Notify the Engineer of the approximate quantity to be added before spreading. When additive stabilizing materials are required, spread the material uniformly over the area to be stabilized.

160-3.2.1 Sampling and Testing of Local Material: Randomly select locations for sampling using a random number generator approved by the Engineer and test at the minimum frequency listed in the table below before mixing. The Engineer will reject the material for failing QC test results. The Engineer will sample for Verification and Resolution testing at the minimum

frequency listed in the table below. The Engineer will perform Verification tests at the minimum frequency listed in the table below.

Test Name	Quality Control	Verification	Resolution
Liquid Limit (LL), Plastic Index (PI), and Organic Content	One per two LOTs	One per eight LOTs	One per eight LOTs

160-3.2.1.1 Verification Comparison Criteria and Resolution Procedures: If the QC and the Department's Verification tests meet the requirements of Section 914 then the Engineer will accept the corresponding LOTs. Otherwise, the Engineer will submit the Resolution sample to the State Materials Office or an AASHTO accredited laboratory designated by the State Materials Office to perform Resolution testing.

If the Resolution Test results meet the requirements of Section 914 then the Engineer will accept the LOTs in question. Otherwise remove the material and apply new material meeting the requirements of Section 914 and retest in accordance with 160-3.2.

160-3.3 Mixing: Perform mixing using rotary tillers, a plant or other equipment meeting the approval of the Engineer. The subgrade may be mixed in one course if the equipment and method of construction provides the uniformity, particle size limitation, compaction and other desired results of 160-4. Thoroughly mix the area to be stabilized throughout the entire depth and width of the stabilizing limits.

Perform the mixing operations, as specified, (either in place or in a plant) regardless of whether the existing soil, or any select soils placed within the limits of the stabilized sections, have the required bearing value without the addition of stabilizing materials.

160-3.4 Maximum Particle Size of Mixed Materials: At the completion of the mixing, ensure that the gradation of the material within the limits of the area being stabilized is such that 97% will pass a 3 1/2 inch sieve and that the material does not have a plasticity index greater than eight or liquid limit greater than 30. Remove any materials not meeting the plasticity requirements from the stabilized area. Break down or remove from the stabilized area materials, including clay lumps or lumps made of clay-size particles (any particle size 2 microns or less), not meeting the gradation requirements.

160-3.5 Bearing Value: Meet the bearing value requirements for the subgrade in accordance with 160-4.

160-3.6 Compaction: After completing the mixing operations and satisfying the requirements for bearing value, uniformity, and particle size. Compact the materials at a moisture content permitting the specified compaction in 160-4.2.3. If the moisture content of the material is improper for attaining the specified density, either add water or allow the material to dry until reaching the proper moisture content for the specified compaction.

160-3.7 Finish Grading: Shape the completed stabilized subgrade to conform with the finished lines, grades, and cross-section indicated in the plans.

Check the subgrade using elevation stakes or other means approved by the Engineer.

160-3.8 Requirements for Condition of Completed Subgrade: After completing the stabilizing and compacting operations, ensure that the subgrade is firm and substantially unyielding to the extent that it will support construction equipment and will have the bearing value required by the plans.

Remove all soft and yielding material, and any other portions of the subgrade which will not compact readily, and replace it with suitable material so that the whole subgrade is brought to line and grade, with proper allowance for subsequent compaction.

160-3.9 Maintenance of Completed Subgrade: After completing the subgrade as specified above, maintain it free from ruts, depressions, and any damage resulting from the hauling or handling of materials, equipment, tools, etc. The Contractor is responsible for maintaining the required density until the subsequent base or pavement is in place including any repairs, replacement, etc., of curb and gutter, sidewalk, etc., which might become necessary in order to recompact the subgrade in the event of underwash or other damage occurring to the previously compacted subgrade. Perform any such recompaction at no expense to the Department. Construct and maintain ditches and drains along the completed subgrade section.

160-4 Acceptance Program.

160-4.1 General Requirements: Meet the requirements of 120-10, except use 160-4.2 instead of 120-10.2, 160-4.3 instead of 120-10.3, and 160-4.4 instead of 120-10.4.

160-4.2 Acceptance Criteria:

160-4.2.1 Bearing Value Requirements:

160-4.2.1.1 General: Within the entire limits of the width and depth of the areas to be stabilized, obtain the required minimum bearing value for each LOT. For any area where the bearing value obtained is deficient from the value indicated in the plans, in excess of the tolerances established herein, spread and mix additional stabilizing material in accordance with 160-3.3. Perform this reprocessing for the full width of the roadway being stabilized and longitudinally for a distance of 50 feet beyond the limits of the area in which the bearing value is deficient.

Determine the quantity of additional stabilizing material to be used in reprocessing.

160-4.2.1.2 Under-tolerances in Bearing Value Requirements: The under-tolerances are allowed for the following specified Bearing Values:

Specified Bearing Value	Under-tolerance
LBR 40	5.0
LBR 35	4.0
LBR 30 (and under)	2.5

The following unsoaked bearing value requirement is based on tests performed on samples obtained after completing mixing operations:

Specified Bearing Value	Unsoaked Bearing Value Required	Under-tolerance
LBR 40	LBR 43	0.0

160-4.2.2 Mixing Depth Requirements: Do not exceed individual plan depth thickness by more than 2 inches or exceed LOT-average depth thickness by more than 1 inch measured to the nearest 0.25 inch. No undertolerance of mixing depth is allowed.

As an exception to the above mixing requirements, where the subgrade is of rock, the Engineer may waive the mixing operations (and the work of stabilizing), and the Department will not pay for stabilization for such sections of the roadway.

160-4.2.3 Density Requirements:

160-4.2.3.1 General: Within the entire limits of the width and depth of the areas to be stabilized, other than as provided in 160-4.2.3.2, obtain a minimum density at any location of 98% of the Modified Proctor maximum density as determined by FM 1-T 180, Method D.

160-4.2.3.2 Exceptions to Density Requirements: The Contractor need not obtain the minimum density specified in 160-4.2.3.1 if within the following limits:

(a) The width and depth of areas which are to be subsequently incorporated into a base course under the same contract.

(b) The upper 6 inches of areas to be grassed under the same contract. Compact these areas to a reasonably firm condition as directed by the Engineer.

160-4.2.4 Frequency: Conduct QC sampling and testing at a minimum frequency listed in the table below. The Engineer will perform Verification sampling and tests at a minimum frequency listed in the table below.

Test Name	Quality Control	Verification	Verification for Shoulder-Only, Bike/Shared Use Path and Sidewalk Construction
Modified Proctor Maximum Density	One per two consecutive LOTs	One per eight consecutive LOTs	One per four LOTs
Density	One per LOT	One per four LOTs	One per two LOTs
Stabilizing Mixing Depth	Three per 500 feet	Witness one per LOT	Witness one per LOT
LBR	One per two consecutive LOTs	One per eight consecutive LOTs	One per four LOTs
Gradation, LL/PI & Soil Classification (Local materials)	Not Required	One per eight consecutive LOTs	One per four LOTs

160-4.3 Additional Requirements:

160-4.3.1 Quality Control Testing:

160-4.3.1.1 Bearing Values: Test the Stabilized Subgrade sample collected in 160-4.3.1.3. Determine the LBR in accordance with FM 5-515 and 160-4.2.4.

160-4.3.1.1.1 Unsoaked LBR: If Unsoaked LBR is desired, submit request for approval to the Engineer. Upon approval by the Engineer to consider the use of Unsoaked LBR, randomly sample and test from three locations in the initial Lot for both Soaked and Unsoaked LBR in accordance with FM 5-515. Ensure all of the tests demonstrate the material achieves the LBR values in 160-4.2.1.2. Continue testing Unsoaked LBR at the frequency shown in 160-4.2.4. Discontinue Unsoaked LBR testing if any unsatisfactory QC LBR test result is obtained or resolution determines an unsatisfactory LBR.

160-4.3.1.2 Mixing Depths: Meet required plan mixing-depths by measuring from the proposed Final Grade Line. Determine test locations, including Stations and Offsets, using the Random Number generator approved by the Department. Notify the Engineer a minimum of 24 hours before checking mixing depths. Record results on forms supplied by the Department.

160-4.3.1.3 Modified Proctor Maximum Density Requirement: Collect enough material to split and create three separate samples. Determine test locations, including Stations and Offsets, using the Random Number generator approved by the Department for the two LOTs under consideration. Retain the Verification and Resolution samples for the Department until the Engineer accepts the LOTs represented by the samples.

160-4.3.2 Department Verification Tests:

160-4.3.2.1 Bearing Value & Soil Classification: The Engineer will sample and test the Stabilized Subgrade for determination of the LBR in accordance with FM 5-515. If the Engineer has approved consideration of the Unsoaked LBR, sample and test the initial LOT for one soaked and one unsoaked LBR in addition to the frequency shown in 160-4.2.4.

If Local Material is used for stabilizing, the Engineer will determine compliance with embankment utilization requirements by testing and classifying the Stabilized Subgrade in accordance with AASHTO T-88 and AASHTO M-145 at the frequency shown in 160-4.2.4.

The Engineer will select test locations, including Stations and Offsets, using a Random Number generator, based on the LOTs under consideration.

160-4.3.2.2 Mixing Depth: The Engineer will witness the Contractor's mixing depth checks to ensure compliance with 160-4.2.2. The Engineer will select test locations, including Stations and Offsets, using a Random Number generator.

160-4.3.2.3 Modified Proctor Maximum Density: The Engineer will randomly select one of the retained split samples and test in accordance with FM 1-T 180, Method D.

160-4.4 Verification Comparison Criteria and Resolution Procedures:

160-4.4.1 Bearing Value & Soil Classification: If the Department's Verification test meets the requirements of 160-4.2.1 and embankment utilization

requirements, the Engineer will accept the corresponding LOTs. Otherwise, the Engineer will collect an additional sample in the same LOT the Verification sample was obtained. The State Materials Office or an AASHTO accredited laboratory designated by the State Materials Office will perform Resolution testing on the additional sample. The material will be sampled and tested in accordance with FM 5-515. If Local Material is used for stabilization, the sample will be tested in accordance with AASHTO T-88, and AASHTO M-145.

If the Resolution Testing results meet the requirements of 160-4.2.1 and embankment utilization requirements then the Engineer will accept the LOTs in question. Otherwise reprocess the corresponding LOTs in accordance with 160-3 and retest in accordance with 160-4.3.1.1.

160-4.4.2 Mixing Depth Thickness: The Department will witness the mixing depth checks.

1. If the depth checks meet the requirements of 160-4.2.2 the Engineer will accept that 500-foot section.

2. If the depth checks confirm shallow depth, re-mix the 500-foot section to an appropriate Depth and re-measure in accordance with 160-4.3.1.2. The Engineer will repeat the witness process.

3. If the depth checks confirm extra deep mixing, conduct an additional QC density test after compaction for the bottom 12 inches of the subgrade for that 500-foot section in addition to a QC density test for the top 12 inches. The additional Density test must meet the requirements of 160-4.2.3.

160-4.4.3 Modified Proctor Maximum Density Determination: The Engineer will compare the Verification test results of 160-4.3.2.3 to the corresponding Quality Control test results. If the test result is within 4.5 lb/ft^3 of the QC test result, the LOTs will be verified. Otherwise, the Engineer will collect the Resolution split sample corresponding to the Verification sample tested. The State Materials Office or an AASHTO accredited laboratory designated by the State Materials Office will perform Resolution testing. The material will be sampled and tested in accordance with FM 1-T 180, Method D.

The Engineer will compare the Resolution Test results with the Quality Control test results. If the Resolution Test result is within 4.5 lb/ft^3 of the corresponding Quality Control test result, the Engineer will use the Quality Control test results for material acceptance purposes for each corresponding pair of LOTs. If the Resolution test result is not within 4.5 lb/ft^3 of the corresponding Quality Control test, the Engineer will collect the remaining Verification split samples for testing. Verification Test results will be used for material acceptance purposes for the LOTs in question**.**

160-4.4.4 Density: When a Verification or Independent Verification density test does not meet 160-4.2.3 (Acceptance Criteria), retest at a site within a 5 feet radius of the Verification test location and observe the following:

1. If the Quality Control retest meets the Acceptance Criteria and compares favorably with the Verification or Independent Verification test, the Engineer will accept the LOTs in question.

2. If the Quality Control retest does not meet the Acceptance Criteria and compares favorably with the Verification or Independent Verification test,

rework and retest the material in that LOT. The Engineer will re-verify the LOTs in question.

3. If the Quality Control retest and the Verification or Independent Verification test do not compare favorably, complete a new equipment-comparison analysis as defined in 120-10.1.2. Once acceptable comparison is achieved, retest the LOTs. The Engineer will perform new verification testing. Acceptance testing will not begin on a new LOT until the Contractor has a gauge that meets the comparison requirements.

160-5 Method of Measurement.

The quantity to be paid for will be the plan quantity, in square yards, completed and accepted.

160-6 Basis of Payment.

Price and payment will constitute full compensation for all work and materials specified in this Section, including furnishing, spreading and mixing of all stabilizing material required and any reprocessing of stabilization areas necessary to attain the specified bearing value. The Department will make full payment for any areas where the existing subgrade materials meet the design bearing value requirements without the addition of stabilizing additives, as well as areas where the Contractor may elect to place select high-bearing materials from other sources within the limits of the stabilizing.

If the item of Borrow Excavation is included in the Contract, any stabilizing materials obtained from designated borrow areas will be included in the pay quantity for Borrow Excavation.

Payment will be made under:

Item No. 160- 4- Stabilization - per square yard.

SECTION 162
PREPARED SOIL LAYER

162-1 Description.

162-1.1 Finish Soil Layer: Unless otherwise called for on the plans, prepare a 6 inch thick layer of existing soil mixed with imported material, if necessary, to achieve the pH and organic matter levels required in Section 987, that is favorable to turf and ground cover growth over areas of the project which are to be seeded, seeded and mulched, or planted, by mixing in an organic material, compost, or commercially available soil amendments. Prepare finish soil layer in areas to be sodded, when called for on the plans.

162-1.2 Organic Soil Layer: When required by a permit, prepare a 6 inch thick layer of organic soil, at locations shown on the plans.

162-1.3 Blanket Material: When required by a permit, place a layer of blanket material at the locations and to the depth shown on the plans.

162-2 Materials.

162-2.1 Finish Soil Layer and Organic Soil Layer: Meet the requirements of Section 987.

162-2.2 Blanket Material: Meet the material classification shown on the plans and Design Standards, Index No. 505.

162-3 Ownership of Surplus Materials.

The Department will retain ownership of all materials suitable for construction of the prepared soil layer until the final job requirements have been fulfilled. Unless otherwise shown in the Contract Documents, upon final acceptance, Contractor shall take ownership of any surplus materials and dispose of in accordance with 120-5.

Where temporary storage of apparent surplus materials within the right-of-way may be impractical, the materials may be stockpiled outside the right-of-way in areas provided by the Contractor until needed on the project or declared surplus. With the Engineer's written approval, the Contractor may dispose of excess material with the stipulation that any portion required to fulfill job requirements will be replaced with equally suitable material at no cost to the Department.

No extra compensation is allowed for any rehandling involved under the provisions of this Subarticle.

162-4 Construction Methods.

Construct the surface of the earthwork to such lines and elevations that will provide a surface conforming to the plan lines and elevations upon completion of the prepared soil operations. Leave the surface of the earthwork in a roughened and loose condition. Prevent contamination of the materials by other construction operations. Remove and replace all materials which fail to meet the required soil classification or become contaminated after placement, and correct any slippage of this material at no cost to the Department. Spread the appropriate material uniformly over areas to receive treatment.

162-4.1 Finish Soil Layer: After spreading, mix the material with the underlying soil to a combined depth of 6 inches, unless otherwise called for in the plans. Continue mixing to provide a uniform finish soil layer true to line and grade.

162-4.2 Organic Soil Layer: Spread materials to the depth of 6 inches.

162-4.3 Blanket Material: Place the blanket material to the depth shown on the plans.

162-5 Acceptance Testing.

The Engineer reserves the right to waive or reduce testing requirements for shoulder treatment projects as defined in the Design Standards, Index 105.

Immediately after completion of construction operations, sample and test the prepared soil layer at a testing laboratory qualified under 6-9. Take random samples at a minimum of one sample per 2,500 square yards of prepared surface. When the source of added material changes, the Engineer will require an additional sample. Test results will be averaged for each 10,000 square yards to

determine specification compliance. The Engineer reserves the right to take and test additional samples to determine specification compliance. For failing samples, take and test additional samples, as directed by the Engineer, to delineate areas that need re-treatment. Perform re-treatment at no additional cost to the Department. Perform additional testing of retreated areas, at locations directed by the Engineer, to determine specification compliance. Provide copies of all test results to the Engineer.

162-5.1 Finish Soil Layer: Test sampled material for organic matter content, pH, primary macronutrients (N, P, K) and secondary macronutrients (S, Ca, Mg) content. Acquire from the soil testing laboratory fertilizer recommendations for the specific plants to be grown in the area. Do not seed, seed and mulch, or place sod until acceptable values for organic content and pH are obtained in accordance with the requirements of 987-1.

162-5.2 Organic Soil Layer: Test sampled material for organic matter content in accordance with the requirements of 987-1.

162-5.3 Blanket Material: Test blanket material for depth in accordance with the plans and for soil classification in accordance with AASHTO M-145. Add materials as necessary to achieve the required depth.

162-6 Method of Measurement.

The quantities to be paid for will be the plan quantity for the following items meeting the requirements of this Section, completed and accepted:

(1) The area, in square yards, of Finish Soil Layer.
(2) The area, in square yards, of Organic Soil Layer.
(3) The area, in square yards, of Blanket Material.

162-7 Basis of Payment.

Prices and payments will be full compensation for completing all work specified in this Section, including furnishing, hauling, and placing materials to the lines and grades shown in the plans.

Payment will be made under:

Item No. 162- 1- Prepared Soil Layer - per square yard.

SECTION 175
CRACKING AND RESEATING EXISTING CONCRETE PAVEMENT

175-1 Description.

Perform controlled cracking of concrete pavement and reseating of the cracked slabs, by rolling, tamping, etc., on the underlying subgrade to provide a firm base for asphalt concrete surfacing.

175-2 Equipment.

175-2.1 For Cracking: Provide pneumatic or gravity-type breakers, or other specifically approved equipment that ensures controlled cracking to the size and extent of uniformity, etc., specified. Control the fall of gravity-type breakers by

leads so that the fall will be straight and vertical. Use hammers for both pneumatic and gravity-type breakers of a type that will crack the concrete cleanly and not punch or unnecessarily shatter the concrete.

175-2.2 For Reseating: Provide vibratory compacting equipment or traffic rollers. Use traffic rollers that weigh at least 15 tons.

175-3 Construction Requirements.

175-3.1 Protection of New Construction and Adjacent Structures: Perform cracking and reseating work prior to beginning all new construction which this work might endanger or disturb. Perform cracking and reseating in a manner that will not damage any existing structures which are to remain, and repair any damage to such structures that this work causes by this work at no expense to the Department.

175-3.2 Cracking and Seating: For the cracked slabs, make clean fractures, as near vertical as practicable. Do not punch the pieces into the subgrade, but firmly seat them thereon, to as uniform a contour as is practicable.

175-3.3 Special Requirements for Asphalt-Surfaced Pavement: Where the existing concrete pavement is covered with an asphalt surface, remove the asphalt surfacing (after the cracking operation) on test areas approximately 10 by 10 feet, at locations selected by the Engineer, in order to determine if the required results are being obtained in the cracking operations. Prepare at least one such test area for each day's operation, and prepare additional areas if deemed necessary by the Engineer.

175-3.4 Dimensions of Slabs: Ensure that the cracked slabs have no dimension greater than 3 feet. In the event that the required results in the cracking are not being obtained, adjust the spacing of blows or the height of drop of the blows as necessary to obtain the required results with the equipment being used.

175-4 Method of Measurement.

The quantity to be paid for will be the plan quantity, in square yards, of existing concrete pavement acceptably cracked and reseated on the subgrade.

175-5 Basis of Payment.

Price and payment will be full compensation for performing and completing all work specified in this Section.

Payment will be made under:

Item No. 175- 1-	Reseating Concrete Pavement - per square yard.

SECTION 200
ROCK BASE

200-1 Description.

Construct a base composed of base rock. Perform work in accordance with an approved Quality Control Plan meeting the requirements of 105-3.

200-2 Materials.

Meet the requirements of either 911, 913, 913A or 915 for the particular type of base to be constructed. The Contractor may use more than one source of base rock on a single Contract provided that a single source is used throughout the entire width and depth of a section of base. Obtain approval from the Engineer before placing material from more than one source. Place material to ensure total thickness single source integrity at any station location of the base. Intermittent placement or "Blending" of sources is not permitted. Base rock may be referred to hereinafter as "rock".

Do not use any of the existing base that is removed to construct the new base.

200-3 Equipment.

Use mechanical rock spreaders, equipped with a device that strikes off the rock uniformly to laying thickness, capable of producing even distribution. For crossovers, intersections and ramp areas; roadway widths of 20 feet or less; the main roadway area when forms are used and any other areas where the use of a mechanical spreader is not practicable; the Contractor may spread the rock using bulldozers or blade graders.

200-4 Transporting Rock.

Transport the rock to its point of use, over rock previously placed, if practicable, and dump it on the end of the preceding spread. Hauling and dumping on the subgrade will be permitted only when, in the Engineer's opinion, these operations will not be detrimental to the subgrade.

200-5 Spreading Rock.

200-5.1 Method of Spreading: Spread the rock uniformly. Remove all segregated areas of fine or coarse rock and replace them with properly graded rock.

200-5.2 Number of Courses: When the specified compacted thickness of the base is greater than 6 inches, construct the base in multiple courses of equal thickness. Individual courses shall not be less than 3 inches. The thickness of the first course may be increased to bear the weight of the construction equipment without disturbing the subgrade.

If, through field tests, the Contractor can demonstrate that the compaction equipment can achieve density for the full depth of a thicker lift, and if approved by the Engineer, the base may be constructed in successive courses of not more than 8 inches compacted thickness.

The Engineer will base approval on results of a test section constructed using the Contractor's specified compaction effort. Notify the Engineer prior to beginning construction of a test section. Construct a test section of the length of one LOT. Perform five QC density tests at random locations within the test section. At each test site, test the bottom 6 inches in addition to the entire course thickness. All QC tests and a Department Verification test must meet the density required by 200-7.2.1. Identify the test section with the compaction effort and thickness in the Logbook. Remove the materials above the bottom 6 inches, at no expense to the Department. The minimum density required on the thicker lift will be the average of the five results obtained on the thick lift in the passing test section. Maintain the exposed surface as close to "undisturbed" as possible; no further compaction will be permitted during the test preparation. If unable to achieve the required density, remove and replace or repair the test section to comply with the specifications at no additional expense to the Department. The Contractor may elect to place material in 6 inches compacted thickness at any time.

Once approved, a change in the source of base material will require the construction of a new test section. Do not change the compaction effort once the test section is approved. The Engineer will periodically verify the density of the bottom 6 inches during thick lift operations.

The Engineer may terminate the use of thick lift construction and instruct the Contractor to revert to the 6 inches maximum lift thickness if the Contractor fails to achieve satisfactory results or meet applicable specifications.

200-5.3 Rock Base for Shoulder Pavement: Unless otherwise permitted, complete all rock base shoulder construction at any particular location before placing the final course of pavement on the traveled roadway. When dumping material for the construction of a rock base on the shoulders, do not allow material capable of scarring or contaminating the pavement surface on the adjacent pavement. Immediately sweep off any rock material that is deposited on the surface course.

200-6 Compacting and Finishing Base.

200-6.1 General: Construct mainline pavement lanes, turn lanes, ramps, parking lots, concrete box culverts and retaining wall systems meeting the requirements of 120-8.1, except replace "Embankment" with "Base".

Construct shoulder-only areas, bike/shared use paths, and sidewalks. Meet the requirements of 120-8.1 except replace "Embankment" with "Base" meeting the acceptance criteria of 200-7.2. Shoulders compacted separately shall be considered separate LOTs.

200-6.1.1 Single Course Base: After spreading, scarify the entire surface, then shape the base to produce the required grade and cross-section, free of scabs and laminations, after compaction.

200-6.1.2 Multiple Course Base: Clean the first course of foreign material, then blade and bring it to a surface cross-section approximately parallel to the finished base. Before spreading any material for the upper courses, allow the Engineer to make density tests for the lower courses to determine that the required compaction has been obtained. After spreading the material for the top

course, scarify finish and shape its surface to produce the required grade and cross-section, free of scabs and laminations, after compaction.

200-6.2 Moisture Content: When the material does not have the proper moisture content to ensure the required density, wet or dry it as required. When adding water, uniformly mix it in to the full depth of the course that is being compacted. During wetting or drying operations, manipulate, as a unit, the entire width and depth of the course that is being compacted.

200-6.3 Thickness Requirements: Within the entire limits of the length and width of the finished base, meet the specified plan thickness in accordance with the requirements of 200-7.3.1.2.

200-6.4 Correction of Defects:

200-6.4.1 Contamination of Base Material: If, at any time, the subgrade material becomes mixed with the base course material, dig out and remove the mixture, and reshape and compact the subgrade. Then replace the materials removed with clean base material, and shape and compact as specified above. Perform this work at no expense to the Department.

200-6.4.2 Cracks and Checks: If cracks or checks appear in the base, either before or after priming, which, in the opinion of the Engineer, would impair the structural efficiency of the base, remove the cracks or checks by rescarifying, reshaping, adding base material where necessary, and recompacting.

200-6.5 Compaction of Widening Strips: Where base construction consists of widening strips and the trench width is not sufficient to permit use of standard base compaction equipment, compact the base using vibratory compactors, trench rollers or other special equipment which will achieve the density requirements specified herein.

When multiple course base construction is required, compact each course prior to spreading material for the overlaying course.

200-7 Acceptance Program.

200-7.1 General Requirements: Meet the requirements of 120-10, except use 200-7.2 instead of 120-10.2, 200-7.3 instead of 120-10.3 and 200-7.4 instead of 120-10.4.

200-7.2 Acceptance Criteria:

200-7.2.1 Density: Within the entire limits of the width and depth of the base, obtain a minimum density in any LOT of 98% of modified Proctor maximum density as determined by FM 1-T 180, Method D. Compact the base of any LOT of shoulder pavement to not less than 95% of the modified Proctor maximum density as determined by FM 1-T 180, Method D.

200-7.2.2 Frequency: Conduct QC sampling and testing at a minimum frequency listed in the table below. The Engineer will perform Verification sampling and tests at a minimum frequency listed in the table below.

Mainline Pavement Lanes, Turn Lanes, Ramps, Parking Lots, Concrete Box Culverts and Retaining Wall Systems		
Test Name	Quality Control	Verification
Modified Proctor Maximum Density	One per eight consecutive LOTs	One per 16 consecutive LOTs
Density	One per LOT	One per four LOTs
Roadway Surface	Ten per LOT	Witness
Roadway Thickness	Three per LOT	Witness

Shoulder-Only, Bike/Shared Use Path and Sidewalk Construction		
Test Name	Quality Control	Verification
Modified Proctor Maximum Density	One per two LOTs	One per four LOTs
Density	One per LOT	One per two LOTs
Surface	Five per 500 feet	Witness
Thickness	Three per 1000 consecutive feet	Witness

200-7.3 Additional Requirements:

200-7.3.1 Quality Control Testing:

200-7.3.1.1 Modified Proctor Maximum Density Requirement: Collect enough material to split and create three separate samples and retain two for the Engineer's Verification and Resolution testing until the Engineer accepts the 16 LOTs represented by the samples.

200-7.3.1.2 Depth and Surface Testing Requirements: Notify the Engineer a minimum of 24 hours before checking base depths and surface checking. Determine test locations including Stations and Offsets, using the Random Number generator approved by the Department. Do not perform depth and surface checks until the Engineer is present to witness. Enter test results into the Department's database. Perform thickness check on the finished base or granular subbase component of a composite base. Provide traffic control, coring/boring equipment, and an operator for the coring/boring equipment. Traffic control is to be provided in accordance with the standard maintenance of traffic requirements of the Contract.

The thickness is considered deficient, if the measured depth is over 1/2 inch less than the specified thickness. Correct all deficient areas of the completed base by scarifying and adding additional base material. As an exception, if authorized by the Department, such areas may be left in place without correction and with no payment.

Check the finished surface of the base course with a template cut to the required crown and with a 15 foot straightedge laid parallel to the centerline of the road. Correct all irregularities greater than 1/4 inch to the satisfaction of the Engineer by scarifying and removing or adding rock as required, and recompact the entire area as specified hereinbefore.

200-7.3.1.3 Surface & Thickness Reduced Testing Frequency: When no Resolution testing is required for 12 consecutive verified LOTs, or if required, the QC test data was upheld, reduce the QC surface and/or thickness checks to one half the minimum requirements as stated in 200-7.2.2 (eg. Reduce frequency from ten per LOT to ten per two LOTs) by identifying the substantiating tests and notifying the Engineer in writing prior to starting reduced frequency of testing. If the Verification test fails, and Quality Control test data is not upheld by Resolution testing the Quality Control testing will revert to the original frequency of 200-7.2.2. The results of the Independent Verification testing will not affect the frequency of the Quality Control testing.

200-7.3.2 Department Verification Tests:

200-7.3.2.1 Maximum Density: The Engineer will randomly select one of the remaining two split samples and test in accordance with FM 1-T 180, Method D.

200-7.3.2.2 Thickness and Surface Testing Requirements: The Department will witness the base depth and surface checks to ensure compliance with 200-7.3.1.2. If the QC test results are not deficient as defined in 200-7.3.1.2, the LOT or 500-foot section will be accepted. If the QC test results are deficient, resolve deficiencies in accordance with 200-7.3.1.2. Repeat acceptance testing. Provide traffic control, coring/boring equipment, and an operator for the coring/boring equipment.

200-7.4 Verification Comparison Criteria and Resolution Procedures:

200-7.4.1 Modified Proctor Maximum Density: The Engineer will compare the Verification test results of 200-7.3.2.1 to the corresponding Quality Control test results. If the test result is within 4.5 lb/ft^3 of the QC test result, the LOTs will be verified. Otherwise, the Engineer will collect the Resolution split sample corresponding to the Verification sample tested. The State Materials Office or an AASHTO accredited laboratory designated by the State Materials Office will perform Resolution testing. The material will be sampled and tested in accordance with FM 1-T 180, Method D.

The Engineer will compare the Resolution Test results with the Quality Control test results. If the Resolution Test result is within 4.5 lb/ft^3 of the corresponding Quality Control test result, the Engineer will use the Quality Control test results for material acceptance purposes for each corresponding set of LOTs. If the Resolution test result is not within 4.5 lb/ft^3 of the corresponding Quality Control test, the Engineer will collect the remaining Verification split sample for testing. Verification Test results will be used for material acceptance purposes for the LOTs in question**.**

200-7.4.2 Density: When a Verification or Independent Verification density test does not meet the requirements of 200-7.2.1 (Acceptance Criteria), retest at a site within a 5 feet radius of the Verification test location and observe the following:

1. If the Quality Control retest meets the Acceptance Criteria and compares favorably with the Verification or Independent Verification test, the Engineer will accept the LOTs in question.

2. If the Quality Control retest does not meet the Acceptance Criteria and compares favorably with the Verification or Independent Verification test,

rework and retest the material in that LOT. The Engineer will re-verify the LOTs in question.

3. If the Quality Control retest and the Verification or Independent Verification test do not compare favorably, complete a new equipment-comparison analysis as defined in 120-10.1.1. Once acceptable comparison is achieved, retest the LOTs. The Engineer will perform new verification testing. Acceptance testing will not begin on a new LOT until the Contractor has a gauge that meets the comparison requirements.

200-7.4.3 Thickness and Surface Testing Requirements: Resolve deficiencies in accordance with 200-7.3.1.2.

200-8 Priming and Maintaining.

200-8.1 Priming: Apply the prime coat only when the base meets the specified density requirements and when the moisture content in the top half of the base does not exceed the optimum moisture of the base material. At the time of priming, ensure that the base is firm, unyielding and in such condition that no undue distortion will occur.

200-8.2 Maintaining: Maintain the true crown and template, with no rutting or other distortion, while applying the surface course.

200-9 Calculations for Average Thickness of Base.

For bases that are not mixed in place, the Engineer will determine the average thickness from the measurements specified in 200-10.1, calculated as follows:

(a) When the measured thickness is more than 1/2 inch greater than the design thickness shown on the typical cross-section in the plans, it will be considered as the design thickness plus 1/2 inch.

(b) Average thickness will be calculated per typical cross-section for the entire job as a unit.

(c) Any areas of base left in place with no payment will not be included in the calculations.

(d) Where it is not possible through borings to distinguish the base materials from the underlying materials, the thickness of the base used in the measurement will be the design thickness.

200-10 Method of Measurement.

200-10.1 General: The quantity to be paid for will be the plan quantity, adjusted as specified below.

200-10.2 Authorized Normal Thickness Base: The surface area of authorized normal thickness base to be adjusted will be the plan quantity as specified above, omitting any areas not allowed for payment under the provisions of 200-6.3 and omitting areas which are to be included for payment under 200-10.3. The adjustment shall be made by adding or deducting, as appropriate, the area of base represented by the difference between the calculated average thickness, determined as provided in 200-9, and the specified normal thickness, converted to equivalent square yards of normal thickness base.

200-10.3 Authorized Variable Thickness Base: Where the base is constructed to a compacted thickness other than the normal thickness as shown on the typical section in the plans, as specified on the plans or ordered by the Engineer for providing additional depths at culverts or bridges, or for providing transitions to connecting pavements, the volume of such authorized variable thickness compacted base will be calculated from authorized lines and grades, or by other methods selected by the Engineer, converted to equivalent square yards of normal thickness base for payment.

200-11 Basis of Payment.

Price and payment will be full compensation for all the work specified in this Section, including correcting all defective surface and deficient thickness, removing cracks and checks as provided in 200-6.4.2, the prime coat application as directed in 300-8, and the additional rock required for crack elimination.

Payment shall be made under:

Item No. 285- 7- Optional Base - per square yard.

SECTION 204
GRADED AGGREGATE BASE

204-1 Description.

Construct a base course composed of graded aggregate.

204-2 Materials.

Use graded aggregate material, produced from Department approved sources, which yields a satisfactory mixture meeting all the requirements of these Specifications after it has been crushed and processed as a part of the mining operations.

The Contractor may furnish the material in two sizes of such gradation that, when combined in a central mix plant pugmill, the resultant mixture meets the required specifications.

Use graded aggregate base material of uniform quality throughout, substantially free from vegetable matter, shale, lumps and clay balls, and having a Limerock Bearing Ratio value of not less than 100. Use material retained on the No. 10 sieve composed of aggregate meeting the following requirements:

Soundness Loss, Sodium, Sulfate: AASHTO T-104..... 15%

Percent Wear: AASHTO T-96 (Grading A)

Group 1 Aggregates..... 45%

Group 2 Aggregates..... 65%

Group 1: This group of aggregates is composed of limestone, marble, or dolomite.

Group 2: This group of aggregates is composed of granite, gneiss, or quartzite.

Use graded aggregate base material meeting the following gradation:

Sieve Size	Percent by Weight Passing

Sieve Size	Percent by Weight Passing
2 inch	100
1 1/2 inch	95 to 100
3/4 inch	65 to 90
3/8 inch	45 to 75
No. 4	35 to 60
No. 10	25 to 45
No. 50	5 to 25
No. 200	0 to 10

For Group 1 aggregates, ensure that the fraction passing the No. 40 sieve has a Plasticity Index (AASHTO T-90) of not more than 4.0 and a Liquid Limit (AASHTO T-89) of not more than 25, and contains not more than 67% of the weight passing the No. 200 sieve.

For Group 2 aggregates, ensure that the material passing the No. 10 sieve has a sand equivalent (AASHTO T-176) value of not less than 28.

The Contractor may use graded aggregate of either Group 1 or Group 2, but only use one group on any Contract. (Graded aggregate may be referred to hereinafter as "aggregate".)

204-3 Equipment.

Provide equipment meeting the requirements of 200-3.

204-4 Transporting Aggregate.

Transport aggregate as specified in 200-4.

204-5 Spreading Aggregate.

Spread aggregate as specified in 200-5.

204-6 Compacting and Finishing Base.

204-6.1 General: Meet the requirements of 200-7.1 with density requirements of 204-6.3.

204-6.1.1 Single-Course Base: Construct as specified in 200-6.1.1.

204-6.1.2 Multiple-Course Base: Construct as specified in 200-6.1.2.

204-6.2 Moisture Content: Meet the requirements of 200-6.2.

204-6.3 Density Requirements: After attaining the proper moisture conditions, uniformly compact the material to a density of not less than 100% of the maximum density as determined by FM 1-T 180. Ensure that the minimum density that will be acceptable at any location outside the traveled roadway (such as intersections, crossovers, turnouts, etc.) is 98% of the maximum density.

204-6.4 Density Tests: Meet the requirements of 200-7.2.

204-6.5 Correction of Defects: Meet the requirements of 200-6.4.

204-6.6 Dust Abatement: Minimize the dispersion of dust from the base material during construction and maintenance operations by applying water or other dust control materials.

204-7 Testing Surface.

Test the surface in accordance with the requirements of 200-7.

204-8 Priming and Maintaining.

Meet the requirements of 200-8.

204-9 Thickness Requirements.

Meet the requirements of 285-6.

204-10 Calculations for Average Thickness of Base.

Calculations for determining the average thickness of base will be made in accordance with 285-7.

204-11 Method of Measurement.

204-11.1 General: The quantity to be paid for will be the area, in square yards, completed and accepted.

204-11.2 Authorized Normal Thickness Base: The surface area of authorized normal thickness base will be calculated as specified in 9-1.3, omitting any areas not allowed for payment under the provisions of 204-9 and omitting areas which are to be included for payment under 204-11.3. The area for payment, of authorized normal thickness base, will be the surface area determined as provided above, adjusted by adding or deducting, as appropriate, the area of base represented by the difference between the calculated average thickness, determined as provided in 204-10, and the specified normal thickness, converted to equivalent square yards of normal thickness base.

204-11.3 Authorized Variable Thickness Base: As specified in 200-10.3.

204-12 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including dust abatement, correcting all defective surface and deficient thickness, removing cracks and checks and the additional aggregate required for such crack elimination.

Payment will be made under:

Item No. 285- 7- Optional Base - per square yard.

SECTION 210
REWORKING LIMEROCK BASE

210-1 Description.

Rework (or rework and widen) the existing rock base, by adding new limerock material as required by the plans. Construct adjacent turnouts, entirely with new limerock.

210-2 Materials.

Meet the limerock material requirements as specified in Section 911 if new limerock is needed. The Contractor may use limerock of either Miami Oolite or Ocala Formation but only use limerock of one formation on any Contract.

210-3 Equipment.

Provide equipment meeting the requirements of 200-3.

210-4 Existing Bituminous Surfaces.

210-4.1 Asphalt Concrete: Remove asphalt concrete surfaces from the base prior to excavating trenches or scarifying the rock. Dispose of removed materials as specified in 120-5.

210-4.2 Bituminous Surface Treatment: Remove and dispose of existing bituminous surface treatment only when specifically specified in the plans. Otherwise, the Contractor may mix the existing bituminous surfacing in with the existing limerock material.

210-5 Trenches and Subgrade.

Where widening the existing base, excavate trenches along the edges of the existing pavement to the width and depth indicated in the plans. Excavate the trenches before scarifying the existing base. Shape, compact, and maintain the subgrade of the trenches and turnouts as specified in 120-9, except that when stabilization of the subgrade is not included in the plans, do not compact the trenches unless the native underlying material has been disturbed. Dispose of all excavated materials as specified in 120-5.

210-6 Spreading, Shaping, and Compacting Rock.

210-6.1 General: Scarify and disk, or otherwise loosen the existing base to such extent that no pieces larger than 3 1/2 inches in greatest dimension remain bonded together. Then, spread the material to the full width of the proposed new base course and to a grade and cross-section roughly parallel to the finished grade. Meet the requirements of 200-7.1.

210-6.2 Widening Strips: Where the widening strips are not of sufficient width to permit the use of standard compaction equipment, compact the rock in accordance with 200-6.5.

210-6.3 Construction Sequence: Do not spread any material for the upper course until the Engineer has made the density tests on the lower course and has determined that the specified compaction requirements have been met. Then, construct the second course of new limerock in accordance with the requirements of 200-5 through 200-7.

210-7 Priming and Maintaining.

Meet the requirements of 200-8.

210-8 Method of Measurement.

210-8.1 Base: The quantity to be paid for will be the plan quantity, in square yards, completed and accepted, including the areas of widened base and of turnouts constructed of new limerock material.

210-8.2 Limerock Material: The quantity to be paid for will be the number of cubic yards of only the new limerock material actually placed in the road and accepted. The quantity will be determined by measurement in loose volume, in truck bodies, at the point of dumping on the road, with proper deduction for all

materials wasted, left in trucks or otherwise not actually used in the road. For this purpose, level the material in the truck bodies to facilitate accurate measurement.

210-9 Basis of Payment.

Prices and payments will be full compensation for performing all work specified in this Section including prime coat application as specified in 300-7, except all earthwork required for this work, and the work of removal and disposal of the existing bituminous surfaces, if required, as indicated in the plans.

When the plans do not provide for direct payment for such work, the cost will be included in the Contract unit price for Reworking Limerock Base.

Payment will be made under:

Item No. 210- 1-	Reworking Limerock Base - per square yard.
Item No. 210- 2-	Limerock, New Material - per cubic yard.

SECTION 230
LIMEROCK STABILIZED BASE

230-1 Description.

Construct a base course composed of roadbed soil stabilized with limerock.

230-2 Materials.

Meet the limerock material requirements as specified in Section 911.

230-3 Equipment.

230-3.1 For Mixing: For mixing in the roadway, provide a heavy-duty rotary tiller or other equipment approved by the Engineer as equally effective for this work.

230-3.2 For Compaction: Select the equipment for compacting the stabilized material, except that for the final finish use a steel-wheeled roller.

230-4 Preparation of Roadbed.

Complete the area to be stabilized to the lines shown in the plans and to a grade parallel to the finished elevation of the stabilized base, before adding the stabilizing material. Ensure that the elevation of the roadbed is such that the base will conform to the typical cross-section upon completing the work. Dispose of any surplus excavated materials resulting from this work, as specified in 120-5.

230-5 Incorporation of Stabilizing Material and Mixing-In.

230-5.1 Spreading and Mixing: Place the limerock on the areas to be stabilized, and spread it uniformly to the loose depth shown in the plans or ordered by the Engineer. Then, thoroughly mix the limerock with the soil. Perform mixing as soon as practicable but not later than one week after placing the limerock on the road. Do not spread more limerock in advance of the mixing operations than can be mixed-in with the soil within one week.

230-5.2 Further Mixing Operations: Repeat the mixing operations as often as may be necessary to distribute the limerock uniformly throughout the soil, as determined by the Engineer. Further manipulate the material to uniformly distribute the limerock throughout the width and depth of the base course.

230-5.3 Plant Mixing: The Contractor may mix the soil, limerock, and water using the central plant-mix method in lieu of mixing in place, provided he obtains a uniform mixture with the proper amount of water.

230-5.4 Shaping Surface: After mixing, shape the surface so it conforms to the grade and typical cross-section shown in the plans after compacting.

230-5.5 Depth of Mixing Stabilizing Material: Ensure that the depth of mixing of the stabilizing material is in accordance with the following table:

Specified Base Thickness (inches)	Required Mixing Depth (inches)	
	Minimum	Maximum
6	5 1/2	7 1/2
8	7 1/4	9 3/4
10	9	12

In the event that the measured depth of mixing is less than the minimum specified above, remix the base course, as directed by the Engineer, until the stabilizing material is distributed to the required depth throughout the base course.

Where the measured depth of mixing exceeds the maximum limits specified in the table, add 1 inch, loose measure, of stabilizing material for each 1 inch of mixing depth in excess of the allowable depth (but in no case less than 1 inch of material, for any excess depth), and mix the added material in the top 6 inches of the base as specified in 230-5.1 and 230-5.2, at no expense to the Department. The Department will not include the volume of stabilizing material, which is added to compensate for excess mixing depth, in the pay quantity, and will not allow any additional compensation for the extra mixing required.

230-6 Compacting and Finishing Base.

Meet the requirements of 200-6.

230-7 Testing Surface.

Test the surface in accordance with the requirements of 200-7.

230-8 Priming and Maintaining.

Meet the requirements of 200-8.

230-9 Method of Measurement.

230-9.1 General: The quantities to be paid for will be the plan quantity, in square yards, completed and accepted.

230-9.2 Quantity of Limerock: The quantity to be paid for will be as specified in 210-8.2.

230-10 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including furnishing, hauling, placing, spreading, mixing, compacting, prime coat application as specified in 300-7 and finishing all limerock stabilizing material; any necessary excavating below the finished grade of the base to provide for placing the stabilizing material; and disposing of all surplus excavation resulting from this work.

Where extra limerock material is placed at locations of culverts, etc., as detailed in the plans, the volume of such material, determined as provided above, will be included in the quantity of Limerock Material to be paid for, but no adjustment will be made in the area of base to be paid for.

Payment will be made under:

Item No. 230- 1-	Limerock Stabilized Base - per square yard.
Item No. 230- 2-	Limerock Material - per cubic yard.

SECTION 234
SUPERPAVE ASPHALT BASE

234-1 Description.

Construct a Superpave Asphalt Concrete base course as defined in these Specifications. Base course mixes are designated as B-12.5. The Contractor may use a Type SP-12.5 mixture, (Traffic Level B or C) in lieu of a Type B-12.5.

On projects with only Traffic Level A and/or B asphalt mixtures, select Option 1 or Option 2 Mixture Acceptance as specified in 234-5. The selection shall be indicated in the Contractor Quality Control Plan in accordance with Section 105 and shall apply to all mixes, including base, structural and friction course mixes, on the entire project. If a contract contains Traffic Level A and/or B asphalt mixtures and also contains Traffic Level C, D, and/or E asphalt mixtures, accept the asphalt mixtures only under Option 1 Material Acceptance.

When Option 2 Mixture Acceptance is selected, the requirements of 330-2 will not apply, with the exception of the roadway requirements as defined in 330-2.2.

234-2 Materials.

234-2.1 General: Use materials that conform to the requirements of Division III. Specific references are as follows:

Superpave PG Asphalt Binder or Recycling Agent	916-1, 916-2
Coarse Aggregate, Stone, Slag or Crushed Gravel	Section 901
Fine Aggregate	Section 902

234-2.2 Reclaimed Asphalt Pavement (RAP): RAP may be used as a component material of the asphalt mixture provided the requirements of 334-2.3 are met.

234-3 General Composition of Mixture.

234-3.1 General: Compose the asphalt mixture using a combination of aggregate (coarse, fine or mixtures thereof), mineral filler if required, and asphalt binder material. Size, grade and combine the aggregate fractions to meet the grading and physical properties of the mix design. Aggregates from various sources may be combined.

234-3.2 Mix Design: Unless otherwise specified, design the mix such that all requirements for a Type SP-12.5, Traffic Level B or C mixture as specified in Section 334 are met.

234-3.2.1 Gradation Classification: Use a fine mix as defined in 334-3.2.2.1.

234-3.2.2 Aggregate Consensus Properties: Meet the aggregate consensus properties at design as specified in 334-3.2.3. Meet the criteria specified for a depth of top of pavement layer from surface of greater than 4 inches.

234-3.2.3 Mix Design Revisions: Meet the requirements of 334-3.3.

234-4 Contractor's Process Control.

Meet the requirements of 330-2 and 334-4.

234-5 Acceptance of the Mixture.

234-5.1 Option 1 Mixture Acceptance: If Option 1 Mixture Acceptance is selected, the mixture will be accepted in accordance with the requirements of 334-5.1 with the following exceptions:

234-5.1.1 Option 1 Acceptance Testing Exceptions: Density testing for acceptance will not be performed in areas as defined in 334-5.1.1.2. In these situations compact the base in accordance with the rolling procedure (equipment and pattern) submitted as part of the Quality Control Plan and as approved by the Engineer. Use the permissible variations from longitudinal and transverse grades as specified in 200-7. The pay factor for LOTs where there are areas not requiring density testing will be prorated based on a pay factor of 1.00 for the tonnage of material in areas not requiring density testing and the actual pay factor for the tonnage of material in areas requiring density.

234-5.2 Option 2 Mixture Acceptance: If Option 2 Mixture Acceptance is selected, the mixture will be accepted in accordance with the requirements of 334-5.2 with the following exceptions:

234-5.2.1 Option 2 Acceptance Testing Exceptions: Density testing for acceptance will not be performed in areas as defined in 334-5.1.1.2.In these situations compact the base in accordance with the rolling procedure (equipment and pattern) as approved by the Engineer. Use the permissible variations from longitudinal and transverse grades as specified in 200-7.

234-6 Plant, Methods and Equipment.

Meet requirements of Section 320, with the following modifications:

234-6.1 Paving Equipment: A motor grader may be used to spread the first course of multiple course bases when the subgrade will not support the use of a mechanical spreader. The Engineer will not require mechanical spreading and

finishing equipment for the construction of base widening strips less than 6 feet in width.

234-6.2 Compaction Equipment: In areas where standard rollers cannot be accommodated, vibratory rollers supplemented with trucks, motor graders, or other compaction equipment approved by the Engineer may be used.

234-7 Construction Requirements.

234-7.1 General: Meet the General Construction Requirements of Section 330, with the following modifications:

234-7.1.1 Temperature Limitations: Spread the mixture only when the air temperature is at least 40ºF. Do not place the material on frozen subgrade.

234-7.1.2 Tack Coat: Unless otherwise authorized by the Engineer, apply a tack coat between successive layers of base material.

234-7.1.3 Thickness of Layers: Construct each course in layers not to exceed 3 inches compacted thickness.

234-8 Thickness Requirements.

234-8.1 General: When the Department pays for the pavement on a square yard basis, the Engineer will determine the thickness of the asphalt base based upon the spread rate of the material. The minimum spread rate for the total thickness shall be established from the plan thickness in the following manner: 43.3 lbs/sy multiplied by the maximum specific gravity of the mix (as indicated on the mix design) for every one inch of desired thickness, or as determined by the Engineer. The weight of the mixture shall be determined as provided in 320-2.2 (including the provisions for automatic recordation system).

The spread rate for each individual layer shall be established by the Engineer. The minimum layer spread rate shall be 43.3 lbs/sy multiplied by the maximum specific gravity (G_{mm}) of the mix (as indicated on the mix design) for every one inch of desired thickness.

234-8.2 Spread Rate Tolerance: Control the average spread rate on a daily basis to within ± 5% of the target spread rate for the individual layer(s) established by the Engineer. When the average daily spread rate is outside this tolerance from the target, adjust the spread rate to the required value established by the Engineer. The Engineer will periodically verify the spread rate at the job site during the paving operation.

234-8.3 Allowable Deficiencies: The Engineer will allow a maximum deficiency from the specified spread rate for the total thickness as follows:

1. For pavement of a specified thickness of 2 1/2 inches or more: 50 lbs/sy.
2. For pavement of a specified thickness of less than 2 1/2 inches: 25 lbs/sy.

234-8.4 Pavement Exceeding Allowable Deficiency in Spread Rate: Where the deficiency in spread rate for the total thickness is: (1) in excess of 50 lbs/sy for pavements with a specified thickness of 2 1/2 inches or more, or (2) in excess of 25 lbs/sy for pavements with a specified thickness of less than 2 1/2 inches, the Engineer may require removal and replacement at no cost or may require a correction as specified in 234-8.5. The Engineer may require the

Contractor to core the pavement for thickness in order to determine the area of pavement with deficient thickness.

As an exception to the above, the Contractor may leave pavement outside the main roadway in place without compensation when the Engineer allows, even though the deficiency exceeds the tolerance as specified above.

The Department will not compensate the Contractor for any pavement removed or for the work of removing such pavement.

234-8.5 Correcting Deficiency by Adding New Surface Material: In the event the total thickness as determined by the spread rate is excessively deficient as defined above and if approved by the Engineer for each particular location, correct the deficient thickness by adding new surface material and compacting it using a rolling pattern as approved by the Engineer. The Engineer will determine the area to be corrected and the thickness of new material added. Perform all overlaying and compacting at no expense to the Department.

234-9 Method of Measurement.

The quantity to be paid for will be the plan quantity. The pay area will be adjusted based upon the following formula:

Pay Area = Surface Area (Project Average Spread Rate/Specified Spread rate for the Total Thickness).

Where: The project average spread rate is calculated by totaling the arithmetic mean of the average daily spread rate values for each layer, and the specified spread rate for the total thickness is based upon the plan thickness converted to spread rate as defined in 234-8.1.

The pay area shall not exceed 105% of the designed surface area.

Prepare a Certification of Quantities, using the Department's current approved form, for the certified Superpave Asphalt Base pay item. Submit this certification to the Engineer no later than Twelve O'clock noon Monday after the estimate cut-off or as directed by the Engineer, based on the quantity of asphalt produced and accepted on the Contract. The certification must include the Contract Number, FPID Number, Certification Number, Certification Date, period represented by Certification, and the tons produced for each asphalt pay item.

234-10 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including the applicable requirements of Sections 320, 330 and 334. The bid price for the asphalt mix will include the cost of the liquid asphalt binder or the asphalt recycling agent and the tack coat application as directed in 300-8. For the calculation of unit price adjustments of bituminous material specified in 9-2.1.1, the average asphalt binder content of the base mixes to be used in these calculations is set at 6.25%.

Payment will be made under:

Item No. 285- 7- Optional Base - per square yard.

SECTION 283
RECLAIMED ASPHALT PAVEMENT BASE

283-1 Description.

Construct a base course composed of reclaimed asphalt pavement (RAP) material. Use RAP material as a base course only on paved shoulders, bike paths, or other non-traffic applications.

283-2 Materials.

Obtain the RAP material by either milling or crushing an existing asphalt pavement. Use material so that at least 97% (by weight) pass a 3 1/2 inch sieve and is graded uniformly down to dust.

When the RAP material is from a Department project and the composition of existing pavement is known, the Engineer may approve material on the basis of the composition. When the composition of obtained RAP is not known, the following procedure will be used for approval:

(1) Conduct a minimum of six extraction gradation analyses of the RAP material. Take samples at random locations in the stockpile. The average asphalt cement content of the six stockpile samples must be 4% or greater with no individual result below 3 1/2%.

(2) Request the Engineer to make a visual inspection of the stockpile of RAP material. Based on this visual inspection of the stockpiled material and the results of the Contractor's extraction gradation analyses, the Engineer will determine the suitability of the materials.

(3) The Engineer may require crushing of stockpiled material to meet the gradation criterion. Perform all crushing before the material is placed.

283-3 Spreading RAP Material.

283-3.1 Method of Spreading: Spread the RAP with a blade or device which strikes off the material uniformly to laying thickness and produces an even distribution of the RAP. The Contractor may also place the RAP material directly from the milling machine into the trench by a conveyor. When placing the RAP material by conveyor directly from the milling machine, obtain the Engineer's approval of the milling process.

283-3.2 Number of Courses: When the specified compacted thickness of the base is greater than 6 inches, construct the base in two courses. Place the first course to a thickness of approximately one half the total thickness of the finished base, or sufficient additional thickness to bear the weight of construction equipment without disturbing the subgrade.

Except as might be permitted by the Engineer for special cases, conduct all RAP base construction operations for shoulders before placing the final pavement on the adjacent traveled roadway.

283-4 Compacting and Finishing Base.

283-4.1 General: Meet the requirements of 200-6.1:

283-4.1.1 Single-Course Base: Construct as specified in 200-6.1.1.

283-4.1.2 Multiple-Course Base: Construct as specified in 200-6.1.2.

283-4.2 Moisture Content: Meet the requirements of 200-6.2. Ensure that the moisture content at the time of compaction is within 2% of optimum.

283-4.3 Density Requirements: After attaining the proper moisture content, compact the material to a density of not less than 95% of maximum density as determined by FM 1-T 180. Where the width of the base construction is not sufficient to permit use of standard base compaction equipment, perform compaction using vibratory compactors, trench rollers, or other special equipment which will provide the density requirements specified herein.

283-4.4 Density Tests: Meet the requirements of 200-7 with the exception of 200-7.2.1. Within the entire limits of the width and depth of the base, obtain a minimum density in any LOT of 95% of the maximum density as determined by FM 1-T 180.

283-4.5 Thickness Requirements: Meets the thickness requirements of 285-6.

283-5 Testing Surface.

Test the surface in accordance with the requirements of 200-6.4.

283-6 Priming and Maintaining.

283-6.1 Priming: Apply the prime coat only when the base meets the specified density requirements and the moisture content in the top half of the base is within 2% of optimum. At the time of priming, ensure that the base is firm, unyielding, and in such condition that no undue distortion will occur. The Engineer will not allow priming if the surface is dry, dusty, or sloughing.

283-6.2 Maintaining: Meet the requirements of 200-8.2.

SECTION 285
OPTIONAL BASE COURSE

285-1 Description.

Construct a base course composed of one of the optional materials shown on the typical cross-sections.

285-2 Materials.

Meet the material requirements as specified in the Section covering the particular type of base to be constructed.

Graded Aggregate	Section 204
Asphalt	Section 234
Limerock	Section 911
Shell Base	Section 913
Shell-Rock	Section 913A
Cemented Coquina	Section 915

285-3 Selection of Base Option.

The plans will include typical cross-sections indicating the various types of base construction (material and thickness) allowable.

Select one base option as allowed for each typical cross-section shown in the plans. Only one base option is permitted for each typical cross-section.

Notify the Engineer in writing of the base option selected for each typical cross-section at least 45 calendar days prior to beginning placement of base material.

285-4 Construction Requirements.

Construct the base in accordance with the Section covering the particular type of base to be constructed.

Limerock	Section 200
Shell Base	Section 200
Shell Rock	Section 200
Cemented Coquina	Section 200
Graded Aggregate	Section 204
Asphalt	Section 234

285-5 Variation in Earthwork Quantities.

The plans will identify the optional materials used by the Department for determining the earthwork quantities (Roadway Excavation, Borrow Excavation, Subsoil Excavation, Subsoil Earthwork, or Embankment). The Department will not revise the quantities, for those items having final pay based on plan quantity, to reflect any volumetric change caused by the Contractor's selection of a different optional material.

285-6 Thickness Requirements.

285-6.1 Measurements: For non-asphalt bases, meet the requirements of 200-7.3.1.2.

For subbases, meet the thickness requirements of 290-4.

The Engineer will determine the thickness of asphalt base courses in accordance with 234-8.1.

285-6.2 Correction of Deficient Areas: For non-asphalt bases, correct all areas of the completed base having a deficiency in thickness in excess of 1/2 inch by scarifying and adding additional base material. As an exception, if authorized by the Engineer, such areas may be left in place without correction and with no payment.

For asphalt bases, correct all areas of deficient thickness in accordance with 234-8.

285-7 Calculation of Average Thickness of Base.

For bases that are not mixed in place, the Engineer will determine the average thickness from the measurements specified in 285-6.1, calculated as follows;

(a) When the measured thickness is more than 1/2 inch greater than the design thickness shown on the typical cross-section in the plans, it will be considered as the design thickness plus 1/2 inch.

(b) Average thickness will be calculated per typical cross-section for the entire job as a unit.

(c) Any areas of base left in place with no payment will not be included in the calculations.

(d) Where it is not possible through borings to distinguish the base materials from the underlying materials, the thickness of the base used in the measurement will be the design thickness.

(e) For Superpave asphalt base course, the average spread rate of each course shall be constructed in compliance with 234-8.

285-8 Method of Measurement.

The quantity to be paid for will be the plan quantity area in square yards, omitting any areas where under-thickness is in excess of the allowable tolerance as specified in 285-6. The pay area will be the surface area, determined as provided above, adjusted in accordance with the following formula:

$$Pay\ Area = Surface\ Area \left(\frac{Calculated\ \ Average\ Thickness\ \ per\ 285\text{-}7}{Plan\ Thickness} \right)$$

The pay area shall not exceed 105% of the surface area.

There will be no adjustment of the pay area on the basis of thickness for base courses constructed utilizing mixed-in-place operations.

For Superpave asphalt base course, the quantity to be paid for will be the plan quantity.

285-9 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including tack coat between base layers, prime coat, cover material for prime coat, bituminous material used in bituminous plant mix, and cement used in soil-cement.

Where the plans include a typical cross-section which requires the construction of an asphalt base only, price adjustments for bituminous material provided for in 9-2.1.2 will apply to that typical cross-section. For typical cross-sections which permit the use of asphalt or other materials for construction of an optional base, price adjustments for bituminous material provided for in 9-2.1.2 will not apply.

Payment will be made under:

Item No. 285- 7- Optional Base - per square yard.

SECTION 286
TURNOUT CONSTRUCTION

286-1 Description.

Construct turnouts or extend existing turnouts on resurfacing and widening-resurfacing projects.

The Department does not include placing of asphalt concrete surface course over turnouts in this Section.

286-2 Materials.

For base material for turnouts, use any material currently specified by the Department for base or surface construction, except do not use hot bituminous mixtures intended for use as open-graded friction course. Proportion bituminous mixtures in accordance with a job-mix formula approved by the Department.

In general, the Engineer will accept the material on the basis of visual inspection, with no testing required.

286-3 Excavation.

Excavate the area over which turnout construction is to be accomplished to the dimensions shown in the plans or the Design Standards. If the surface of the underlying soil is disturbed during the excavation operation, compact it to the approximate density of the surrounding undisturbed soil.

If an existing paved turnout lies within the specified limits for turnout construction, leave the existing base and surface in place, as directed by the Engineer.

286-4 Spreading, Compacting, and Finishing Base.

Uniformly spread base material over the prepared area to a depth which will, upon completion of compaction and finishing, result in turnout base conforming with the specified lines and elevations. Then, strike off the base material to a plane paralleling the finished surface, and compact it in a manner similar to that used in the construction of roadway base. The Engineer will not require any specific density.

Finish the surface to the specified grade and cross-section.

286-5 Method of Measurement.

The quantity to be paid for will be the plan quantity area, in square yards, except, when turnout construction is specified to be paid for by weight of mixture, the weight will be measured as specified in 320-2.

286-6 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including excavating; compacting excavated areas; furnishing material; placing, compacting, and finishing of base; and incidental work.

The cost of any bituminous material used in hot bituminous mix, or for prime coat or tack coat between base layers, will not be paid for separately.

Payment will be made under:

Item No. 286- 1-	Turnout Construction - per square yard.
Item No. 286- 2-	Turnout Construction (Asphalt) - per ton.

SECTION 287
ASPHALT TREATED PERMEABLE BASE

287-1 Description.

Construct Asphalt Treated Permeable Base (ATPB) and Outlet Pipe for use under concrete pavement, in accordance with the details shown in the plans and the Design Standards, Index No. 287. Meet the plant and equipment requirements of Section 320 and the general construction requirements of Section 330, except as noted below.

287-2 Materials.

Meet the following requirements:

Coarse Aggregate, Stone, Slag, or Crushed Gravel
Grade No. 57 or 67 ..... Section 901
Superpave PG Asphalt Binder (PG 67-22) (1) 916-1
Hydrated Lime (2) ..... AASHTO M-303 Type 1
Polyvinyl-Chloride Pipe (3) ..... Section 948
Polyethylene Pipe (3) ..... Section 948
Geotextile Fabric ..... Section 985

(1) Use PG 67-22 in the ATPB containing 0.75% heat-stable anti-strip additive (by weight of asphalt) from an approved source. Introduce and mix the anti-strip additive at the terminal.

(2) For mixtures containing granite, add hydrated lime at a dosage rate of 1.0% by weight of the total dry aggregate in lieu of adding 0.75% anti-strip additive. Provide certified test results for each shipment of hydrated lime indicating compliance with the specifications. In addition, meet the requirements of 337-9.2 and 337-9.3.

(3) Use either Polyvinyl-Chloride Pipe or Polyethylene Pipe, unless otherwise specified in the Contract Documents.

287-3 Composition of Mixture.

287-3.1 General: Use ATPB composed of a combination of coarse aggregate and asphalt cement. Use a mix design verified by the Engineer.

287-3.2 Mix Design: Submit a proposed mix design along with representative samples of all component materials to the Engineer, at least two weeks before the scheduled start of production. Establish the design asphalt content within the range of 2.0 – 4.0%, by weight of total mixture. During the mix design process, the Engineer may adjust the asphalt content within the 2.0 - 4.0% range. The Engineer may increase or decrease the specified asphalt content during production of the mix after testing and visual inspection. Ensure that a minimum of 95% of the aggregate is coated. There will be no separate payment for the bituminous material in the mix. Establish the mix temperature within the range of 230ºF to 250ºF, or as approved by the Engineer.

287-4 Control of Quality.

Provide the necessary control of the ATPB and construction in accordance with the applicable provisions of 330-2.

287-5 Acceptance of the Mixture at the Plant.

The ATPB mixture will be accepted at the plant with respect to 334-5.1 with the following exceptions:

1. The mixture will be accepted with respect to gradation ($P_{-1/2}$ if #57 stone is used and $P_{-3/8}$ if #67 stone is used) and asphalt binder content (P_b) only.

2. Testing in accordance with AASHTO TP4-00 and FM 1 T-209 (and conditioning of the mix prior to testing) will not be required as part of 334-5.1.1.1.

3. The standard LOT size will be, 2,000 tons, with each LOT subdivided into four equal sublots of 500 tons each.

4. Initial production requirements of 334-5.1.3 do not apply.

5. The Between-Laboratory Precision Values described in Table 334-6 are modified to include ($P_{-1/2}$ and $P_{-3/8}$) with a maximum difference per FM 1 T-030 (Figure 2).

6. Table 334-5 (Master Production Range) is replaced by Table 287-1.

Table 287-1
ATPB Master Production Range

Characteristic	Tolerance (1)
Asphalt Binder Content (%)	Target ± 0.60
Passing 1/2 inch Sieve (%) if using #57 stone	Target ± 12.00
Passing 3/8 inch Sieve (%) if using #67 stone	Target ± 12.00

(1) Tolerances for sample size of n = 1 from the verified mix design

287-5.1 Individual Test Tolerances for ATPB Production: In the event that an individual Quality Control test result of a sublot for gradation ($P_{-1/2}$ if #57 stone is used and $P_{-3/8}$ if #67 stone is used), or asphalt binder content does not meet the requirements of Table 287-1, take steps to correct the situation and actions taken shall be reported to the Engineer.

In the event that two consecutive individual Quality Control test results for gradation ($P_{-1/2}$ if #57 stone is used and $P_{-3/8}$ if #67 stone is used) or asphalt binder content do not meet the requirements of Table 287-1, the LOT will be automatically terminated and production of the mixture stopped until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Evaluate any material represented by the failing test result in accordance with 334-5.1.9.

287-6 Acceptance of the Mixture at the Roadway.

Acceptance of the Contractor's methods of placement and compaction will be based upon the completion of a 500 foot test section, (initially and at other times as determined by the Engineer), acceptable to the Engineer, prior to further placement. In the event that the placement/compaction method deviates from the approved method, cease placement of the mix until the problem is adequately resolved to the satisfaction of the Engineer.

287-7 Temperature and Storage Limitations.

Place the ATPB material when the atmospheric temperature is above 50ºF and rising. Do not use ATPB material that was mixed more than two hours prior to placement.

287-8 Construction Requirements.

287-8.1 Placement: Ensure that the structural course on which ATPB is to be placed conforms to the compaction and elevation tolerances specified in the Contract Documents and is free of loose or extraneous material. Fill any area of the structural course which is lower than the grade established by the plans with structural course material, at no additional cost to the Department.

Place and compact ATPB in one lift, with a compacted thickness of 4 ± 0.5 inches (except the trench which includes the subdrainage pipe), in accordance with these Specifications, lines, grades, dimensions and notes as shown in the plans.

Place and compact ATPB material around the subdrainage pipe for the full width of the trench, in layers not exceeding 8 inches (loose measure). Do not displace or damage the subdrainage pipe or filter fabric.

Remove and replace all ATPB material which is greater than 1/2 inch below the grade shown in the plans or, in the opinion of the Engineer, is damaged or contaminated, at no additional cost to the Department.

287-8.2 Compaction: Compact the ATPB by one of the following methods:

1. A steel-wheeled, tandem roller which will produce an operating weight of not more than 140 PLI of drum width.

2. A steel-wheeled tandem roller weighing from 8 to 12 tons.

Compact the ATPB material (in the static mode only) as approved by the Engineer. Begin compaction as soon as the surface temperature has cooled to 190°F, or as approved by the Engineer and complete compaction before the surface temperature has cooled to 100°F. If necessary, cool the ATPB material with water.

287-8.3 Surface Requirements: Ensure that the finished surface of the ATPB does not vary more than ±1/2 inch from the grade shown in the plans.

The Engineer may approve removal of high spots to within specified tolerance by a method which does not produce contaminating fines. Remove and replace ATPB material that is outside the established tolerance, at no additional cost to the Department. Neither grinding nor milling will be permitted.

287-9 Subdrainage Pipe and Geotextile Material.

Place the subdrainage pipe and geotextile material (filter fabric) in accordance with the plans and Design Standards, Index No. 287.

287-10 Outlet Pipe.

Install outlet fittings and pipes concurrent with subdrainage pipe to provide positive gravity drainage and eliminate soil intrusion. The Engineer will restrict installation of additional sections of ATPB, until appropriate outlets are installed.

Ensure that all fittings and materials are designed and installed to eliminate soil intrusion into the system.

Connect the open end of the outlet pipe into either an existing drainage structure, existing ditch pavement or terminate with a concrete apron.

Do not block the drainage system at any time. Ensure that at the time of inspection and project acceptance, all outlet pipes and concrete aprons are clear of earth material, vegetation, and other debris.

287-11 Compensation.

Meet the requirements of 334-8 with the following exceptions:

1. Pay factors will be calculated for asphalt binder content and the percentages passing the 1/2 inch and the 3/8 inch sieves only.
2. Table 287-2 replaces Table 334-6.
3. Table 287-3 replaces Table 334-7.
4. The Composite Pay Factor in 334-8.3 is replaced with the following:

CPF = [(0.25 x PF 1/2 inch or 3/8 inch) + (0.75 x PF AC)]

Note: Use the PF for the 1/2 inch sieve if #57 stone is used in the mixture or use the PF for the 3/8 inch sieve if #67 stone is used in the mixture.

Table 287-2
Small Quantity Pay Table for ATPB

Pay Factor	1-Test Deviation	2-Test Average Deviation
Asphalt Binder Content (%)		
1.00	0.00-0.50	0.00-0.35
0.90	0.51-0.60	0.36-0.42
0.80	>0.60	>0.42
1/2 inch Sieve (%) if using #57 stone		
1.00	0.00-11.00	0.00-7.78
0.90	11.01-12.00	7.79-8.49
0.80	>12.00	>8.49
3/8 inch Sieve (%) if using #67 stone		
1.00	0.00- 11.00	0.00- 7.78
0.90	11.01-12.00	7.79-8.49
0.80	>12.00	>8.49

Table 287-3
Specification Limits for ATPB

Quality Characteristic	Specification Limits
Asphalt Binder Content (%)	Target ± 0.45
Passing 1/2 inch sieve (%) if using #57 stone	Target ± 10.00
Passing 3/8 inch sieve (%) if using #67 stone	Target ± 10.00

287-12 Low Quality Material.

Meet the requirements of 334-5.1.9. For ATPB, use the Master Production Range defined in Table 287-1 in lieu of Table 334-5.

287-13 Method of Measurement.

287-13.1 Asphalt Treated Permeable Base: The quantity of ATPB to be paid for will be the plan quantity, in cubic yards, completed and accepted, subject to 9-3.2. No allowance will be made for ATPB placed outside plan dimensions, unless otherwise ordered by the Engineer.

287-13.2 Outlet Pipe: The quantity of outlet pipe to be paid for will be the length, in feet, measured in place along the centerline and gradient of the pipe, completed and accepted.

287-14 Basis of Payment.

287-14.1 Asphalt Permeable Base: Price and payment will be full compensation for work specified in this Section, including furnishing all labor, materials (including the ATPB material, geotextile, and subdrainage pipe), tools, equipment, and incidentals, necessary to complete the work.

287-14.2 Outlet Pipe: Price and payment will be full compensation for work specified in this Section, including removal of existing shoulder pavement, trench excavation, pipe and fittings, standard aprons, galvanized hardware cloth (rodent screens), grouting around and stubbing into existing or proposed drainage structures or ditch pavement; restoration of ditch pavement, sod and other areas disturbed by the Contractor, backfill in place, disposal of excess materials and incidentals, necessary to complete the work.

287-14.3 Payment Items: Payment will be made under:

Item No. 287- 1-	Asphalt Treated Permeable Base - per cubic yard.
Item No. 446- 71-1	Edgedrain Outlet Pipe - per foot.

SECTION 288
CEMENT TREATED PERMEABLE BASE

288-1 Description.

288-1.1 General: Construct Cement Treated Permeable Base and Outlet Pipe as shown in the plans and Design Standards, Index No. 287. Use any one of the types of pipe listed in 288-2, unless a particular type is specifically required by the Contract Documents. Use only perforated pipe, and do not use open joints.

288-1.2 Concrete Plant and Cement Concrete pavement: Meet the requirements of Section 346 for plant and equipment, and Section 350 for general construction requirements.

Work will be accepted in accordance with the applicable provisions in Section 350.

288-2 Materials.

Meet the following requirements:

Coarse Aggregate	Section 901
Portland Cement	Section 921
Water	Section 923
Polyvinyl-Chloride Pipe	Section 948

Polyethylene Pipe ..... Section 948
Geotextile Fabric ..... Section 985

For Cement Treated Permeable Base, the concrete requirements of Section 346 are modified as follows:

Use Type I or II portland cement (no fly ash or other pozzolans permitted).

Composition:

Grade of coarse aggregate (stone) ..... # 57 or # 67
Maximum Water/Cement ratio* 0.40
Minimum cement factor** ..... 9 lb/ft^3
Maximum Slump Range ..... Not Applicable
Fine Aggregate ..... None
Admixtures ..... None

*The Engineer will approve the Water/Cement ratio.

**±2 lbs/ft^3

Do not use materials which contain hardened lumps, crusts, or frozen matter, or are contaminated with dissimilar material.

288-3 Control of Quality.

288-3.1 General: Meet the provisions of this Section and Chapter 9.2 of the Materials Manual – Concrete Production Facilities Guidelines, which may be view at the following URL:
www.dot.state.fl.us/specificationsoffice/materialsmanual/section92.pdf .

288-3.2 Concrete Design Mix: Submit the proposed design mix prior to production, on the "Concrete Mix Design" form, for the Engineer's approval. Use only Cement Treated Permeable Base design mixes having prior approval of the Engineer.

Furnish sufficient material of each component when requested by the Engineer, for verification of the proposed mix design by the State Materials Office. Verify the unit weight requirements as determined in accordance with FM 5-530. Also, provide one of the following with the design mix submittal:

(1) Evidence from three sets of production data, either from Department acceptance tests or independently verifiable commercial mixes, that Cement Treated Permeable Base produced in accordance with the proposed design mix meets the requirements of this Section.

(2) Test data from a single trial batch of a 1 yd^3 minimum is required, which demonstrates that the Cement Treated Permeable Base produced using the proposed mix, designated ingredients, and designated water-cement ratio meets the requirements of this Section.

288-3.3 Batch Adjustment - Materials: Meet the theoretical yield requirements of the approved mix design. Inform the Engineer of any adjustments to the approved mix design. Note any batch adjustments and record the actual quantities incorporated into the mix, on the concrete "Delivery Ticket/Certification" form.

288-3.4 Delivery Certification: Furnish to the Engineer a complete "Delivery Ticket/Certification" form with each batch of Cement Treated Permeable Base prior to unloading at the site.

288-4 Acceptance of Placement.

Acceptance of the Contractor's method of placement and compaction will be based upon the completion of a 500 foot test section, acceptable to the Engineer, prior to further placement.

For the purpose of acceptance and partial payment, each days production will be divided into LOTs as specified in Section 346 and in accordance with the applicable requirements of Sections 5, 6, and 9.

288-5 Temperature Requirements.

Place Cement Treated Permeable Base only when the atmospheric temperature is above 40°F and rising.

288-6 Construction Requirements.

288-6.1 Placement: Ensure that the structural course on which Cement Treated Permeable Base is to be placed conforms to the compaction and elevation tolerances specified in the plans and is free of loose or extraneous material. Fill any area of the structural course which is lower than the grade established by the plans with structural course material, at no additional cost to the Department.

Place and compact Cement Treated Permeable Base in one course (except the trench which includes the subdrainage pipe), in accordance with these Specifications, lines, grades, dimensions and notes as shown in the plans. Placement may be accomplished by either the fixed-form or the slip-form method.

Place and compact Cement Treated Permeable Base material around the subdrainage pipe for the full width of the trench, in layers not exceeding 8 inches (loose measure). Do not displace or damage the subdrainage pipe or filter fabric.

Remove and replace all Cement Treated Permeable Base material which is greater than 1/2 inch below the grade shown in the plans or is not covered with the next layer of material within five calendar days after initial placement or in the opinion of the Engineer is damaged or contaminated, at no additional cost to the Department.

288-6.2 Compaction: Compact the Cement Treated Permeable Base by one of the following methods.

1. One complete coverages with a steel-wheeled, two-axle tandem roller weighing between 4 and 10 tons in static mode.
2. By vibratory plates or screeds.

There will be no density requirements for Cement Treated Permeable Base.

288-6.3 Curing: Sprinkle the Cement Treated Permeable Base surface with a fine spray of water every two hours for a period of eight hours or cover with polyethylene sheets for three or four calendar days.

Begin the curing process the morning after placement of the base.

288-6.4 Surface Requirements: Ensure that the finished surface of the Cement Treated Permeable Base does not vary more than ±1/2 inch from the grade shown in the plans.

The Engineer may approve removal of high spots to within the specified tolerance by a method which does not produce contaminating fines. Remove and replace Cement Treated Permeable Base material that is above tolerance, at no additional cost to the Department. Neither grinding nor milling will be permitted.

288-7 Sampling and Testing.

The Engineer will take random samples of the Cement Treated Permeable Base at the point of placement in accordance with FM 5-530 to determine the unit weight. Cement Treated Permeable Base not within ± 3 lbs/ft^3 of the unit weight of the approved mix design will be rejected.

Remove and replace all rejected Cement Treated Permeable Base at no cost to the Department.

288-8 Subdrainage Pipe and Geotextile Material.

Place the subdrainage pipe and geotextile material (filter fabric) in accordance with the plans and Design Standards, Index No 287.

288-9 Outlet Pipe.

Install outlet fittings and pipes concurrent with subdrainage pipe to provide positive gravity drainage and eliminate soil intrusion. The Engineer will restrict installation of additional sections of Cement Treated Permeable Base, until appropriate outlets are installed.

Ensure that all fittings and materials are designed and installed to eliminate soil intrusion into the system.

Connect the open end of the outlet pipe into either an existing drainage structure, existing ditch pavement or terminate with a concrete apron.

Do not block the drainage system at any time. Ensure that at the time of inspection and project acceptance, all outlet pipes and concrete aprons are clear of earth material, vegetation, and other debris.

288-10 Method of Measurement.

288-10.1 Cement Treated Permeable Base: The quantity of Cement Treated Permeable Base to be paid for will be the plan quantity, in cubic yards, completed and accepted, subject to 9-3.2.

288-10.2 Outlet Pipe: The quantity of outlet pipe to be paid for will be the length, in feet, completed and accepted, measured in place along the centerline and gradient of the outlet pipe.

288-11 Basis of Payment.

288-11.1 Cement Treated Permeable Base: Price and payment will be full compensation for work specified in this Section, including furnishing all labor, materials (including the Cement Treated Permeable Base material, geotextile, and subdrainage pipe), tools, equipment, and incidentals, necessary to complete the work.

288-11.2 Outlet Pipe: Price and payment will be full compensation for work specified in this Section, including removal of existing shoulder pavement, trench excavation, pipe and fittings, standard aprons, galvanized hardware cloth (rodent screens), grouting around and stubbing into existing or proposed inlets and

drainage structures or paved ditches; restoration of ditch pavement and other areas disturbed by the Contractor, backfill in place, and disposal of excess materials and incidentals, necessary to complete the work.

Payment will be made under:

Item No. 288- 1-	Cement Treated Permeable Base - per cubic yard.
Item No. 446- 71-1-	Edgedrain Outlet Pipe - per foot.

SECTION 290
GRANULAR SUBBASE

290-1 Description.

Construct a granular subbase as a component of an Optional Base.

290-2 Materials.

Select one of the materials listed below and conform to the following requirements:

Graded Aggregate 204-2
Limerock .....Section 911
Bank Run Shell.....Section 913
Shell Rock .....Section 913A
Cemented Coquina .....Section 915

290-3 Construction Methods.

For the subbase material selected, construct the subbase in conformance with the following:

Limerock .....Section 200
Bank Run Shell.....Section 200
Shell Rock .....Section 200
Cemented Coquina .....Section 200
Graded Aggregate .....Section 204

Straightedge and hard-planing provisions will not apply. Compact the subbase to a minimum of 98% of the maximum density as determined under AASHTO FM 1 T-180, Method D. Priming is not required.

When Granular Subbase is substituted for Subgrade on shoulders, achieve a minimum of 95% density of the maximum density as determined under AASHTO FM 1 T-180, Method D.

290-4 Thickness Requirements.

290-4.1 General: Do not substitute granular subbase materials in excess of the tolerance specified for the asphalt portion of the Optional Base.

290-4.2 Measurements: When the Department is ready to measure the finished subbase, provide the coring equipment and the operator and include this in the unit price for Optional Base. The Engineer will select the coring locations and make the acceptance measurements. Thickness measurements will be taken through 3 inch diameter holes. For subbase areas greater than 1,000 yd^2, the

minimum frequency of measurement will be one per 200 feet of roadway. For smaller subbase areas, the minimum frequency of measurement will be one per 500 yd^2 of subbase.

290-4.3 Maximum Allowable Thickness: The maximum allowable thickness of the subbase is 4 1/4 inches. Remove and replace areas of subbase exceeding the maximum allowable thickness.

290-4.4 Minimum Allowable Thickness: The minimum allowable thickness of the subbase is 3 1/2 inches. Remove and replace areas not meeting the minimum allowable thickness. If authorized by the Engineer, additional asphalt may be substituted to achieve the full combined Optional Base thickness.

SECTION 300
PRIME AND TACK COATS FOR BASE COURSES

300-1 Description.

Apply bituminous prime coats on previously prepared bases, and apply bituminous tack coats on previously prepared bases and on existing pavement surfaces.

300-2 Materials.

300-2.1 Prime Coat: For prime coat, use Cut-back Asphalt Grade RC-70 or RC-250 meeting the requirements of 916-3; Emulsified Asphalt Grades SS-1 or CSS-1, SS-1H, or CSS-1H diluted in equal proportion with water; Emulsified Asphalt Grade AE-60, AE-90, AE-150, or AE-200 diluted at the ratio of six parts emulsified asphalt to four parts water; Special MS-Emulsion diluted at the ratio of six parts emulsified asphalt to four parts water; Asphalt Emulsion Prime (AEP), Emulsion Prime (RS Type), or EPR-1 Prime meeting the requirements of 916-4, or other types and grades of bituminous material which may be specified in the Contract Documents.

Where the above materials for use as a prime coat are to be diluted, certify that the dilution was done in accordance with this Section for each load of material used.

The Contractor may select any of the specified bituminous materials unless the Contract Documents indicate the use of a specific material. The Engineer may allow types and grades of bituminous material other than those specified above if the Contractor can show that the alternate material will properly perform the function of prime coat material.

300-2.2 Cover Material for Prime Coat: Uniformly cover the primed base by a light application of cover material. However, if using EPR-1 prime material, the Engineer may waive the cover material requirement if the primed base is not exposed to general traffic and construction traffic does not mar the prime coat so as to expose the base. The Contractor may use either sand or screenings for the cover material. For the sand, meet the requirements as specified in 902-2 or 902-6, and for the screenings, meet the requirements as specified in 902-5. If exposing the primed base course to general traffic, apply a cover material that has been coated with 2 to 4% asphalt cement. Apply the asphalt coated material at approximately 10 lb/yd^2. Roll the entire surface of asphalt coated prime material with a traffic roller as required to produce a reasonably dense mat.

300-2.3 Tack Coat: Unless the Contract Documents call for a specific type or grade of tack coat, use RA-500 meeting the requirements of 916-2, heated to a temperature of 250 to 300ºF or undiluted Emulsified Asphalt Grades RS-1h, RS-2, CRS-1h, or NTSS-1hm meeting the requirements of 916-4. Heat RS-1h, RS-2, CRS-1h, and NTSS-1hm to a temperature of 150 to 180ºF. The Contractor may use RS-1h modified to include up to 3% naphtha to improve handling of the

material during the winter months of December, January and February or at any other time, as approved by the Engineer.

For night paving, use RA-500 tack coat. The Engineer may approve RS-1h, RS-2, CRS-1h, or NTSS-1hm for night paving if the Contractor demonstrates, at the time of use, that the emulsion will break and not affect the progress of the paving operation.

300-3 Equipment.

300-3.1 Pressure Distributor: Provide a pressure distributor that is equipped with pneumatic tires having a sufficient width of rubber in contact with the road surface to avoid breaking the bond or forming a rut in the surface. Ensure that the distance between the centers of openings of the outside nozzles of the spray bar is equal to the width of the application required, within an allowable variation of 2 inches. Ensure that the outside nozzle at each end of the spray bar has an area of opening not less than 25% or more than 75% in excess of the other nozzles. Ensure that all other nozzles have uniform openings. When the application covers less than the full width, the Contractor may allow the normal opening of the end nozzle at the junction line to remain the same as those of the interior nozzles.

300-3.2 Sampling Device: Equip all pressure distributors and transport tanks with an approved spigot-type sampling device.

300-3.3 Temperature Sensing Device: Equip all pressure distributors and transport tanks with an approved dial type thermometer.

Use a thermometer with a temperature range from 50 to 500ºF with maximum 25ºF increments with a minimum dial diameter of 2 inches.

Locate the thermometer near the midpoint in length and within the middle third of the height of the tank, or as specified by the manufacturer (if in a safe and easily accessible location). Enclose the thermometer in a well with a protective window or by other means as necessary to keep the instrument clean and in the proper working condition.

300-4 Contractor's Quality Control.

Provide the necessary quality control of the prime and tack coats and application in accordance with the Contract requirements. Provide in the Quality Control Plan, procedures for monitoring and controlling of rate of application. If the rate of application varies by more than 5% from the rate set by the Engineer or varies beyond the range established in 300-7or 300-8, immediately make all corrections necessary to bring the spread rate into the acceptable range. The Engineer may take additional measurements at any time. The Engineer will randomly check the Contractor's measurement to verify the spread rate.

300-5 Cleaning Base and Protection of Adjacent Work.

Before applying any bituminous material, remove all loose material, dust, dirt, caked clay and other foreign material which might prevent proper bond with the existing surface for the full width of the application. Take particular care in cleaning the outer edges of the strip to be treated, to ensure that the prime or tack coat will adhere.

When applying the prime or tack coat adjacent to curb and gutter, valley gutter, or any other concrete surfaces, cover such concrete surfaces, except where they are to be covered with a bituminous wearing course, with heavy paper or otherwise protect them as approved by the Engineer, while applying the prime or tack coat. Remove any bituminous material deposited on such concrete surfaces.

300-6 Weather Limitations.

Do not apply prime and tack coats when the air temperature in the shade and away from artificial heat is less than 40ºF at the location where the application is to be made or when weather conditions or the surface conditions are otherwise unfavorable.

300-7 Application of Prime Coat.

300-7.1 General: Clean the surface to be primed and ensure that the moisture content of the base does not exceed the optimum moisture. Ensure that the temperature of the prime material is between 100 and 150ºF. The Engineer will designate the actual temperature to ensure uniform distribution. Apply the material with a pressure distributor. Determine the application amount based on the character of the surface. Use an amount sufficient to coat the surface thoroughly and uniformly with no excess.

300-7.2 Rate of Application:

300-7.2.1 Limerock, Limerock Stabilized, and Local Rock Bases: For these bases, use a rate of application that is not less than 0.10 gal/yd^2, unless a lower rate is directed by the Engineer. Determine the application rate at the beginning of each day's production, and as needed to control the operation, a minimum of twice per day.

300-7.2.2 Sand-Clay, Shell and Shell Stabilized Bases: For these bases, use a rate of application that is not less than 0.15 gal/yd^2, unless a lower rate is directed by the Engineer. Determine the application rate at the beginning of each day's production, and as needed to control the operation, a minimum of twice per day.

300-7.3 Sprinkling: If so required by the Engineer, lightly sprinkle the base with water and roll it with a traffic roller in advance of the application of the prime coat.

300-7.4 Partial Width of Application: If traffic conditions warrant, the Engineer may require that the application be made on only 1/2 the width of the base at one time, in which case use positive means to secure the correct amount of bituminous material at the joint.

300-8 Application of Tack Coat.

300-8.1 General: Where the Engineer requires a tack coat prior to laying a bituminous surface, apply the tack coat as specified herein below.

300-8.2 Where Required: In general, the Engineer will not require a tack coat on primed bases except in areas that have become excessively dirty and cannot be cleaned, or in areas where the prime has cured to the extent that it has lost all bonding effect. Place a tack coat on all asphalt base courses before placing the structural course.

300-8.3 Method of Application: Apply the tack coat with a pressure distributor except that on small jobs, if approved by the Engineer, apply it by other mechanical devices or by hand methods. Heat the bituminous material to a suitable temperature as designated by the Engineer, and apply it in a thin, uniform layer.

300-8.4 Rate of Application: Use a rate of application between 0.02 to 0.08 gal/yd^2. The rate of application will be approved by the Engineer and may be varied or adjusted by the Engineer to meet specific field conditions. For mix placed directly on concrete pavement, set the target rate of application at 0.08 gal/yd^2. For mix placed on a milled surface or where the existing surface is oxidized and cracked, set the target rate of application rate at 0.06 gal/yd^2. For open-graded friction course, set the target rate of application at 0.045 gal/yd^2. For mix placed on newly constructed asphalt layers, set the rate of application at 0.02 gal/yd^2. Determine the rate of application at the beginning of each day's production, and as needed to control the operation, a minimum of twice per day. Control the rate of application to be within plus or minus 0.01 gal/yd^2 of that approved by the Engineer. When using RA-500, multiply the target rate of application by 0.6.

300-8.5 Curing and Time of Application: The Engineer will designate the curing period for the tack coat. Apply the tack coat sufficiently in advance of the laying of the bituminous mix to permit drying, but do not apply the tack coat so far in advance that it might lose its adhesiveness as a result of being covered with dust or other foreign material.

300-8.6 Protection: Keep the tack coat surface free from traffic until the subsequent layer of bituminous hot mix has been laid.

300-9 Method of Measurement.

300-9.1 General: The quantity specified will be the volume, in gallons of bituminous material actually applied and accepted. This spread rate will be determined from measurements made by the Contractor and verified by the Engineer based on tank calibrations, as specified in 300-9.2. Where it is specified that prime coat or tack coat material is to be diluted with water, the amount specified for the spread rate will be the volume after dilution.

300-9.2 Calibration of Tanks: Ensure that all distributors used for applying tack or prime coats are calibrated prior to use by a reliable and recognized firm engaged in calibrating tanks. Provide a certification of calibration and the calibration chart to the Engineer prior to use. In lieu of a volumetrically calibrated distributor, use a distributor that is equipped with a calibrated meter and is approved by the Engineer.

300-9.3 Temperature Correction: Measure the volume and increase or decrease the volume actually measured to a corrected volume at a temperature of 60ºF.

Make the correction for temperature by applying the applicable conversion factor (K), as shown below.

For petroleum oils having a specific gravity (60ºF/60ºF) above 0.966, K = 0.00035 per degree.

For petroleum oils having a specific gravity (60ºF/60ºF) of between 0.850 and 0.966, K = 0.00040 per degree.

For emulsified asphalt, K = 0.00025 per degree.

When volume-correction tables based on the above conversion factors are not available, use the following formula in computing the corrections for volumetric change:

$$V = \frac{V^1}{K\,(T - 60) + 1}$$

Where:

V= Volume of the bituminous material at 60ºF (pay volume).

V^1= Volume of bituminous material as measured.

K= Correction factor (Coefficient of Expansion).

T= Temperature (in ºF), of the bituminous material when measured.

300-10 Basis of Payment.

There is no direct payment for the work specified in this Section, it is incidental to, and is to be included in the other items of related work.

SECTION 320
HOT BITUMINOUS MIXTURES - PLANT, METHODS, AND EQUIPMENT

320-1 General.

This Section specifies the plant and methods of operation for preparing all plant-mixed hot bituminous mixtures for surface courses and bases, and the requirements for the equipment to be used in the construction of the pavements and bases.

320-2 Requirements for All Plants.

320-2.1 General: Design, manufacture, coordinate, and operate the asphalt plant in a manner that will consistently produce a mixture within the job mix tolerances and temperatures specified.

320-2.2 Electronic Weigh Systems: Equip the asphalt plant with an electronic weigh system that: has an automatic printout, is certified every six months by an approved certified scale technician, and meets weekly comparison checks with certified truck scales as specified in 320-2.2.4. Weigh all plant produced hot mix asphalt on the electronic weigh system, regardless of the method of measurement for payment.

Include, as a minimum, the following information on the printed delivery ticket:

(a) Sequential load number.

(b) Project number.

(c) Date.

(d) Name and location of plant.

(e) Mix design number.
(f) Place for hand-recording mix temperature.
(g) Truck number.
(h) Gross, tare, and net weights (as applicable).
(i) Accumulated total of mix.
(j) Tons.

Print the delivery ticket with an original and at least one copy. Furnish the original to the Engineer at the plant and one copy to the Engineer at the paving site.

Utilize any one of the following three electronic weigh systems:

320-2.2.1 Electronic Weigh System on the Truck Scales: Provide an electronic weigh system on all truck scales, which is equipped with an automatic recordation system that is approved by the Engineer. Use scales of the type that directly indicate the total weight of the loaded truck. Use scales meeting the requirements for accuracy, condition, etc., of the Bureau of Weights and Measures of the Florida Department of Agriculture, and re-certify such fact every six months, either by the Bureau of Weights and Measures or by a registered scale technician.

320-2.2.2 Electronic Weigh System on Hopper Beneath a Surge or Storage Bin: Provide an electronic weigh system on the hopper (hopper scales or load cells) beneath the surge or storage bin, which is equipped with an automatic recordation system approved by the Engineer.

320-2.2.3 Automatic Batch Plant with Printout: For batch plants, provide an approved automatic printer system which will print the individual or cumulative weights of aggregate and liquid asphalt delivered to the pugmill and the total net weight of the asphalt mix measured by hopper scales or load cell type scales. Use the automatic printer system only in conjunction with automatic batching and mixing control systems that have been approved by the Engineer.

320-2.2.4 Weekly Electronic Weigh System Comparison Checks: Check the accuracy of the electronic weighing system at the commencement of production and thereafter at least once a week during production by one of the following two methods:

320-2.2.4.1. Electronic Weigh Systems on Truck Scales:

(a) The Engineer will randomly select a loaded truck of asphalt mix and record the truck number and gross weight from the Contractor's delivery ticket.

(b) Weigh the selected truck on a certified truck scale, which is not owned by the Contractor and record the gross weight for the comparison check. If another certified truck scale is not available, the Engineer may permit another set of certified truck scales owned by the Contractor to be used. The Engineer may elect to witness the scale check.

(c) The gross weight of the loaded truck as shown on the Contractor's delivery ticket will be compared to the gross weight of the loaded truck from the other certified truck scale. The maximum permissible deviation is 8 pounds per ton of load, based on the certified truck scale weight.

(d) If the distance from the asphalt plant to the nearest certified truck scale is enough for fuel consumption to affect the accuracy of the

comparison checks, a fuel adjustment may be calculated by using the truck odometer readings for the distance measurement, and 6.1 miles per gallon for the fuel consumption rate, and 115 ounces per gallon for fuel weight.

(e) During production, when an additional certified truck scale is not available for comparison checks, the Engineer may permit the Contractor to weigh the truck on his certified scales used during production and then weigh it on another certified truck scale, as soon the other scale is available for the comparison checks.

In addition to the periodic checks as specified above, check the scales at any time the accuracy of the scales becomes questionable. When such inaccuracy does not appear to be sufficient to seriously affect the weighing operations, the Engineer will allow a period of two calendar days for the Contractor to effect the required scales check. However, in the event the indicated inaccuracy is sufficient to seriously affect the mixture, the Engineer may require immediate shut-down until the accuracy of the scales has been checked and necessary corrections have been made. Include the cost of all scale checks in the bid price for asphalt concrete, at no additional cost to the Department.

320-2.2.4.2. For Electronic Weigh Systems on Hoppers Beneath a Surge or Storage Bins and Automatic Batch Plants with Printout:

(a) The Engineer will randomly select a loaded truck of asphalt mix and record the truck number, and the net weight of the asphalt mix from the Contractor's delivery ticket.

(b) Weigh the selected truck on a certified truck scale, which is not owned by the Contractor and record the gross weight for the comparison check. If another certified truck scale is not available, the Engineer may permit another set of certified truck scales owned by the Contractor to be used. The Engineer may elect to witness the scale check.

(c) Deliver the asphalt mix to the project, then weigh the selected empty truck on the same certified truck scales. Record the tare weight of the truck.

(d) Compare the net weight of the asphalt mix from the delivery ticket to the calculated net weight of the asphalt mix as determined by the certified truck scale weights. The maximum permissible deviation is 8 pounds per ton of load, based on the certified truck scale weight.

(e) Use the fuel adjustment as specified in 320-2.2.4.1(d), when the distance from the asphalt plant to the nearest certified truck scale is enough for fuel consumption to affect the accuracy of the comparison checks.

(f) During production, when an additional certified truck scale is not available for comparison checks, the Engineer may permit the Contractor to load a truck with aggregate from the pugmill, surge or storage bin, and follow the above procedures to conduct the comparison checks as soon as certified truck scale is available.

If the check shows a greater difference than the tolerance specified above, then recheck on a second set of certified scales. If the check and recheck indicate that the printed weight is out of tolerance, have a certified scale technician check the electronic weigh system and certify the accuracy of the

printer. While the system is out of tolerance and before its adjustment, the Engineer may allow the Contractor to continue production only if provisions are made to use a set of certified truck scales to determine the truck weights.

320-2.3 Equipment for Preparation of Bituminous Material: Equip bituminous material storage tanks to heat liquid asphalt under effective and positive control to the temperatures required for the various mixtures. Heat using hot-oil, steam, electricity, or other means whereby no flame comes in contact with the tank. Use a circulating system of adequate size to ensure proper and continuous circulation during the entire operating period. Use steam or hot-oil jacketed pipe lines and fittings to prevent heat loss. Locate a thermometer, reading from 200 to 400°F, either in the storage tank or in the bituminous feed line. Locate a sampling device on the discharge piping exiting the storage tank or at a location as approved by the Engineer.

320-2.4 Cold Feed: Provide a separate cold bin for each component of the fine and coarse aggregates required by the design mix. Equip the cold bins with accurate mechanical means for feeding the aggregates uniformly into the dryer in the proportions required for the finished mix to maintain uniform production and temperature. When using RAP as a component material, use a grizzly or grid over the RAP cold bin, in-line roller crusher, screen, or other suitable means to prevent oversized RAP material from showing up in the completed recycled mixture. If oversized RAP material appears in the completed recycled mix, take the appropriate corrective action immediately. If the appropriate corrective actions are not immediately taken, stop plant operations.

320-2.5 Dryer: Provide a dryer of any satisfactory design for heating and drying the mineral aggregates. Use a dryer capable of heating the aggregates to within the specified temperature range for any mix, and equip the dryer with an electric pyrometer placed at the discharge chute to automatically register the temperature of the heated aggregates.

320-2.6 Bituminous Control Unit: Provide a satisfactory means, either by weighing, metering, or volumetric measuring, to obtain the proper amount of bituminous material in the mix, within the tolerance specified for the job mix. Provide either steam or hot-oil jacketing for maintaining the bituminous material at the specified temperature in the pipe lines, meters, weigh buckets, spray bars, and other containers of flow lines.

320-2.7 Contractor's Responsibilities: Acceptance of any automatic delivery ticket printout, electronic weight delivery ticket, other evidence of weight of the materials or approval of any particular type of materials or production methods will not constitute agreement by the Department that such matters are in accordance with the Contract Documents and it shall be the Contractor's responsibility to ensure that the materials delivered to the project are in accordance with the Contract Documents.

320-3 Special Requirements for Batch Plants.

320-3.1 Gradation Unit: Provide plant screens capable of separating the fine and coarse aggregates and of further separating the coarse aggregate into specific sizes. (The coarse aggregate is defined as the aggregate retained on the No. 10

screen.) In addition, equip the gradation unit with a scalping screen to restrict the maximum size of the aggregates.

320-3.2 Hot Bins: Provide storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Provide hot bins with divided compartments to ensure separate and adequate storage of the appropriate fractions of the aggregate. Equip each compartment with an overflow chute of suitable size and location to prevent any backing up of material into other bins.

320-3.3 Sampling of Hot Aggregate: Provide a convenient and accurate means for obtaining samples of hot aggregates from each bin before the material enters the pugmill.

320-3.4 Weigh Box or Hopper: Equip the batch plant with a means for accurately weighing each bin size of aggregate and the mineral filler into the weigh box or hopper. Suspend the weigh box or hopper on scales. Use a weigh box or hopper of ample size to hold a full batch without running over. Support it on fulcrums and knife edges, so constructed that they will not be thrown out of alignment or adjustment during batching operations. Use gates both on the hot bins and on the weigh box or hopper that are constructed to prevent leakage.

320-3.5 Pugmills: For all pugmills, do not exceed a clearance of 1 inch between the paddle tips and the lining of the pugmill. For pugmills with both long and short paddle arms, apply this requirement to the long arms only. When any paddle is worn more than 3/4 inch from its original dimensions, replace or restore it to its original dimensions. Operate the pugmills in the manner recommended by the manufacturer. Use a plant with a batch mixer of the twin-shaft pugmill type, hot-oil or steam jacketed, and capable of producing a uniform mixture within the job mix tolerance specified. Set paddles to produce a circular or "runaround" action in the pugmill. Ensure that the depth of the material in the pugmill does not extend above the tips of the paddles. Use a pugmill with a capacity of at least 1 ton unless permission for lesser capacity is approved by the Engineer.

320-3.6 Control of Mixing Time: Use a plant that is equipped with a positive means to control the time of mixing and to ensure the completion of the mixing cycle designated by the Engineer. Provide all timing devices and bypass switches with a means for being locked into the desired position as directed by the Engineer.

320-4 Special Requirements for Drum Mixer Plants.

320-4.1 Weight Measurements of Aggregate: Equip the plant with a weigh-in-motion scale that is capable of measuring the quantity of aggregate (and RAP) entering the dryer.

320-4.2 Synchronization of Aggregate Feed and Bituminous Material Feed: Couple the bituminous feed control with the total aggregate weight device, including the RAP feed, in such a manner as to automatically vary the asphalt binder feed rate as necessary to maintain the required proportions.

320-4.3 Hot Storage or Surge Bins: Equip the plant with either a surge bin or storage silo that is capable of storing an adequate amount of material to assure a uniform and consistent product.

320-5 Paving Equipment.

320-5.1 Mechanical Spreading and Screeding Equipment:

320-5.1.1 General: Provide mechanical spreading and screeding equipment of an approved type that is self-propelled and can be steered. Equip it with a receiving and distribution hopper and a mechanical screed. Use a mechanical screed capable of adjustment to regulate the depth of material spread and to produce the desired cross-section.

320-5.1.2 Automatic Screed Control: For all asphalt courses, placed with mechanical spreading and finishing equipment, equip the paving machine with automatic longitudinal screed controls of either the skid type, traveling stringline type, or non-contact averaging ski type. Ensure that the length of the skid, traveling stringline, or non-contact averaging ski is at least 25 feet. On the final layer of base, overbuild, and structural courses, and for friction courses, use the joint matcher in lieu of the skid, traveling stringline, or non-contact averaging ski on all passes after the initial pass. Furnish a paving machine equipped with electronic transverse screed controls.

320-5.1.3 Inflation of Tires: When using paving machines equipped with pneumatic tires, the Engineer may require that the tires be ballasted.

320-5.1.4 Screed Width: Provide paving machines on full width lanes that have a screed width greater than 8 feet. Do not use extendable screed strike-off devices that do not provide preliminary compaction of the mat in place of fixed screed extensions. The Contractor may use a strike-off device on irregular areas that would normally be done by hand and on shoulders 4 feet or less in width. When using the strike-off device on shoulders in lieu of an adjustable screed extension, the Contractor must demonstrate the ability to obtain an acceptable texture, density, and thickness.

When using an extendable screed device to extend the screed's width on the full width lane or shoulder by 24 inches or greater, the Engineer will require an auger extension, paddle, or kicker device unless the Contractor provides written documentation from the manufacturer that these are not necessary.

320-5.2 Motor Graders: Provide two motor graders for spreading leveling courses. Equip them with a blade that is at least 2 feet longer than the width of the lane being leveled. Use motor graders that are rated at not less than 6 tons and are self-propelled and power-controlled. Mount them on smooth tread or rib-type tires (no lug types allowed) with a wheel base of at least 15 feet. Equip the front motor grader with a spreader box capable of spreading the mix at the required rate.

320-5.3 Rollers:

320-5.3.1 Steel-Wheeled Rollers: Provide compaction equipment capable of meeting the density requirements described in these Specifications. In the event that density testing is not required, provide a tandem steel-wheeled roller weighing a minimum of 8 tons for seal rolling, and for the final rolling, use a separate roller with a minimum weight of 8 tons. Variations from these requirements shall be approved by the Engineer.

320-5.3.2 Traffic Rollers: Provide compaction equipment capable of meeting the density requirements described in these Specifications. In the event

that density testing is not required, provide a self-propelled, pneumatic-tired traffic roller equipped with at least seven smooth-tread, low pressure tires, equipped with pads or scrapers on each tire. Maintain the tire pressure between 50 and 55 psi or as specified by the manufacturer. Use rollers with a minimum weight of 6 tons. Do not use wobble-wheeled rollers. Variations from these requirements shall be approved by the Engineer.

320-5.3.3 Prevention of Adhesion: Do not allow the mixture to adhere to the wheels of any rollers. Do not use fuel oil or other petroleum distillates to prevent adhesion. Do not use any method which results in water being sprinkled directly onto the mixture.

320-5.4 Trucks: Transport the mix in trucks of tight construction, which prevents the loss of material and the excessive loss of heat. Provide each truck with a tarpaulin or other waterproof cover mounted in such a manner that it can cover the entire load when required. When in place, overlap the waterproof cover on all sides so that it can be tied down.

320-5.5 Coring Equipment: Furnish a suitable saw or drill for obtaining the required density cores.

320-5.6 Hand Tools: Provide the necessary hand tools such as rakes, shovels, etc., and a suitable means for keeping them clean.

SECTION 327
MILLING OF EXISTING ASPHALT PAVEMENT

327-1 Description.

Remove existing asphalt concrete pavement by milling to improve the rideability and cross slope of the finished pavement, to lower the finished grade adjacent to existing curb prior to resurfacing, or to completely remove existing pavement.

When milling to improve rideability, the plans will specify an average depth of cut.

Take ownership of milled material.

327-2 Equipment.

Provide a milling machine capable of maintaining a depth of cut and cross slope that will achieve the results specified in the Contract Documents. Use a machine with a minimum overall length (out to out measurement excluding the conveyor) of 18 feet and a minimum cutting width of 6 feet.

Equip the milling machine with a built-in automatic grade control system that can control the transverse slope and the longitudinal profile to produce the specified results.

To start the project, the Engineer will approve any commercially manufactured milling machine that meets the above requirements. If it becomes evident after starting milling that the milling machine cannot consistently produce the specified results, the Engineer will reject the milling machine for further use.

The Contractor may use a smaller milling machine when milling to lower the grade adjacent to existing curb or other areas where it is impractical to use the above described equipment.

Equip the milling machine with means to effectively limit the amount of dust escaping during the removal operation.

For complete pavement removal, the Engineer may approve the use of alternate removal and crushing equipment in lieu of the equipment specified above.

327-3 Construction.

Remove the existing raised reflective pavement markers prior to milling. Include the cost of removing existing pavement markers in the price for milling.

When milling to improve rideability or cross slope, remove the existing pavement to the average depth specified in the plans, in a manner that will restore the pavement surface to a uniform cross-section and longitudinal profile. The Engineer may require the use of a stringline to ensure maintaining the proper alignment.

Establish the longitudinal profile of the milled surface in accordance with the milling plans. Ensure that the final cross slope of the milled surface parallels the surface cross slope shown on the plans or as directed by the Engineer. Establish the cross slope of the milled surface by a second sensing device near the outside edge of the cut or by an automatic cross slope control mechanism. The plans may waive the requirement of automatic grade or cross slope controls where the situation warrants such action.

Multiple cuts may be made to achieve the required pavement configuration or depth of cut. Include in the Quality Control Plan a system to control the cross slope of the milling surface with a minimum frequency of one cross slope measurement every 250 feet during milling operations in order to ensure that the slopes are uniform and in compliance with the designed milling slope. When the difference between the measured cross slope and the designed cross slope exceeds ±0.2% for travel lanes (including turn lanes) and ±0.5% for shoulders, make all corrections immediately to bring the cross slope into an acceptable range. The Engineer will periodically verify the Contractor's measurements at the job site.

The Engineer will randomly take ten measurements of the cross slope per day for the first two days of milling operation. If the average cross slope of the ten random measurements per day varies more than the required tolerance (0.2% for travel lanes including turn lanes and 0.5% for shoulders), the milling operation shall be stopped until appropriate corrective actions are made to bring the cross slope into an acceptable range. Approval of the Engineer will be required prior to resuming the milling operation. A recheck of ten random measurements will be made after corrective actions are taken. If the recheck indicates that the cross slope is out of control, the deficient section(s) shall be corrected to bring the cross slope into an acceptable range. During milling operations, the Engineer reserves the right to take ten cross slope measurements per day. If the average cross slope of the ten measurements varies more than the permissible tolerance, the milling operation will be stopped until appropriate

corrective actions are made to bring the cross slope into an acceptable range and the deficient sections shall be corrected accordingly.

The Engineer may waive the corrections specified above if an engineering determination indicates that the deficiencies are sufficiently separated so as not to significantly affect the final cross slope.

For intersections, tapers, crossovers, transitions at the beginning and end of the project and in other similar areas, the cross slope will be adjusted as directed by the Engineer to match the actual site conditions.

Operate the milling machine to minimize the amount of dust being emitted. The Engineer may require prewetting of the pavement.

Provide positive drainage of the milled surface and the adjacent pavement. Perform this operation on the same day as milling. Repave all milled surfaces no later than the day after the surface was milled unless otherwise stated in the plans.

If traffic is to be maintained on the milled surface prior to the placement of the new asphalt concrete, provide suitable transitions between areas of varying thickness to create a smooth longitudinal riding surface. Produce a pattern of striations that will provide an acceptable riding surface. The Engineer will control the traveling speed of the milling machine to produce a texture that will provide an acceptable riding surface.

Prior to opening an area which has been milled to traffic, sweep the pavement with a power broom or other approved equipment to remove, to the greatest extent practicable, fine material which will create dust under traffic. Sweep in a manner that will minimize the potential for creation of a traffic hazard and to minimize air pollution.

Sweep the milled surface with a power broom prior to placing asphalt concrete.

In urban and other sensitive areas, use a street sweeper or other equipment capable of removing excess milled materials and controlling dust. Obtain the Engineer's approval of such equipment, contingent upon its demonstrated ability to do the work.

Perform the sweeping operation immediately after the milling operations or as directed by the Engineer.

327-4 Milled Surface.

Provide a milled surface with a reasonably uniform texture, within 1/4 inch of a true profile grade, and with no deviation in excess of 1/4 inch from a straightedge applied to the pavement perpendicular to the centerline. Ensure that the variation of the longitudinal joint between multiple cut areas does not exceed 1/4 inch. The Engineer may accept areas varying from a true surface in excess of the above stated tolerance without correction if the Engineer determines that they were caused by a pre-existing condition which could not have reasonably been corrected by the milling operations. Correct any unsuitable texture or profile, as determined by the Engineer, at no additional expense to the Department.

The Engineer may require remilling of any area where a surface lamination causes a non-uniform texture to occur.

327-5 Method of Measurement.

The quantity to be paid for will be the plan quantity area, in square yards, over which milling is completed and accepted.

327-6 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including hauling off and stockpiling or otherwise disposing of the milled material.

Payment will be made under:

Item No. 327- 70-	Milling Existing Asphalt Pavement - per square yard.

SECTION 330
HOT BITUMINOUS MIXTURES - GENERAL CONSTRUCTION REQUIREMENTS

330-1 Description.

Construct plant-mixed hot bituminous pavements and bases. Establish and maintain a quality control system that provides assurance that all materials, products and completed construction submitted for acceptance meet Contract requirements.

330-2 Quality Control Requirements.

330-2.1 Minimum Quality Control Plan Requirements: In addition to the requirements set forth in Section 105, perform as a minimum the following activities necessary to maintain process control and meet specification requirements:

Stockpiles: Assure materials are placed in the correct stockpile; assure good stockpiling techniques; inspect stockpiles for separation, contamination, segregation, etc.; properly identify and label each stockpile.

Incoming Aggregate: Obtain gradations and bulk specific gravity (G_{sb}) values from aggregate supplier for reference; determine the gradation of all component materials; routinely compare gradations and G_{sb} values to mix design.

Cold Bins: Calibrate the cold gate/feeder belt for each material; determine cold gate/feeder belt settings; observe operation of cold feeder for uniformity.

Dryer: Observe pyrometer for aggregate temperature control; observe efficiency of the burner.

For Batch Plants, determine percent used and weight to be pulled from each bin to assure compliance with Mix Design, check mixing time, and check operations of weigh bucket and scales.

For Drum Mixer Plants, determine aggregate moisture content, and calibrate the weigh bridge on the charging conveyor.

Control Charts: Plot and keep charts updated daily for all Quality Control Sampling and Testing and post in the asphalt lab where they can be seen. Provide the following charts:

1. All components used to determine the composite pay factor (No. 8 sieve, No. 200 sieve, asphalt binder content, air voids, and density) by lot.

2. Gradation of incoming aggregate.

3. Gradation and asphalt content of RAP.

4. Any other test result or material characteristic (as determined by the Contractor) necessary for process control.

The above listed minimum activities are to be considered normal activities necessary to control the production of hot mix asphalt at an acceptable quality level. It is recognized, however, that depending on the type of process or materials, some of the activities listed may not be necessary and in other cases, additional activities may be required. The frequency of these activities will also vary with the process and the materials. When the process varies from the defined process average and variability targets, the frequency of these activities will be increased until the proper conditions have been restored.

330-2.2 Minimum Process Control Testing Requirements: Perform, as a minimum, the following activities at the testing frequencies provided below:

Asphalt Plant

1. Hot Mix Asphalt: Determine the asphalt binder content; mix gradation and volumetric properties at a minimum frequency of one per day. In the event that the daily production exceeds 1,000 tons, perform these tests a minimum of two times per day. Quality Control tests used in the acceptance decision may be used to fulfill this requirement. Verify modifier addition.

2. Aggregate (Including RAP and each size fraction for fractionated RAP): One sample per 1,000 tons of incoming material as it is stockpiled for gradation. The testing of RAP material shall include the determination of asphalt binder content and gradation of extracted aggregate.

3. Mix temperature for the first five loads and one out of every five loads thereafter.

4. Aggregate moisture content from stockpiles or combined cold feed aggregate - one per day.

5. Other tests (as determined necessary by the Contractor) for process control.

Roadway

1. Monitor the pavement temperature with an infrared temperature device. Monitor the roadway density with either 6 inches diameter roadway cores, a nuclear density gauge, or other density measuring device, at a minimum frequency of once per 1,500 feet of pavement. When the layer thickness is greater than or equal to 1 inch (or the spread rate is greater than or equal to 105 lb/yd^2) and an approved rolling pattern is used in lieu of density testing, identify in the QC Plan how the pavement density will be monitored.

2. Mix temperature for the first five loads and one out of every five loads thereafter.

3. Monitor the pavement smoothness with a 15-foot rolling straightedge, as required by these specifications.

4. Monitor the pavement cross slope at a frequency necessary to fulfill the requirements of these specifications, and identify a system to control the cross slope of each pavement layer during construction.

5. Monitor the mix spread rate at the beginning of each day's production, and as needed to control the operations, at a minimum of once per 200 tons placed to ensure that the spread rate is within 5% of the target spread rate. When determining the spread rate, use an average of five truckloads of mix.

If the Contractor fails to maintain the construction process in accordance with the quality control requirements herein stated, the Engineer may elect to stop the construction operation at any time until the deficiencies are corrected.

330-2.3 Minimum Quality Control System Requirements:

330-2.3.1 Personnel Qualifications: Provide Quality Control Technicians in accordance with Section 105.

330-2.3.2 Hot Mix Asphalt Testing Laboratory Requirements: Furnish or have furnished a fully equipped asphalt laboratory (permanent or portable) at the production site. The Laboratory must be qualified under the Department's Laboratory Qualification Program, as described in Section 105-6. In addition, the laboratory shall meet the following requirements:

1. Area - The effective working area of the laboratory shall be a minimum of 180 ft^2, with a layout of which will facilitate multiple tests being run simultaneously by two technicians. This area does not include the space for desks, chairs and file cabinets. Any variations shall be approved by the Engineer.

2. Lighting - The lighting in the lab must be adequate to illuminate all areas of the work.

3. Temperature Control - Equip the lab with heating and air conditioning units that provide a satisfactory working environment.

4. Ventilation - Equip the lab with fume hoods and exhaust fans that will remove all hazardous fumes from within the laboratory in accordance with OSHA requirements.

5. Equipment and Supplies - Furnish the lab with the necessary sampling and testing equipment and supplies for performing contractor Quality Control and Department Verification Sampling and Testing. A detailed list of equipment and supplies required for each test is included in the appropriate FDOT, AASHTO, or ASTM Test Method.

6. Calibration of the Superpave Gyratory Compactor: Calibrate the Superpave Gyratory Compactor in accordance with the manufacturer's recommendations. Identify in the Quality Control Plan the established frequencies and document all calibrations.

7. Personal Computer - Provide a personal computer capable of running a Microsoft Excel™ spreadsheet program, along with a printer.

8. Communication - Provide a telephone and fax machine (with a private line) for the use of the testing facility's quality control personnel. In addition, provide an Internet connection capable of uploading data to the Department's database and for e-mail communications.

330-3 Limitations of Operations.

330-3.1 Weather Limitations: Do not transport asphalt mix from the plant to the roadway unless all weather conditions are suitable for the laying operations.

330-3.2 Limitations of Laying Operations:

330-3.2.1 General: Spread the mixture only when the surface upon which it is to be laid has been previously prepared, is intact, firm, and properly cured, and is dry. Do not place friction course until the adjacent shoulder area has been dressed and grassed.

330-3.2.2 Temperature: Spread the mixture only when the air temperature in the shade and away from artificial heat is at least 40ºF for layers greater than 1 inch (100 lb/yd^2) in thickness and at least 45ºF for layers 1 inch (100 lb/yd^2) or less in thickness (this includes leveling courses). The minimum temperature requirement for leveling courses with a spread rate of 50 lb/yd^2 or less is 50ºF.

330-3.2.3 Wind: Do not spread the mixture when the wind is blowing to such an extent that proper and adequate compaction cannot be maintained or when sand, dust, etc., are being deposited on the surface being paved to the extent that the bond between layers will be diminished.

330-3.2.4 Night Paving: Provide sufficient lighting for night operations.

330-4 Preparation of Asphalt Cement.

Deliver the asphalt cement to the asphalt plant at a temperature not to exceed 370ºF, and equip the transport tanks with sampling and temperature sensing devices meeting the requirements of 300-3.2. Maintain the asphalt cement in storage within a range of 230 to 370ºF in advance of mixing operations. Maintain constant heating within these limits, and do not allow wide fluctuations of temperature during a day's production.

330-5 Preparation of Aggregates.

330-5.1 Stockpiles: Place each aggregate component in an individual stockpile, and separate each from the adjacent stockpiles, either by space or by a system of bulkheads. Prevent the intermingling of different materials in stockpiles at all times. Identify each stockpile, including RAP, as shown on the mix design.

330-5.2 Prevention of Segregation: Form and maintain stockpiles in a manner that will prevent segregation. If a stockpile is determined to have excessive segregation, the Engineer will disapprove the material for use on the project until the appropriate actions have been taken to correct the problem.

330-5.3 Blending of Aggregates: Stockpile all aggregates prior to blending or placing in the cold hoppers. Place all aggregates to be blended or proportioned in separate bins at the cold hopper. Proportion by means of securely positioned calibrated gates or other approved devices.

330-5.4 Cold Bins:

330-5.4.1 Adequacy of Bins: Use separate bin compartments in the cold aggregate feeder that are constructed to prevent any spilling or leakage of aggregate from one bin to another. Ensure that each bin compartment has the capacity and design to permit a uniform flow of aggregates. Mount all of the bin compartments over a feeder of uniform speed, which will deliver the specified proportions of the separate aggregates to the drier at all times. If necessary, equip the bins with vibrators to ensure a uniform flow of the aggregates at all times.

330-5.4.2 Gates: Provide each bin compartment with a gate which is adjustable in a vertical direction. Provide gates that can be held securely at any specified vertical opening. Equip the gates with a measuring device for measuring the vertical opening of the gates from a horizontal plane level with the bottom of the feeder.

330-5.5 Mineral Filler: If mineral filler is required in the mix, feed or weigh it in separately from the other aggregates.

330-5.6 Heating and Drying: Heat and dry the aggregates before screening. Control the temperature of the aggregates so that the temperature of the completed mixture at the plant falls within the permissible range allowed by this Section.

330-5.7 Screening Unit:

330-5.7.1 Oversize Aggregate: Remove any oversized pieces of aggregate by the use of a scalping screen. Do not return this oversized material to the stockpile for reuse unless it has been crushed and reprocessed into sizes that will pass the scalping screen.

330-5.7.2 Screening: Ensure that the quantity of aggregates being discharged onto the screens does not exceed the capacity of the screens to actually separate the aggregates into the required sizes. Allow up to a maximum of 10% plus-10 material in the minus-10 bin. The Engineer will determine the maximum amount of minus-10 material allowed in the plus-10 bins, in accordance with its effect on the uniformity of the mix.

330-6 Preparation of the Mixture.

330-6.1 Batch Mixing:

330-6.1.1 Aggregates: Once the dried aggregates and mineral filler (if required) are prepared in the manner previously described and combined in batches to meet the verified mix design by weighing each separate bin size, convey them to the empty mixer.

330-6.1.2 Asphalt Binder: Introduce the accurately measured hot asphalt binder into the mixer simultaneously with, or after, the hot aggregates. Continue mixing until the mixture is thoroughly uniform with all particles fully coated.

330-6.1.3 Mixing Time: The mixing time begins when the measuring devices for both the asphalt and the aggregates indicate that all the material is in the mixer, and continues until the material begins to leave the mixing unit. Since the mixing time varies in relation to the nature of the aggregates and the capacity of the mixer, mix sufficiently to produce a thoroughly and uniformly coated mixture.

330-6.2 Continuous Mixing: Introduce the dried aggregates and mineral filler (if required), prepared as specified and proportioned to meet the verified mix design, into the mixer in synchronization with the accurate feeding of the hot asphalt cement. Mix sufficiently to produce a thoroughly and uniformly coated mixture.

330-6.3 Mix Temperature: Heat and combine the ingredients of the mix in such a manner as to produce a mixture with a temperature, when discharged from the pugmill or surge bin, which is within the master range as defined below.

Determine the temperature of the completed mixture using a quick-reading thermometer through a hole in the side of the loaded truck immediately after loading. Locate 1/4 inch hole on both sides of the truck body within the middle third of the length of the body, and at a distance from 6 to 10 inches above the surface supporting the mixture. If a truck body already has a hole located in the general vicinity of the specified location, use this hole. At the Engineer's discretion, the Contractor may take the temperature of the load over the top of the truck in lieu of using the hole in the side of the truck.

The normal frequency for taking asphalt mix temperatures will be for each day, for each design mix on the first five loads and one out of every five loads thereafter. Take the temperature of the asphalt mix at the plant and at the roadway before the mix is placed at the normal frequency. Record the temperature on the front of the respective delivery ticket. The Engineer shall review the plant and roadway temperature readings and may take additional temperature measurements at any time.

The master range for all mix designs will be the target mix temperature from the mix design ±30ºF. There are two master ranges; one at the asphalt plant (mixing temperature from the mix design ±30ºF) and one at the roadway (compaction temperature from the mix design ±30ºF). Reject any load or portion of a load of asphalt mix at the plant with a temperature outside of this master range. Reject any load or portion of a load of asphalt mix at the roadway with a temperature outside of this master range. The Engineer will be immediately notified of the rejection.

If any single load at the plant or at the roadway is within the master range but differs from the target mix temperature by more than ±25ºF or if the average difference of the temperature measurements from the target mix temperature for five loads exceeds ±15ºF, the temperature of every load will be monitored until the temperature falls within the specified tolerance range in Table 330-1; at this time the normal frequency may be resumed.

Table 330-1	
Temperature Tolerance From Verified Mix Design	
Any Single Measurement	±25ºF
Average of Any Five Consecutive Measurements	±15ºF

330-6.4 Maximum Period of Storage: Allow the maximum time that any mix may be kept in a hot storage or surge bin to be 72 hours.

330-6.5 Contractor's Responsibility for Mixture Requirements: Produce a homogeneous mixture, free from moisture and with no segregated materials, that meets all specification requirements. Also apply these requirements to all mixes produced by the drum mixer process and all mixes processed through a hot storage or surge bin, both before and after storage.

330-7 Transportation of the Mixture.

Transport the mixture in tight vehicles previously cleaned of all foreign material. After cleaning, thinly coat the inside surface of the truck bodies with

soapy water or an asphalt release agent as needed to prevent the mixture from adhering to the beds. Do not allow excess liquid to pond in the truck body. Do not use diesel fuel or any other hazardous or environmentally detrimental material as a coating for the inside surface of the truck body. Cover each load during cool and cloudy weather and at any time there is a probability of rain.

330-8 Preparation of Application Surfaces.

330-8.1 Cleaning: Prior to the laying of the mixture, clean the surface of the base or pavement to be covered of all loose and deleterious material by the use of power brooms or blowers, supplemented by hand brooming where necessary.

330-8.2 Patching and Leveling Courses: Where an asphalt mix is to be placed on an existing pavement or old base which is irregular, and wherever the plans indicate, bring the existing surface to proper grade and cross-section by the application of patching or leveling courses.

330-8.3 Application Over Surface Treatment: Where an asphalt mix is to be placed over a newly constructed surface treatment, sweep and dispose of all loose material from the paving area.

330-8.4 Coating Surfaces of Contacting Structures: Paint all structures which will be in actual contact with the asphalt mixture, with the exception of the vertical faces of existing pavements and curbs or curb and gutter, with a uniform coating of asphalt cement to provide a closely bonded, watertight joint.

330-8.5 Tack Coat:

330-8.5.1 Tack Coat Required: Apply a tack coat, as specified in Section 300, on existing pavement structures that are to be overlaid with an asphalt mix and between successive layers of all asphalt mixes.

330-8.5.2 Tack Coat at Engineer's Option: Apply a tack coat on the following surfaces only when so directed by the Engineer:

1. Freshly primed bases.
2. Surface treatment.

330-9 Placing Mixture.

330-9.1 Requirements Applicable to All Types:

330-9.1.1 Alignment of Edges: Lay all asphalt concrete mixtures, including leveling courses, other than the pavement edge just adjacent to curb and gutter or other true edges, by the stringline method to obtain an accurate, uniform alignment of the pavement edge. Control the unsupported pavement edge to ensure that it will not deviate more than ±1.5 inches from the stringline.

330-9.1.2 Temperature of Spreading: Maintain the temperature of the mix at the time of spreading within the master range as defined in 330-6.3. The minimum frequency for taking mix temperatures on the roadway will be as indicated in 330-6.3. Any load or portion of a load of asphalt mix on the roadway with a temperature outside of the master range shall be rejected for use on the project. The Engineer will be immediately notified of the rejection.

330-9.1.3 Rain and Surface Conditions: Immediately cease transportation of asphalt mixtures from the plant when rain begins at the roadway. Do not place asphalt mixtures while rain is falling, or when there is water on the surface to be covered. Once the rain has stopped and water has been

removed from the tacked surface to the satisfaction of the Engineer and the temperature of the mixture caught in transit still meets the requirements as specified in 330-9.1.2, the Contractor may then place the mixture caught in transit.

330-9.1.4 Speed of Paver: Establish the forward speed of the asphalt paver based on the rate of delivery of the mix to the roadway but not faster than the optimum speed needed to adequately compact the pavement.

330-9.1.5 Number of Crews Required: For each paving machine operated, use a separate crew, each crew operating as a full unit. The Contractor's CTQP Paving Level II technician in charge of the paving operations may be responsible for more than one crew but must be physically accessible to the Engineer at all times when placing mix.

330-9.1.6 Checking Depth of Layer: Check the depth of each layer at frequent intervals, and make adjustments when the thickness exceeds the allowable tolerance. When making an adjustment, allow the paving machine to travel a minimum distance of 32 feet to stabilize before the second check is made to determine the effects of the adjustment.

330-9.1.7 Hand Spreading: In limited areas where the use of the spreader is impossible or impracticable, the Contractor may spread and finish the mixture by hand.

330-9.1.8 Straightedging and Back-patching: Straightedge and back-patch after obtaining initial compaction and while the material is still hot.

330-9.2 Requirements Applicable to Courses Other Than Leveling:

330-9.2.1 Spreading and Finishing: Upon arrival, dump the mixture in the approved mechanical spreader, and immediately spread and strike-off the mixture to the full width required, and to such loose depth for each course that, when the work is completed, the required weight of mixture per square yard, or the specified thickness, is secured. Carry a uniform amount of mixture ahead of the screed at all times.

330-9.2.2 Thickness of Layers: Construct each course of Type SP mixtures in layers of the thickness shown in Section 334.

330-9.2.3 Laying Width: If necessary due to the traffic requirements, lay the mixture in strips in such a manner as to provide for the passage of traffic. As an option, where the road is closed to traffic, lay the mixture to the full width with machines traveling in echelon.

330-9.2.4 Correcting Defects: Before starting any rolling, check the surface; correct any irregularities; remove all drippings, fat sandy accumulations from the screed, and fat spots from any source; and replace them with satisfactory material. Do not skin patch. When correcting a depression while the mixture is hot, scarify the surface and add fresh mixture.

330-9.3 Requirements Applicable Only to Leveling Courses:

330-9.3.1 Patching Depressions: Before spreading any leveling course, fill all depressions in the existing surface more than 1 inch deep by spot patching with leveling course mixture, and then compact them thoroughly.

330-9.3.2 Spreading Leveling Courses: Place all courses of leveling by the use of two motor graders, equip one with a spreader box. Use other types of leveling devices after they have been approved by the Engineer.

330-9.3.3 Rate of Application: When using Type SP-9.5 (fine graded) for leveling, do not allow the average spread of a layer to be less than 50 lb/yd^2 or more than 75 lb/yd^2. The quantity of mix for leveling shown in the plans represents the average for the entire project; however, the Contractor may vary the rate of application throughout the project as directed by the Engineer. When leveling in connection with base widening, the Engineer may require placing all the leveling mix prior to the widening operation.

330-9.3.4 Placing Leveling Course Over Existing Pavement: When the Contract Documents specify a leveling course to be placed over cracked concrete pavement, including existing concrete pavement covered with an asphalt surface, place the first layer of leveling course as soon as possible but no later than 48 hours after cracking the concrete.

330-9.3.5 Removal of Excess Joint Material: Where placing a leveling course over existing concrete pavement or bridge decks, trim the excess joint filler in the cracks and joints flush with the surface prior to placing the first layer of the leveling course.

330-10 Compacting Mixture.

330-10.1 Provisions Applicable to All Types:

330-10.1.1 Equipment and Sequence: For each paving operation, furnish a separate set of rollers, with their operators.

When density testing for acceptance is required, select equipment, sequence, and coverage of rolling to meet the specified density requirement. The coverage is the number of times the roller passes over a given area of pavement. Regardless of the rolling procedure used, complete the final rolling before the surface temperature of the pavement drops to the extent that effective compaction may not be achieved or the rollers begin to damage the pavement.

When density testing for acceptance is not required, propose an alternative rolling pattern to be approved by the Engineer or use the following standard rolling procedure:

1. Seal (breakdown) Rolling: Provide two static coverages with a tandem steel-wheeled roller, weighing 5 to 15 tons, following as close behind the paver as possible without pick-up, undue displacement, or blistering of the material.

2. Intermediate rolling: Provide five static coverages with a pneumatic-tired roller, following as close behind the seal (breakdown) rolling operation as the mix will permit.

3. Final rolling: Provide one static coverage with a tandem steel-wheeled roller, weighing 5 to 15 tons, after completing the seal (breakdown) rolling and intermediate rolling, but before the surface pavement temperature drops to the extent that effective compaction may not be achieved or the rollers begin to damage the pavement.

330-10.1.2 Rolling Procedures: Utilize procedures that will uniformly compact the pavement layer to the desired density level.

Roll across the mat, overlapping the adjacent pass by at least 6 inches. Roll slowly enough to avoid displacement of the mixture, and correct

any displacement at once by the use of rakes and the addition of fresh mixture if required. Continue final rolling to eliminate all roller marks.

330-10.1.3 Compaction of Areas Inaccessible to Rollers: Use hand tamps or other satisfactory means to compact areas which are inaccessible to a roller, such as areas adjacent to curbs, gutters, bridges, manholes, etc.

330-10.1.4 Rolling Patching and Leveling Courses: Use pneumatic-tired rollers to roll all patching and leveling courses. When placing the initial leveling course over broken concrete pavement, use a pneumatic-tired roller that weighs at least 15 tons.

330-10.1.5 Correcting Defects: Do not allow the rollers to deposit gasoline, oil, or grease onto the pavement. Remove and replace any areas damaged by such deposits as directed by the Engineer. While rolling is in progress, test the surface continuously, and correct all discrepancies to comply with the surface requirements. Remove and replace all drippings, fat or lean areas, and defective construction of any description. Remedy depressions that develop before completing the rolling by loosening the mixture and adding new mixture to bring the depressions to a true surface. Should any depression remain after obtaining the final compaction, remove the full depth of the mixture, and replace it with sufficient new mixture to form a true and even surface. Correct all high spots, high joints, and honeycombing as directed by the Engineer. Remove and replace any mixture remaining unbonded after rolling. Correct all defects prior to laying the subsequent course.

330-10.1.6 Use of Traffic Roller on First Overbuild Course: Use a pneumatic-tired roller on the first overbuild course. Compact with a minimum of five coverages.

330-10.1.7 Use of Traffic Roller or Vibratory Roller on First Structural Layer Placed on a Milled Surface: Use a pneumatic-tired roller or vibratory roller on the first structural layer placed on a milled surface.

330-10.1.8 Use of Traffic Roller or Vibratory Roller on First Structural Layer Placed on an Asphalt Rubber Membrane Interlayer (ARMI): Use a pneumatic-tired roller or a vibratory roller on the first structural layer placed on an ARMI.

330-10.1.9 Compaction at Bridge Structures: Compact asphalt mixtures placed over bridge decks and approach slabs using static compaction only. Utilize the standard rolling procedure described in 330-10.1.1 or an alternative procedure approved by the Engineer.

330-11 Joints.

330-11.1 Transverse Joints: Place the mixture as continuously as possible. Do not pass the roller over the unprotected end of the freshly laid mixture except when discontinuing the laying operation long enough to permit the mixture to become chilled. When thus interrupting the laying operation, construct a transverse joint by cutting back on the previous run to expose the full depth of the mat.

330-11.2 Longitudinal Joints: For all layers of pavement except the leveling course, place each layer so that longitudinal construction joints are offset 6 to 12 inches laterally between successive layers. Plan offsets in advance so that

longitudinal joints of the friction course are not in wheel path areas. The longitudinal joints for friction course layers should be within 6 inches of the lane edge or at the center of the lane. The Engineer may waive this requirement where offsetting is not feasible due to the sequence of construction.

330-11.3 General: When laying fresh mixture against the exposed edges of joints (trimmed or formed as provided above), place it in close contact with the exposed edge to produce an even, well-compacted joint after rolling.

330-11.4 Placing Asphalt Next to Concrete Pavement: When placing asphalt next to concrete pavement, construct the joint in accordance with Section 350.

330-12 Surface Requirements.

330-12.1 General: Construct a smooth pavement with good surface texture and the proper cross-slope.

330-12.2 Texture of the Finished Surface of Paving Layers: Produce a finished surface of uniform texture and compaction with no pulled, torn, raveled, crushed or loosened portions and free of segregation, bleeding, flushing, sand streaks, sand spots, or ripples. Address any pavement not meeting the requirements of this specification in accordance with 330-12.5.

Do not use asphalt concrete mixtures containing aggregates that cause a different color appearance in the final wearing surface unless the section is greater than or equal to one mile in length and across the full width of the pavement, including shoulders and turn lanes. Exceptions to these requirements will be permitted if approved by the Engineer.

330-12.3 Cross Slope: Construct a pavement surface with cross slopes in compliance with the requirements of the Contract Documents. Furnish a level with a minimum length of 4 feet or a digital measuring device approved by the Engineer for the control of cross slope. Make this level or measuring device available at the jobsite at all times during paving operations. Utilize electronic transverse screed controls on the paving machine (unless directed otherwise by the Engineer) to obtain an accurate transverse slope of the pavement surface.

330-12.3.1 Quality Control Requirements: Measure the cross slope of the pavement surface by placing the measuring device perpendicular to the roadway centerline. Report the cross slope to the nearest 0.1%. Record all the measurements on an approved form and submit to the Engineer for documentation.

Measure the cross slope at a minimum frequency of one measurement every 100 feet during paving operations to ensure that the cross slope is uniform and in compliance with the design cross slope. When the difference between the measured cross slope and the design cross slope exceeds ±0.2% for travel lanes (including turn lanes) or ±0.5% for shoulders, make all corrections immediately to bring the cross slope into the acceptable range.

When the cross slope is consistently within the acceptable range, upon the approval of the Engineer, the frequency of the cross slope measurements can be reduced to one measurement every 250 feet during paving operations.

330-12.3.2 Verification: The Engineer will verify the Contractor's cross slope measurements by randomly taking a minimum of ten measurements of the cross slope over a day's production. If the average cross slope of the ten random measurements varies more than the allowable tolerance from the design cross slope (0.2% for travel lanes including turn lanes and 0.5% for shoulders), take immediate action to bring the cross slope into the acceptable range. A recheck of the cross slope will then be made following the adjustment. If the recheck indicates that the cross slope is still out of tolerance, stop the paving operations and address any pavement not meeting the requirements of this specification in accordance with 330-12.5. Resume paving operations only upon approval of the Engineer. The Engineer reserves the right to verify the pavement cross slope at any time by taking cross slope measurements as described above.

The Engineer may waive the corrections specified above (at no reduction in payment) if:

1) the deficiencies are sufficiently separated so as not to affect the overall ride quality, traffic safety and surface drainage characteristics of the pavement and;

2) the corrective action would unnecessarily mar the appearance of the finished pavement.

For intersections, tapers, crossovers, transitions at beginning and end of project and similar areas, adjust the cross slope to match the actual site conditions or as directed by the Engineer.

330-12.4 Pavement Smoothness: Construct a smooth pavement meeting the requirements of this Specification.

330-12.4.1 General: Furnish a 15 foot manual and a 15 foot rolling straightedge meeting the requirements of FM 5-509. Obtain a smooth surface on all pavement courses placed, and then straightedge all layers as required by this specification.

330-12.4.2 Test Method: Perform all straightedge testing in accordance with FM 5-509 in the outside wheel path of each lane. The Engineer, or these specifications, may require additional testing at other locations within the lane.

330-12.4.3 Traffic Control: Provide traffic control in accordance with Section 102 and the Design Standards Index Nos. 607 or 619 during all testing. When traffic control cannot be provided in accordance with Index Nos. 607 or 619, submit an alternative Traffic Control Plan as specified in 102-4. Include the cost of this traffic control in the Contract bid prices for the asphalt items.

330-12.4.4 Process Control Testing: Assume full responsibility for controlling all paving operations and processes such that the requirements of these Specifications are met at all times. Address in the QC Plan the methods to be used to control smoothness.

330-12.4.5 Quality Control Testing:

330-12.4.5.1 General: Straightedge the final Type SP structural layer and friction course layer in accordance with 330-12.4.2, regardless of whether the method of acceptance is by straightedge or laser profiler. Test all pavement lanes and ramps where the width is constant and document all deficiencies in excess of 3/16 inch on a form approved by the Engineer.

330-12.4.5.2 Rolling Straightedge Exceptions: Testing with the rolling straightedge will not be required in the following areas: shoulders, intersections, tapers, crossovers, parking lots and similar areas, or in the following areas when they are less than 250 feet in length: turn lanes, acceleration/deceleration lanes and side streets.

In the event the Engineer identifies a surface irregularity in the above areas that is determined to be objectionable, straightedge and address all deficiencies in excess of 3/8 inch in accordance with 330-12.5.

The Engineer may waive straightedge requirements for transverse joints at the beginning and end of the project, and at the beginning and end of bridge structures, if the deficiencies are caused by factors beyond the control of the Contractor, as determined by the Engineer. In addition, the Engineer may also waive the straightedging requirements on ramps and superelevated sections where the geometrical orientation of the pavement results in an inaccurate measurement with the rolling straightedge.

330-12.4.5.3 Intermediate Layers: When the design speed is 55 mph or greater, the intermediate Type SP layer will be opened to traffic and the Engineer identifies a surface irregularity that is determined to be objectionable, straightedge and address all deficiencies in excess of 3/8 inch within 72 hours of placement in accordance with 330-12.5.

330-12.4.5.4 Final Type SP Structural Layer: Straightedge the final Type SP structural layer in accordance with 330-12.4.2, either behind the final roller of the paving train or as a separate operation. Notify the Engineer of the location and time of straightedge testing a minimum of 48 hours before beginning testing. The Engineer will verify the straightedge testing by observing the Quality Control straightedging operations. Address all deficiencies in excess of 3/16 inch in accordance with 330-12.5.

For bicycle paths, straightedge the final Type SP structural layer with a rolling straightedge, either behind the final roller of the paving train or as a separate operation. Address all deficiencies in excess of 5/16 inch in accordance with 330-12.5. If the Engineer determines that the deficiencies on the bicycle path are due to field geometrical conditions, the Engineer will waive corrections with no deduction to the pay item quantity.

330-12.4.5.5 Friction Course Layer: Straightedge the friction course layer in accordance with 330-12.4.2, either behind the final roller of the paving train or as a separate operation upon completion of all paving operations. Notify the Engineer of the location and time of straightedge testing a minimum of 48 hours before beginning testing. The Engineer will verify the straightedge testing by observing the Quality Control straightedging operations. Address all deficiencies in excess of 3/16 inch in accordance with 330-12.5. For laser acceptance, corrections may be made either before or after laser acceptance testing.

330-12.4.6 Acceptance:

330-12.4.6.1 Straightedge Acceptance: For areas of roadways where the design speed is less than 55 miles per hour, acceptance for pavement smoothness of the friction course will be based on verified Quality Control measurements using the straightedge as required by 330-12.4.5. The Engineer

will verify the straightedge testing by observing the Quality Control straightedging operations.

330-12.4.6.2 Laser Acceptance: For areas of high speed roadways where the design speed is equal to or greater than 55 miles per hour, acceptance testing for pavement smoothness of the friction course (for mainline traffic lanes only) will be based on the Laser Profiler. Ramps, acceleration and deceleration lanes, and other areas not suitable for testing with the Laser Profiler will be tested and accepted with the straightedge in accordance with 330-12.4.5.5 and 330-12.4.6.1.

The pavement smoothness of each lane will be determined by a Laser Profiler furnished and operated by the Department in accordance with FM 5-549 and a report issued with the Ride Number (RN) reported to one decimal place. If corrections are made, as required following Laser Acceptance, the pavement will not be retested for smoothness using the Laser Profiler.

For this testing, the pavement will be divided into 0.1 mile segments. Partial segments equal to or greater than 0.01 mile will be considered as a 0.1 mile segment. The pavement will be accepted as follows:

1) For segments with a RN greater than or equal to 4.0, the pavement will be accepted at full pay.

2) For segments with a RN less than 4.0, the Engineer will further evaluate the data in 0.01 mile intervals for both wheel paths.

If the RN is 3.5 or above for all 0.01 mile intervals in both wheel paths, the segment will be accepted at full payment.

If the RN is less than 3.5 for one or more 0.01 mile intervals, the segment will be tested with the rolling straightedge in both wheel paths in accordance with FM 5-509. If approved by the Engineer, this straightedging may be completed (in both wheel paths) as part of the Quality Control straightedging operations described in 330-12.4.5.5, prior to testing with the laser profiler. Notify the Engineer of the location and time of straightedge testing a minimum of 48 hours before beginning testing. The Engineer will verify the straightedge testing by observing the Quality Control straightedging operations. Address all deficiencies in excess of 3/16 inch in accordance with 330-12.5.

Test and accept areas at the beginning and ending of the project, bridge approaches and departures, and areas where the segment is less than 0.01 mile, with the straightedge in accordance with 330-12.4.5.5 and 330-12.4.6.1.

330-12.5 Unacceptable Pavement:

330-12.5.1 Corrections: Address all areas of unacceptable pavement at no cost to the Department. Retest all corrected areas and assure the requirements of these specifications are met.

330-12.5.1.1 Structural Layers: Correct all deficiencies, as defined in these Specifications, in the Type SP structural layers by one of the methods described below:

a. Remove and replace the full depth of the layer, extending a minimum of 50 feet on both sides (where possible) of the defective area for the full width of the paving lane.

b. Mill the pavement surface to a depth and width that is adequate to remove the deficiency. (This option only applies if the structural layer is not the final surface layer.)

330-12.5.1.2 Friction Course: Correct deficiencies in the friction course layer by removing and replacing the full depth of the layer, extending a minimum of 50 feet on both sides (where possible) of the defective area for the full width of the paving lane. As an exception, the Engineer may allow the contractor to leave these areas in place at if it is determined by the Engineer that the deficiency is not a significant detriment to the pavement quality. A reduction to the pay quantity item will be made in accordance with 330-12.5.2.

330-12.5.2 Reduction in Pay Item Quantity: When the Engineer elects to waive corrections, the Department will reduce the pay quantity for the pay item in question by the amount of material that the Contractor would have removed and replaced had the correction been made. When the pay quantity is in tons, the Department will base the reduction on the volume of material that the Contractor would have removed (the length by the lane width by layer thickness) multiplied by the maximum specific gravity of the mix as determined through the following equation:

$$\text{Quantity (tons)} = L \times W \times t \times G_{mm} \times 0.0024$$

Where: L = Lane length (ft.)
W = Lane width (ft.)
t = Layer thickness (in.)
G_{mm} = Maximum specific gravity from verified mix design

For FC-5 open-graded friction course, the Department will base the reduction on the area that the Contractor would have removed (the length by lane width) multiplied by a spread rate of 80 lb/yd^2 as determined through the following equation:

$$\text{Quantity (tons)} = L \times W \times 0.0044$$

Where: L = Lane length (ft.)
W = Lane width (ft.)

330-13 Protection of Finished Surface.

Keep sections of newly compacted asphalt concrete, which are to be covered by additional courses, clean until the successive course is laid.

Do not dump embankment or base material directly on the pavement. Dress shoulders before placing the friction course on adjacent pavement.

Equip blade graders operating adjacent to the pavement during shoulder construction with a 2 inch by 8 inch or larger board, or other attachment providing essentially the same results, attached to their blades in such manner that it extends below the blade edge in order to protect the pavement surface from damage by the grader blade.

To prevent rutting or other distortion, protect sections of newly finished dense-graded friction course and the last structural layer prior to the friction course from traffic until the surface temperature has cooled below 160ºF.

The Contractor may use artificial methods to cool the pavement to expedite paving operations. The Department may direct the Contractor to use artificial

cooling methods when maintenance of traffic requires opening the pavement to traffic at the earliest possible time.

SECTION 334
SUPERPAVE ASPHALT CONCRETE

334-1 Description.

334-1.1 General: Construct a Superpave Asphalt Concrete pavement with the type of mixture specified in the Contract, or when offered as alternates, as selected. Superpave mixes are identified as Type SP-9.5, Type SP-12.5 or Type SP-19.0.

Meet the requirements of Section 320 for plant and equipment. Meet the general construction requirements of Section 330, except as modified herein, including the provision for Quality Control Plans and Quality Control Systems as specified in 6-8.

On projects with only Traffic Level A and/or B asphalt mixtures, select Option 1 or Option 2 Mixture Acceptance as specified in 334-5. The selection shall be indicated in the Contractor Quality Control Plan in accordance with Section 105 and shall apply to all mixes, including base, structural and friction courses, on the entire project. Traffic Level C, D and E mixtures will be accepted under Option 1 Mixture Acceptance only. On Contracts having both Traffic Level A or B and Traffic Level C, D or E asphalt mixtures, material will be accepted only under Option 1 Material Acceptance.

When Option 2 Mixture Acceptance is selected, the requirements of 330-2 will not apply, with the exception of the roadway requirements as defined in 330-2.2.

For Option 1 Mixture Acceptance, the Engineer will accept the work on a LOT to LOT basis in accordance with 334-5.1. The LOTs will be subdivided into sublots and the size of a LOT and sublot will be as specified in 334-5.1.2.

For Option 2 Mixture Acceptance, the Engineer will accept the work in accordance with 334-5.2.

334-1.2 Traffic Levels: The requirements for Type SP Asphalt Concrete mixtures are based on the design traffic level of the project, expressed in 18,000 pound Equivalent Single Axle Loads (ESAL's). The five traffic levels are as shown in Table 334-1.

Table 334-1
Superpave Traffic Levels

Traffic Level	Traffic Level ($1x10^6$ ESAL's)
A	<0.3
B	0.3 to <3
C	3 to <10
D	10 to <30
E	≥30

The traffic level(s) for the project are as specified in the Contract. A Type SP mix one traffic level higher than the traffic level specified in the Contract may be substituted, at no cost to the Department (i.e. Traffic Level B may be substituted for Traffic Level A, etc.).

334-1.3 Gradation Classification: The Superpave mixes are classified as either coarse or fine, depending on the overall gradation of the mixture. Coarse and fine mixes are defined in 334-3.2.2.

The equivalent AASHTO nominal maximum aggregate size Superpave mixes are as follows:

Type SP-9.5 ..... 9.5 mm
Type SP-12.5 ..... 12.5 mm
Type SP-19.0 ..... 19.0 mm

334-1.4 Thickness: The total thickness of the Type SP asphalt layer(s) will be the plan thickness as shown in the Contract Documents. Before paving, propose a thickness for each individual layer meeting the requirements of this specification, which when combined with other layers (as applicable) will equal the plan thickness. For construction purposes, the plan thickness and individual layer thickness will be converted to spread rate based on the maximum specific gravity of the asphalt mix being used, as well as the minimum density level, as shown in the following equation:

Spread rate (lbs/yd^2) $= t \times G_{mm} \times 43.3$

Where: t = Thickness (in.) (Plan thickness or individual layer thickness)

G_{mm} = Maximum specific gravity from the verified mix design

The weight of the mixture shall be determined as provided in 320-2.2. For target purposes only, spread rate calculations should be rounded to the nearest whole number.

Note: Plan quantities are based on a G_{mm} of 2.540, corresponding to a spread rate of 110 lbs/yd^2-in. Pay quantities will be based on the actual maximum specific gravity of the mix being used.

334-1.4.1 Layer Thicknesses - Fine Mixes: The allowable layer thicknesses for fine Type SP Asphalt Concrete mixtures are as follows:

Type SP-9.5 ..... 1 - 1 1/2 inches
Type SP-12.5 ..... 1 1/2 - 2 1/2 inches
Type SP-19.0 ..... 2 - 3 inches

In addition to the minimum and maximum thickness requirements, the following restrictions are placed on fine mixes when used as a structural course:

Type SP-9.5 - Limited to the top two structural layers, two layers maximum.

Type SP-9.5 – May not be used on Traffic Level D and E applications.

Type SP-19.0 - May not be used in the final (top) structural layer.

334-1.4.2 Layer Thicknesses - Coarse Mixes: The allowable layer thicknesses for coarse Type SP Asphalt Concrete mixtures are as follows:

Type SP-9.5 ..... 1 1/2 - 2 inches
Type SP-12.5 ..... 2 - 3 inches

Type SP-19.0 ..... 3 - 3 1/2 inches

In addition to the minimum and maximum thickness requirements, the following restrictions are placed on coarse mixes when used as a structural course:

Type SP-19.0 - May not be used in the final (top) structural layer.

334-1.4.3 Additional Requirements: The following requirements also apply to coarse and fine Type SP Asphalt Concrete mixtures:

1. A minimum 1 1/2 inch initial lift is required over an Asphalt Rubber Membrane Interlayer (ARMI).

2. When construction includes the paving of adjacent shoulders (≤5 feet wide), the layer thickness for the upper pavement layer and shoulder must be the same and paved in a single pass, unless called for differently in the Contract Documents.

3. All overbuild layers must be fine Type SP Asphalt Concrete designed at the traffic level as stated in the Contract. Use the minimum and maximum layer thicknesses as specified above unless called for differently in the Contract Documents. On variable thickness overbuild layers, the minimum allowable thickness may be reduced by 1/2 inch, and the maximum allowable thickness may be increased 1/2 inch, unless called for differently in the Contract Documents.

334-2 Materials.

334-2.1 General Requirements: Meet the material requirements specified in Division III. Specific references are as follows:

Superpave PG Asphalt Binder or Recycling Agent 916-1, 916-2
Coarse Aggregate ..... Section 901
Fine Aggregate ..... Section 902

334-2.2 Superpave Asphalt Binder: Unless specified otherwise in the Contract, use a PG 67-22 asphalt binder. In addition, meet the requirements of 334-2.3.

334-2.3 Reclaimed Asphalt Pavement (RAP) Material: :

334-2.3.1 General Requirements: RAP may be used as a component of the asphalt mixture subject to the following requirements:

1. For Traffic Levels A, B and C mixtures, limit the amount of RAP material used in the mix to a maximum of 50 percent by weight of total aggregate. For Traffic Levels D and E mixtures, limit the amount of RAP material used in the mix to a maximum of 30 percent by weight of total aggregate.

2. When using a PG 76-22 Asphalt Binder, limit the amount of RAP material used in the mix to a maximum of 15 percent by weight of total aggregate. As an exception, amounts greater than 15 percent RAP by weight of total aggregate can be used if no more than 15% by weight of the total asphalt binder comes from the RAP material.

3. Assume full responsibility for the design, production and construction of asphalt mixes which incorporate RAP as a component material.

4. Use RAP from an FDOT approved stockpile or RAP that has an FDOT furnished Pavement Composition Data Sheet.

5. Provide stockpiled RAP material that is reasonably consistent in characteristics and contains no aggregate particles which are soft or conglomerates of fines.

6. Provide RAP material having a minimum average asphalt content of 4.0 percent by weight of total mix. As an exception, when using fractionated RAP, the minimum average asphalt content for the coarse portion of the RAP shall be 2.5 percent by weight of the coarse portion of the RAP. The coarse portion of the RAP shall be the portion of the RAP retained on the No. 4 sieve. The Engineer may sample the stockpile(s) to verify that this requirement is met.

334-2.3.2 Material Characterization: Assume responsibility for establishing the asphalt binder content, gradation, viscosity and bulk specific gravity (G_{sb}) of the RAP material based on a representative sampling of the material. Obtain the samples by one of the following methods:

1. Roadway cores: Cut a minimum number of cores to be representative of the pavement prior to milling. Fill the core holes prior to opening to traffic. Assume responsibility for accounting for the degradation that will occur during the milling operation.

2. Milling: Obtain representative samples by milling the existing pavement to the full depth shown on the plans for a minimum length of approximately 200 feet. If required to maintain traffic, immediately replace the pavement removed with the mix specified in the Contract. This mix will be paid for at the Contract unit price.

3. Stockpile sampling: Obtain samples from a stockpile of either milled or processed RAP. Take representative samples at random locations around the stockpile. Request the Engineer to make a visual inspection of the stockpiled RAP material. Based on visual inspection and a review of the test data, the Engineer will determine the suitability of the stockpiled materials. Once the RAP stockpile has been approved, do not add additional material without prior approval of the Engineer.

Determine the binder content and gradation of the RAP material in accordance with FM 5-563 and FM 1-T 030, respectively. Extract and recover the asphalt binder from the RAP in accordance with FM 5-524 and FM 3-D 5404, respectively. Determine the viscosity of the recovered asphalt binder in accordance with ASTM D-2171. Establish the G_{sb} of the RAP material by using one of the following methods:

a) Calculate the G_{sb} value based upon the effective specific gravity (G_{se}) of the RAP material, determined on the basis of the asphalt binder content and maximum specific gravity (G_{mm}) of the RAP material. The Engineer will approve the estimated asphalt binder absorption value used in the calculation.

b) Measure the G_{sb} of the RAP aggregate, in accordance with FM 1-T 084 and FM 1-T 085. Obtain the aggregate by using either a solvent or ignition oven extraction method.

334-2.3.3 Pavement Composition: When the Contract includes milling of the existing asphalt pavement, the Pavement Composition Data Sheet may be available on the Department's website. The URL for obtaining this information, if available, is:

www.dot.state.fl.us/statematerialsoffice/laboratory/asphalt/centrallaboratory/compositions/index.htm .

334-2.3.4 Asphalt Binder for Mixes with RAP: Select the appropriate asphalt binder grade based on Table 334-2. The Engineer reserves the right to change the asphalt binder type and grade at design based on the characteristics of the RAP asphalt binder, and reserves the right to make changes during production. Maintain the viscosity of the recycled mixture within the range of 5,000 to 15,000 poises. Obtain a sample of the mixture for the Engineer within the first 1,000 tons of production and at a continuing frequency of one sample per 4,000 tons of mix.

Table 334-2
Asphalt Binder Grade for Mixes Containing RAP

Percent RAP	Asphalt Binder Grade
<20	PG 67-22
20 – 29	PG 64-22
≥ 30	Recycling Agent

334-2.4 Recycled Crushed Glass: Recycled crushed glass may be used as a component of the asphalt mixture subject to the following requirements:

1. Consider the recycled crushed glass a local material and meet all requirements specified in 902-6.
2. Limit the amount of recycled crushed glass to a maximum of 15 percent by weight of total aggregate.
3. Use an asphalt binder that contains a minimum of 0.5 percent anti-stripping agent by weight of binder. The antistrip additive shall be one of the products included on the Qualified Products List specified in 6-1 of the Specifications. The antistrip additive shall be introduced into the asphalt binder by the supplier during loading.
4. Do not use recycled crushed glass in friction course mixtures or in structural course mixtures which are to be used as the final wearing surface.

334-3 General Composition of Mixture.

334-3.1 General: Compose the asphalt mixture using a combination of aggregate (coarse, fine or mixtures thereof), mineral filler, if required, and asphalt binder material. Size, grade and combine the aggregate fractions to meet the grading and physical properties of the mix design. Aggregates from various sources may be combined.

334-3.2 Mix Design:

334-3.2.1 General: Design the asphalt mixture in accordance with AASHTO R35-04, except as noted herein. Prior to the production of any asphalt mixture, submit the proposed mix design with supporting test data indicating compliance with all mix design criteria to the Engineer. For Traffic Level B through E mix designs, include representative samples of all component materials, including asphalt binder. Allow the State Materials Engineer a maximum of four weeks to either conditionally verify or reject the mix as designed.

For Traffic Level C through E mix designs, final verification of the mix design will occur when the requirements of 334-5.1.2.1 have been met. Do not use more than three mix designs per nominal maximum aggregate size per traffic level per binder grade per contract year. Exceeding this limitation will result in a maximum Composite Pay Factor of 1.00 as defined in 334-8.2 for all designs used beyond this limit.

The Engineer will consider any marked variations from original test data for a mix design or any evidence of inadequate field performance of a mix design as sufficient evidence that the properties of the mix design have changed, and the Engineer will no longer allow the use of the mix design.

334-3.2.2 Mixture Gradation Requirements: Combine the coarse and fine aggregate in proportions that will produce an asphalt mixture meeting all of the requirements defined in this specification and conform to the gradation requirements at design as defined in AASHTO M-323-04, Table 3. Aggregates from various sources may be combined.

334-3.2.2.1 Mixture Gradation Classification: Plot the combined mixture gradation on an FHWA 0.45 Power Gradation Chart. Include the Control Points from AASHTO M-323-04, Table-3, as well as the Primary Control Sieve (PCS) Control Point from AASHTO M-323-04, Table 4. Coarse mixes are defined as having a combined aggregate gradation that passes below the primary control sieve control point and below the maximum density line for all sieve sizes smaller than the primary control sieve. Fine mixes are defined as having a gradation that passes above the primary control sieve control point and above the maximum density line for all sieve sizes smaller than the primary control sieve and larger than the #100 sieve. Use a fine mix for Traffic Levels A through C; use either a coarse mix or fine mix for Traffic Levels D and E.

334-3.2.3 Aggregate Consensus Properties: For Traffic Level C through E mixtures, meet the following consensus properties at design for the aggregate blend.

Aggregate consensus properties do not apply to Traffic Level A and B mixtures.

334-3.2.3.1 Coarse Aggregate Angularity: When tested in accordance with ASTM D-5821, meet the percentage of fractured faces requirements specified in AASHTO M-323-04, Table 5.

334-3.2.3.2 Fine Aggregate Angularity: When tested in accordance with AASHTO T-304, Method A, meet the uncompacted void content of fine aggregate specified in AASHTO M-323-04, Table 5.

334-3.2.3.3 Flat and Elongated Particles: When tested in accordance with ASTM D-4791, (with the exception that the material passing the 3/8 inch sieve and retained on the No. 4 sieve shall be included), meet the requirements specified in AASHTO M-323-04, Table 5. Measure the aggregate using the ratio of 5:1, comparing the length (longest dimension) to the thickness (shortest dimension) of the aggregate particles.

334-3.2.3.4 Sand Equivalent: When tested in accordance with AASHTO T-176, meet the sand equivalent requirements specified in AASHTO M-323-04, Table 5.

334-3.2.4 Gyratory Compaction: Compact the design mixture in accordance with AASHTO T-312-04, with the following exception: use the number of gyrations at N_{design} as defined in Table 334-3.

Table 334-3
Gyratory Compaction Requirements

Traffic Level	N_{design} Number of Gyrations
A	50
B	65
C	75
D	100
E	100

334-3.2.5 Design Criteria: Meet the requirements for nominal maximum aggregate size as defined in AASHTO M-323-04, as well as for relative density, VMA, VFA, and dust-to-binder ratio as specified in AASHTO M-323-04, Table 6. Use a dust-to-binder ratio of 0.8 to 1.6 for coarse mixes. $N_{maximum}$ requirements are not applicable for Traffic Level A and B mixtures.

334-3.2.6 Moisture Susceptibility:

1. For Traffic Level A and B mixtures, use a liquid anti-strip additive, which is on the Department's Qualified Products List, at a rate of 0.5% by weight of the asphalt binder.

2. For Traffic Level C through E mixtures, test 4 inch specimens in accordance with FM 1-T 283. Provide a mixture having a retained tensile strength ratio of at least 0.80 and a minimum tensile strength (unconditioned) of 100 psi. If necessary, add a liquid anti-stripping agent, which is on the Department's Qualified Products List or hydrated lime (meeting the requirements of 337-10.2) in order to meet these criteria.

334-3.2.7 Additional Information: In addition to the requirements listed above, provide the following information with each proposed mix design submitted for verification:

1. The design traffic level and the design number of gyrations (N_{design}).

2. The source and description of the materials to be used.

3. The DOT source number and the DOT product code of the aggregate components furnished from a DOT approved source.

4. The gradation and proportions of the raw materials as intended to be combined in the paving mixture. The gradation of the component materials shall be representative of the material at the time of use. Compensate for any change in aggregate gradation caused by handling and processing as necessary.

5. A single percentage of the combined mineral aggregate passing each specified sieve. Degradation of the aggregate due to processing (particularly material passing the No. 200 sieve) should be accounted for and identified.

6. The bulk specific gravity (G_{sb}) value for each individual aggregate and RAP component, as identified in the Department's aggregate control program.

7. A single percentage of asphalt binder by weight of total mix intended to be incorporated in the completed mixture, shown to the nearest 0.1 percent.

8. A target temperature at which the mixture is to be discharged from the plant (mixing temperature) and a target roadway temperature (compaction temperature) (per 330-6.3). Do not exceed a target temperature of 330°F for modified asphalts (PG 76-22, ARB5, and ARB-12) and 315°F for unmodified asphalts.

9. Provide the physical properties achieved at four different asphalt binder contents. One of which shall be at the optimum asphalt content, and must conform to all specified physical requirements.

10. The name of the CTQP Qualified Mix Designer.

11. The ignition oven calibration factor.

334-3.3 Mix Design Revisions: During production, the Contractor may request a target value revision to a mix design, subject to meeting the following requirements: (1) the target change falls within the limits defined in Table 334-4, (2) appropriate data exists demonstrating that the mix complies with production air voids specification criteria, and (3) the mixture gradation meets the basic gradation requirements defined in 334-3.2.2.

Table 334-4
Limits for Potential Adjustments to Mix Design Target Values

Characteristic	Limit from Original Mix Design
No. 8 sieve and Coarser	± 5.0 percent
No. 16 sieve	± 4.0 percent
No. 30 sieve	± 4.0 percent
No. 50 sieve	± 3.0 percent
No. 100 sieve	± 3.0 percent
No. 200 sieve	± 1.0 percent
Asphalt Binder Content (1)	± 0.3 percent

(1) Reductions to the asphalt binder content will not be permitted if the VMA during production is lower than 1.0 percent below the design criteria.

Submit all requests for revisions to mix designs, along with supporting documentation, to the Engineer. In order to expedite the revision process, the request for revision or discussions on the possibility of a revision may be made verbally, but must be followed up by a written request. The verified mix design will remain in effect until the Engineer authorizes a change. In no case will the effective date of the revision be established earlier than the date of the first communication between the Contractor and the Engineer regarding the revision.

A new design mix will be required if aggregate sources change, or for any substitution of an aggregate product with a different aggregate code, unless approved by the Engineer.

334-4 Contractor Process Control (for Option 1 Mixture Acceptance).

Assume full responsibility for controlling all operations and processes such that the requirements of these Specifications are met at all times. Perform any tests necessary at the plant and roadway for process control purposes. The Engineer will not use these test results in the acceptance payment decision.

Address in the Quality Control Plan how Process Control failures will be handled. When a Process Control failure occurs, investigate, at a minimum, the production process, testing equipment and/or sampling methods to determine the cause of the failure, and make any necessary changes to assure compliance with these Specifications. Obtain a follow up sample immediately after corrective actions are taken to assess the adequacy of the corrections. In the event the follow-up Process Control sample also fails to meet Specification requirements, cease production of the asphalt mixture until the problem is adequately resolved to the satisfaction of the Quality Control Manager.

334-5 Acceptance of the Mixture.

334-5.1 Option 1 Mixture Acceptance:

334-5.1.1 General: The mixture will be accepted at the plant with respect to gradation (P_{-8} and P_{-200}), asphalt content (P_b), and volumetrics (volumetrics is defined as air voids at N_{design}). The mixture will be accepted on the roadway with respect to density of roadway cores. Acceptance will be on a LOT-by-LOT basis (for each mix design) based on tests of random samples obtained within each sublot taken at a frequency of one set of samples per sublot. A roadway LOT and a plant production LOT shall be the same. Acceptance of the mixture will be based on Contractor Quality Control test results that have been verified by the Department.

334-5.1.1.1 Sampling and Testing Requirements: Obtain the samples in accordance with FM 1 T-168. Obtain samples at the plant of a sufficient quantity to be split into three smaller samples; one for Quality Control, one for Verification and one for Resolution testing; each sample at approximately 35 pounds. The split samples for Verification testing and Resolution testing shall be reduced in size and stored in three boxes each. The approximate size of each box must be 12" x 8" x 4". Provide, label and safely store sample boxes in a manner agreed upon by the Engineer for future testing.

The asphalt content of the mixture will be determined in accordance with FM 5-563. In the event the FM 5-563 ignition oven goes out of service during production, the Contractor may elect to use a replacement oven at another location for no more than 72 hours while the oven is being repaired. The gradation of the recovered aggregate will be determined in accordance with FM 1-T 030. Volumetric testing will be in accordance with AASHTO T-312-04 and FM 1 T-209. Prior to testing volumetric samples, condition the test-sized sample for one hour ± five minutes at the target roadway compaction temperature in a covered, shallow, flat pan, such that the mixture temperature at the end of the one hour conditioning period is within ± 20° F of the roadway compaction temperature. Test for roadway density in accordance with FM 1-T 166.

334-5.1.1.2 Acceptance Testing Exceptions: When the total combined quantity of hot mix asphalt for the project, as indicated in the plans for

Type SP and Type FC mixtures only, is less than 2000 tons, the Engineer will accept the mix on the basis of visual inspection. The Engineer may require the Contractor to run process control tests for informational purposes, as defined in 334-4, or may run independent verification tests to determine the acceptability of the material.

Density testing for acceptance will not be performed on widening strips or shoulders with a width of 5 feet or less, open-graded friction courses, variable thickness overbuild courses, leveling courses, any asphalt layer placed on subgrade (regardless of type), miscellaneous asphalt pavement, or any course with a specified thickness less than 1 inch or a specified spread rate that converts to less than 1 inch as described in 334-1.4. Density testing for acceptance will not be performed on asphalt courses placed on bridge decks or approach slabs; compact these courses in static mode only per the requirements of 330-10.1.9. In addition, density testing for acceptance will not be performed on the following areas when they are less than 1,000 feet (continuous) in length: crossovers, intersections, turning lanes, acceleration lanes, deceleration lanes, shoulders, parallel parking lanes or ramps.

Where density testing for acceptance is not required, compact these courses (with the exception of open-graded friction courses) in accordance with the rolling procedure (equipment and pattern) as approved by the Engineer or with Standard Rolling Procedure as specified in 330-10.1.2. In the event that the rolling procedure deviates from the procedure approved by the Engineer, or the Standard Rolling Procedure, placement of the mix shall be stopped.

The density pay factor (as defined in 334-8.2) for LOTs where there are areas not requiring density testing for acceptance will be prorated based on a pay factor of 1.00 for the quantity (tonnage) of material in areas not requiring density testing for acceptance and the actual pay factor for the tonnage of material in areas requiring density testing.

334-5.1.2 LOT Sizes: LOT sizes will be either 2,000 tons or 4,000 tons. The Initial Production LOT of all mix designs used on a project shall consist of 2,000 tons, subdivided into four equal sublots of 500 tons each. Following the Initial Production LOT, each remaining LOT will be defined (as selected by the Contractor prior to the start of the LOT) as either (1) 2,000 tons, with each LOT subdivided into four equal sublots of 500 tons each, or (2) 4,000 tons (as authorized by the Engineer per 334-5.1.2.1), with each LOT subdivided into four equal sublots of 1,000 tons each. Before the beginning of a LOT, the Engineer will develop a random sampling plan for each sublot and direct the Contractor on sample points, based on tonnage, for each sublot during construction.

In the event a LOT is terminated per 334-5.1.4.4, the LOT size upon resuming production of the mixture will be 2000 tons until the requirements of 334-5.1.2.1 are met.

334-5.1.2.1 Criteria for 4,000 ton LOTs: At the completion of the Initial Production LOT, the quality of the as-produced material will be evaluated by the Engineer. Begin the option of 4,000 ton LOT sizes only when authorized by the Engineer based upon the Quality Control test results for the Initial Production LOT meeting the following:

1. A minimum Pay Factor of 0.90 for each asphalt quality characteristic as defined in 334-8.2.

2. A favorable comparison with the Verification test results. Comparisons between the Quality Control and Verification test results will be based on between-laboratory precision values shown in Table 334-6.

3. A coefficient of permeability of less than 125 x 10^{-5}cm/s on each roadway core as determined in accordance with FM 5-565. Permeability criteria apply only to coarse mixes when the average density for the sublot is less than 93.00 percent of G_{mm}, or when an individual density value is less than 91.00 percent of G_{mm}.

In the event that the Initial Production LOT does not meet these criteria, limit production LOT sizes to 2,000 tons with 500 ton sublots until these criteria are met.

334-5.1.2.2 Partial LOTs: A partial LOT is defined as a LOT size that is less than a full LOT. A partial LOT may occur due to the following:

l. The completion of a given mix type or mix design on a project.

2. LOTs will be terminated 20 calendar days after the start of the LOT. (Time periods other than 20 days may be used if agreed to by both the Engineer and the Contractor.)

3. A LOT is terminated per 334-5.1.4.4.

All partial LOTs will be evaluated based on the number of tests available, and will not be redefined.

334-5.1.3 Initial Production Requirements: The Initial Production LOT of all mix designs shall be established at 2,000 tons. During this period demonstrate the capability to produce and place the mixture as specified unless waived by the Engineer. If necessary, during this time, make adjustments to the mix design, as defined in 334-3.3. Any target value adjustments to the mix design will result in the LOT being terminated and evaluated for payment purposes per 334-8. Do not begin 4,000 ton LOT sizes until a 2,000 ton initial production LOT (for each mix design) has been successfully completed, or is waived by the Engineer.

At the sole option of the Engineer, the requirement for an Initial Production LOT may be waived based on evidence of satisfactory production, placement and performance on previous projects for that particular mix.

334-5.1.3.1 Plant Sampling and Testing Requirements: Obtain one random sample of mix per sublot in accordance with 334-5.1.1.1 as directed by the Engineer. Test the Quality Control split sample for gradation, asphalt binder content and volumetrics in accordance with 334-5.1.1.1. Complete all Quality Control testing within one working day from the time the samples were obtained.

334-5.1.3.2 Roadway Sampling and Testing Requirements: Obtain five 6 inch diameter roadway cores within 24 hours of placement at random locations as directed by the Engineer within each sublot. Test these Quality Control samples for density in accordance with 334-5.1.1.1. The G_{mm} used for the density evaluation will be based on the Quality Control test result for the corresponding sublot.

On coarse mixes when the average density for an Initial Production sublot is less than 93.00 percent of G_{mm}, or an individual core density is less than 91.00 percent of G_{mm}, cut five 6 inch diameter roadway cores (at locations determined by the Engineer) and have them evaluated for permeability in accordance with FM 5-565 by a laboratory as approved by the Engineer. If approved by the Engineer, the original cores cut for density testing purposes may be used to evaluate permeability.

334-5.1.3.3 Verification of Initial Production LOT: For Verification purposes the Engineer will test a minimum of one split sample as described in 334-5.1.1.1 from the Initial Production LOT at the completion of the LOT. The plant and roadway random samples shall be from the same sublot. However, for situations where roadway density is not required for the random sublot chosen, then another sublot shall be randomly chosen for roadway density only. Results of the testing and analysis for the LOT will be made available to the Contractor within one working day from when the LOT is completed.

The Verification test results will be compared with the corresponding Quality Control test results based on the between-laboratory precision values shown in Table 334-6.

If all of the specified mix characteristics compare favorably, then the LOT will be accepted, with payment based on the Quality Control results for the LOT.

If any of the results do not compare favorably, then the split Resolution samples from the LOT will be sent to the Resolution laboratory for testing, as described in 334-5.1.6.

334-5.1.3.4 Acceptance of Initial Production LOT: The Initial Production LOT shall be considered a single LOT and will receive a Composite Pay Factor as determined in 334-8, based on results of the verified Quality Control tests, or as determined by the Resolution System.

334-5.1.4 Quality Control Sampling and Testing: Obtain all samples randomly as directed by the Engineer.

Should the Engineer determine that the Quality Control requirements are not being met or that unsatisfactory results are being obtained, or should any instances of falsification of test data occur, approval of the Contractor's Quality Control Plan will be suspended and production will be stopped.

334-5.1.4.1 Lost or Missing Verification/Resolution Samples: In the event that any of the Verification and/or Resolution samples that are in the custody of the Contractor are lost, damaged, destroyed, or are otherwise unavailable for testing, the minimum possible pay factor for each quality characteristic as described in 334-8.2 will be applied to the entire LOT in question, unless called for otherwise by the Engineer. Specifically, if the LOT in question has more than two sublots, the pay factor for each quality characteristic will be 0.55. If the LOT has two or less sublots, the pay factor for each quality characteristic will be 0.80. In either event, the material in question will also be evaluated in accordance with 334-5.1.9.5.

If any of the Verification and/or Resolution samples that are in the custody of the Department are lost, damaged, destroyed or are otherwise

unavailable for testing, the corresponding Quality Control test result will be considered verified, and payment will be based upon the Contractor's data.

334-5.1.4.2 Plant Sampling and Testing Requirements: Obtain one random sample of mix per sublot in accordance with 334-5.1.1.1 as directed by the Engineer. Test the Quality Control split sample for gradation, asphalt binder content and volumetrics in accordance with 334-5.1.1.1. Complete all Quality Control testing within one working day from the time the samples were obtained.

334-5.1.4.3 Roadway Sampling and Testing Requirements: Obtain five 6 inch diameter roadway cores within 24 hours of placement at random locations as directed by the Engineer within each sublot. Test these Quality Control samples for density (G_{mb}) in accordance with 334-5.1.1.1. In situations where it is impractical to cut five cores per sublot, obtain a minimum of three cores per sublot at random locations as identified by the Engineer. Do not obtain cores any closer than 12 inches from an unsupported edge. Maintain traffic during the coring operation; core the roadway, patch the core holes (within three days of coring); and trim the cores to the proper thickness prior to density testing.

Density for the sublot shall be based on the average value for the cores cut from the sublot with the target density being the maximum specific gravity (G_{mm}) of the sublot. Once the average density of a sublot has been determined, do not retest the samples unless approved by the Engineer. Ensure proper handling and storage of all cores until the LOT in question has been accepted.

334-5.1.4.4 Individual Test Tolerances for Quality Control Testing: Terminate the LOT if any of the following Quality Control failures occur:

1) An individual test result of a sublot for air voids does not meet the requirements of Table 334-5,

2) The average sublot density for coarse mixes does not meet the requirements of Table 334-5,

3) Two consecutive test results for gradation (P_{-200} only) do not meet the requirements of Table 334-5,

4) Two consecutive test results for asphalt binder content do not meet the requirements of Table 334-5,

5) The average sublot density for two consecutive sublots for fine mixes does not meet the requirements of Table 334-5,

6) Two core densities for coarse mixes within a sublot are less than 91.00 percent of G_{mm}.

When a LOT is terminated due to a QC failure, stop production of the mixture until the problem is resolved to the satisfaction of the Quality Control Manager(s) and/or Asphalt Plant Level II technician(s) responsible for the decision to resume production after a quality control failure, as identified in 105-8.6.4. In the event that it can be demonstrated that the problem can immediately be or already has been resolved, it will not be necessary to stop production. When a LOT is terminated, make all necessary changes to correct the problem. Do not resume production until appropriate corrections have been

made. Inform the Engineer of the problem and corrections made to correct the problem. After resuming production, sample and test the material to verify that the changes have corrected the problem. Summarize this information and provide it to the Engineer prior to the end of the work shift when production resumes.

In the event that a Quality Control failure is not addressed as defined above, the Engineer's approval will be required prior to resuming production after any future Quality Control failures.

Address any material represented by a failing test result in accordance with 334-5.1.9.5. Any LOT terminated under this Subarticle will be limited to a maximum Pay Factor of 1.00 (as defined in 334-8.2) for each quality characteristic.

Table 334-5
Master Production Range

Characteristic	Tolerance (1)
Asphalt Binder Content (percent)	Target ±0.55
Passing No. 200 Sieve (percent)	Target ±1.50
Air Voids (percent) Coarse Graded	2.00 - 6.00
Air Voids (percent) Fine Graded	2.30 – 6.00
Density, percent G_{mm} (2)	
Coarse Graded (minimum)	93.00
Fine Graded (minimum)	90.00

(1) Tolerances for sample size of n = 1 from the verified mix design
(2) Based on an average of 5 randomly located cores

334-5.1.5 Verification Testing: In order to determine the validity of the Contractor's Quality Control test results prior to their use in the Acceptance decision, the Engineer will run verification tests.

334-5.1.5.1 Plant Testing: At the completion of each LOT, the Engineer will test a minimum of one Verification split sample randomly selected from the LOT. Results of the testing and analysis for the LOT will be made available to the Contractor within one working day from the time the LOT is completed. Verification samples shall be reheated at the target roadway compaction temperature for 1 1/2 hours ± 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1.1.

The Verification test results will be compared with the Quality Control test results based on the between-laboratory precision values shown in Table 334-6.

Table 334-6
Between-Laboratory Precision Values

Property	Maximum Difference
G_{mm}	0.016
G_{mb}	0.022
P_b	0.44 percent
P_{-200}	FM 1-T 030 (Figure 2)

Table 334-6 Between-Laboratory Precision Values	
Property	Maximum Difference
P_{-8}	FM 1-T 030 (Figure 2)

If all of the specified mix characteristics compare favorably, then the LOT will be accepted, with payment based on the Contractor's Quality Control test data for the LOT.

If any of the results do not compare favorably, then the Resolution samples from the LOT will be sent to the Resolution laboratory for testing, as described in 334-5.1.6.

334-5.1.5.2 Roadway Testing: At the completion of each LOT, the Engineer will determine the density (G_{mb}) of each core (previously tested by Quality Control) as described in 334-5.1.1.1 from the same sublot as the Plant samples. For situations where roadway density is not required for the random sublot chosen, then another sublot shall be randomly chosen for roadway density cores only. Results of the testing and analysis for the LOT will be made available to the Contractor within one working day from the time the LOT is completed.

The individual Verification test results will be compared with individual Quality Control test results by the Engineer based on the between-laboratory precision values given in Table 334-6 for G_{mb}.

If each of the core test results compare favorably, then the LOT will be accepted with respect to density, with payment based on the Contractor's Quality Control test data for the LOT.

If any of the results do not compare favorably, then the core samples from the LOT will be sent to the Resolution laboratory for testing as specified in 334-5.1.6.

334-5.1.6 Resolution System:

334-5.1.6.1 Plant Samples: In the event of an unfavorable comparison between the Contractor's Quality Control test results and the Engineer's Verification test results on any of the properties identified in Table 334-6, the Resolution laboratory will test all of the split samples from the LOT for only the property (or properties) in question. Resolution samples shall be reheated at the target roadway compaction temperature for 1 1/2 hours ± 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1.1.

334-5.1.6.2 Roadway Samples: In the event of an unfavorable comparison between the Contractor's Quality Control test data and the Engineer's Verification test data on the density results, the Resolution laboratory will test all of the cores from the LOT. Testing will be as described in 334-5.1.1.1. Any damaged roadway cores will not be included in the evaluation; replace damaged cores with additional cores at the direction of the Engineer.

334-5.1.6.3 Resolution Determination: If the Resolution laboratory results compare favorably (for the property or properties in question) with all of the Quality Control results, then acceptance and payment for the LOT will be based on the Quality Control results, and the Department will bear the costs

associated with Resolution testing. No additional compensation, either monetary or time, will be made for the impacts of any such testing.

If the Resolution laboratory results do not compare favorably (for the property or properties in question) with all of the Quality Control results, then acceptance and payment for the LOT will be based on the Resolution test data for the LOT, and the costs of the Resolution testing will be deducted from monthly estimates. No additional time will be granted for the impacts of any such testing. In addition, in the event that the application of the Resolution test data results in a failure to meet the requirements of Table 334-5, address any material represented by the failing test result in accordance with 334-5.1.9.5.

In the event of an unfavorable comparison between the Resolution test results and Quality Control test results, make the necessary adjustments to assure that future comparisons are favorable.

334-5.1.7 Independent Verification Testing:

334-5.1.7.1 Plant: The Contractor shall provide sample boxes and take samples as directed by the Engineer for Independent Verification testing. Obtain enough material for three complete sets of tests (two samples for Independent Verification testing by the Engineer and one sample for testing by the Contractor). If agreed upon by both the Engineer and the Contractor, only one sample for Independent Verification testing by the Engineer may be obtained. Independent Verification samples will be reheated at the target roadway compaction temperature for 1 1/2 hours ± 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1.1. The Contractor's split sample, if tested immediately after sampling, shall be reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1.1. If the Contractor's sample is not tested immediately after sampling, then the sample shall be reheated at the target roadway compaction temperature for 1 1/2 hours ± 5 minutes, reduced to the appropriate testing size, and conditioned and tested as described in 334-5.1.1.1. The Contractor's test results shall be provided to the Engineer within one working day from the time the sample was obtained.

If any of the Independent Verification test results do not meet the requirements of Table 334-5, then a comparison of the Independent Verification test results and the Contractor's test results, if available, will be made. If a comparison of the Independent Verification test results and the Contractor's test results meets the precision values of Table 334-6 for the material properties in question, or if the Contractor's test results are not available, then the Independent Verification test results are considered verified and the Contractor shall cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Address any material represented by the failing test results in accordance with 334-5.1.9.5.

If a comparison of the Independent Verification test results and the Contractor's test results does not meet the precision values of Table 334-6 for the material properties in question, then the second Independent Verification sample shall be tested by the Engineer for the material properties in question. If a

comparison between the first and second Independent Verification test results does not meet the precision values of Table 334-6 for the material properties in question, then the first Independent Verification test results are considered unverified for the material properties in question and no action shall be taken.

If a comparison between the first and second Independent Verification test results meets the precision values of Table 334-6 for the material properties in question, then the first Independent Verification sample is considered verified and the Contractor shall cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Address any material represented by the failing test results in accordance with 334-5.1.9.5.

The Engineer has the option to use the Independent Verification sample for comparison testing as specified in 334-6.

334-5.1.7.2 Roadway: Obtain five roadway cores as directed by the Engineer for Independent Verification testing. These independent cores will be obtained from the same LOTs and sublots as the Independent Verification Plant samples, or as directed by the Engineer. The density of these cores will be obtained as described in 334-5.1.1.1. If the average of the results for the sublot does not meet the requirements of Table 334-5 for density, cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Address any material represented by the failing test results in accordance with 334-5.1.9.5.

334-5.1.8 Surface Tolerance: The asphalt mixture will be accepted on the roadway with respect to surface tolerance in accordance with the applicable requirements of 330-12.

334-5.1.9 Minimum Acceptable Quality Levels:

334-5.1.9.1 Pay Factors Below 0.90: In the event that an individual pay factor for any quality characteristic of a LOT falls below 0.90, take steps to correct the situation and report the actions to the Engineer. In the event that the pay factor for the same quality characteristic for two consecutive LOTs is below 0.90, cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Actions taken must be approved by the Engineer before production resumes.

334-5.1.9.2 Composite Pay Factors Less Than 0.90 and Greater Than or Equal to 0.80: If the composite pay factor for the LOT is less than 0.90 and greater than or equal to 0.80, cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer), unless it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. Actions taken must be approved by the Engineer before production resumes.

334-5.1.9.3 Composite Pay Factors Less Than 0.80 and Greater Than or Equal to 0.75: If the composite pay factor for the LOT is less than 0.80

and greater than or equal to 0.75, address the defective material in accordance with 334-5.1.9.5.

334-5.1.9.4 Composite Pay Factors Less Than 0.75: If the composite pay factor for the LOT is less than 0.75, remove and replace the defective LOT at no cost to the Department, or as approved by the Engineer.

334-5.1.9.5 Defective Material: Assume responsibility for removing and replacing all defective material placed on the project, at no cost to the Department.

As an exception to the above and upon approval of the Engineer, obtain an engineering analysis by an independent laboratory (as approved by the Engineer) to determine the disposition of the material. The engineering analysis must be signed and sealed by a Professional Engineer licensed in the State of Florida.

The Engineer may determine that an engineering analysis is not necessary or may perform an engineering analysis to determine the disposition of the material.

Any material that remains in place will be accepted with a composite pay factor as determined by 334-8, or as determined by the Engineer.

If the defective material is due to a gradation, asphalt binder content or density failure, upon approval of the Engineer the Contractor may perform delineation tests on roadway cores in lieu of an engineering analysis to determine the limits of the defective material that requires removal and replacement. Prior to any delineation testing, all sampling locations shall be approved by the Engineer. All delineation sampling and testing shall be monitored and verified by the Engineer. The minimum limit of removal of defective material is fifty-feet either side of the failed sample. For materials that are defective due to air voids, an engineering analysis is required.

334-5.2 Option 2 Mixture Acceptance:

334-5.2.1 General: The mixture will be accepted with respect to gradation (P_{-8} and P_{-200}), asphalt content (P_b) and density of roadway cores. Acceptance of the mixture will be based on the Engineer's test results. Acceptance will be on a LOT-by-LOT basis (for each mix design) based on tests of random samples obtained within each sublot taken at a frequency of one set of samples per sublot. A roadway LOT and a plant production LOT shall be the same. A LOT shall consist of a maximum of four sublots, where a sublot is defined as one day's production. A day's production is defined as a period of time no longer than 24 hours where a minimum of 100 tons of hot mix asphalt for the project (including Type B, Type SP and Type FC) is produced. When less than 100 tons of hot mix asphalt for the project (including Type B, Type SP and Type FC) is produced in a day, no acceptance testing will be required. A LOT shall not extend past seven calendar days from the start of the LOT. A LOT shall be complete after four sublots have been produced or seven calendar days have transpired (whichever comes first).

If a Traffic Level C mixture is substituted for a Traffic Level B mixture per 334-1.2 and Option 2 was selected, the mixture will be accepted under Option 2.

334-5.2.2 Gradation and Asphalt Content Testing: The Engineer (or Contractor, if directed by the Engineer) will randomly obtain a minimum of one sample per sublot. The samples shall be obtained in accordance with FM 1-T 168. At the completion of the LOT or seven calendar days (whichever comes first), the Engineer will randomly test one sample for gradation per FM 1-T 030, asphalt content per FM 5-563 and maximum specific gravity per FM 1-T 209.

334-5.2.3 Roadway Density Testing: Obtain five 6 inch diameter roadway cores within 24 hours of placement at random locations as directed by the Engineer within each sublot. In situations where it is impractical to cut five cores per sublot, obtain a minimum of three cores per sublot at random locations as identified by the Engineer. Do not obtain cores any closer than 12 inches from an unsupported edge. Maintain traffic during the coring operation, core the roadway and patch the core holes (within three days of coring).The Engineer will determine density of the cores from the same sublot as the sample for gradation and asphalt content tested in 334-5.2.2.

334-5.2.4 Acceptance Criteria: Acceptance will be on a pass/fail basis. Engineer's test results that meet the criteria shown in Table 334-7, Criteria A, will be accepted at full pay.

Table 334-7
Acceptance Criteria for Traffic Level A and B Mixtures

Characteristic	Tolerance (1)	
	Criteria A	Criteria B
Asphalt Binder Content (percent)	Target ± 0.55	Target ± 0.75
Passing No. 8 Sieve (percent)	Target ± 5.50	Target ± 10.00
Passing No. 200 Sieve (percent)	Target ± 1.50	Target ± 3.50
Density, minimum percent G_{mm} (2) (3)	92.00	90.00

Notes:
(1) Tolerances for sample size of n = 1 from the verified mix design.
(2) Based on the average value of the roadway cores and Gmm for the sample.
(3) If the Engineer (or Contract Documents) limits compaction to the static mode only, the tolerance for Criteria A shall be 91.00 and the tolerance for Criteria B shall be 90.00.

334-5.2.5 Failing Test Results: Should any of the test result(s) for the sample not meet the criteria given in Table 334-7, Criteria A, then the material for that sublot is considered defective. Cease production of the asphalt mixture until the problem is adequately resolved (to the satisfaction of the Engineer). The work can proceed if it can be demonstrated to the satisfaction of the Engineer that the problem can immediately be (or already has been) resolved. The Engineer will then test the remaining samples for all of the characteristics in Table 334-7 to determine the extent of the defective material. The additional samples to be tested are those from the remaining sublots of the LOT. The Contractor has the following options with respect to defective material:

1. Remove and replace the defective material at no cost to the Department.

2. Leave the defective material in place at 75% pay, if approved by the Engineer.

3. Perform delineation testing using a testing plan and a qualified laboratory approved by the Engineer to determine the limits of the defective material. The Engineer reserves the right to witness delineation testing conducted by the approved laboratory. Delineated material not meeting the criteria given in Table 334-7, Criteria A, shall be removed and replaced at no cost to the Department or left in place at 75% pay, if approved by the Engineer.

Should the test result(s) for the sample not meet the criteria given in Table 334-7, Criteria B, the Contractor has the following options with respect to the defective material:

1. Remove and replace the defective material at no cost to the Department.

2. Perform delineation testing using a testing plan and a qualified laboratory approved by the Engineer to determine the limits of the defective material. The Engineer reserves the right to witness delineation testing conducted by the approved laboratory. Delineated material not meeting the criteria given in Table 334-7, Criteria A, but meeting the criteria given in Table 334-7, Criteria B shall be removed and replaced at no cost to the Department or left in place at 75% pay, if approved by the Engineer. Delineated material not meeting the criteria given in Table 334-7, Criteria B shall be removed and replaced at no cost to the Department.

334-5.2.6 Acceptance Testing Exceptions: When the total quantity of hot mix asphalt for the project, as indicated on the plans for Type SP and Type FC mixtures only, is less than 2000 tons, the Engineer will accept the mix on the basis of visual inspection, the Engineer may run acceptance tests to determine the acceptability of the material.

Density testing for acceptance will not be performed on widening strips or shoulders with a width of 5 feet or less, variable thickness overbuild courses, leveling courses, first lift of asphalt base course placed on subgrade, asphalt layers placed directly on stabilization layers, miscellaneous asphalt pavement, or any course with a specified thickness less than 1 inch or a specified spread rate that converts to less than 1 inch as described in 334-1.4. Density testing for acceptance will not be performed on asphalt courses placed on bridge decks or approach slabs; compact these courses in static mode only per the requirements of 330-10.1.9. In addition, density testing for acceptance will not be performed on the following areas when they are less than 1,000 feet in length: crossovers, intersections, turning lanes, acceleration lanes, deceleration lanes, shoulders, parallel parking lanes or ramps.

Where density testing for acceptance is not required, compact these courses (with the exception of open-graded friction courses) in accordance with the rolling procedure (equipment and pattern) approved by the Engineer or with Standard Rolling Procedure as specified in 330-10.1.2. In the event that the rolling procedure deviates from the procedure approved by the Engineer, or the Standard Rolling Procedure, placement of the mix shall be stopped.

334-5.2.7 Surface Tolerance: The asphalt mixture will be accepted on the roadway with respect to surface tolerance in accordance with the applicable requirements of 330-12.

334-6 Comparison Testing.

For materials accepted under Option 1, at the start of the project (unless waived by the Engineer) and at other times as determined necessary by the Engineer, provide split samples for comparison testing with the Engineer. The purpose of these tests is to verify that the testing equipment is functioning properly and that the testing procedures are being performed correctly. In the event that the Engineer determines that there is a problem with the Contractor's testing equipment and/or testing procedures, immediately correct the problem to the Engineer's satisfaction. In the event that the problem is not immediately corrected, cease production of the asphalt mixture until the problem is adequately resolved to the satisfaction of the Engineer.

If so agreed to by both the Contractor and the Engineer, the split sample used for comparison testing may also be used for the Quality Control sample. The split sample used for comparison testing will also meet the requirements for Independent Verification Testing described in 334-5.1.7.

For materials accepted under Option 2, the requirements of this Article do not apply.

334-7 Method of Measurement.

For the work specified under this Section (including the pertinent provisions of Sections 320 and 330), the quantity to be paid for will be the weight of the mixture, in tons. The pay quantity will be based on the project average spread rate, excluding overbuild, limited to a maximum of 105% of the spread rate determined in accordance with 334-1.4 or as set by the Engineer. The project average spread rate is calculated by totaling the arithmetic mean of the average daily spread rate values for each layer.

The bid price for the asphalt mix will include the cost of the liquid asphalt or the asphalt recycling agent and the tack coat application as directed in 300-8. There will be no separate payment or unit price adjustment for the asphalt binder material in the asphalt mix. For the calculation of unit price adjustments of bituminous material, the average asphalt content will be based on the percentage specified in 9-2.1.2. The weight will be determined as provided in 320-2 (including the provisions for the automatic recordation system).

Prepare a Certification of Quantities, using the Department's current approved form, for the certified Superpave asphalt concrete pay item. Submit this certification to the Engineer no later than Twelve O'clock noon Monday after the estimate cut-off or as directed by the Engineer, based on the quantity of asphalt produced and accepted on the roadway per Contract. The certification must include the Contract Number, FPID Number, Certification Number, Certification Date, period represented by Certification and the tons produced for each asphalt pay item.

334-8 Basis of Payment.

334-8.1 General: Price and payment will be full compensation for all the work specified under this Section (including the applicable requirements of Sections 320 and 330). There will be no pay adjustments for materials accepted in accordance with 334-5.2.

For materials accepted in accordance with 334-5.1, based upon the quality of the material, a pay adjustment will be applied to the bid price of the material as determined on a LOT by LOT basis. The pay adjustment will be assessed by calculating a Pay Factor for the following individual quality characteristics: pavement density, air voids, asphalt binder content, and the percentage passing the No. 200 and No. 8 sieves. The pay adjustment will be computed by multiplying a Composite Pay Factor for the LOT by the bid price per ton. Perform all calculations with the Department's Asphalt Plant - Pay Factor Worksheets (Form No. 675-030-22).

334-8.2 Pay Factors:

334-8.2.1 Two or Less Sublot Test Results: In the event that two or less sublot test results are available for a LOT, Pay Factors will be determined based on Table 334-8, using the average of the accumulated deviations from the target value. (Deviations are absolute values with no plus or minus signs.) Use the 1-Test column when there is only one sublot test result and use the 2-Tests column when there are two sublots.

Table 334-8
Small Quantity Pay Table

Pay Factor	1 Sublot Test Deviation	2 Sublot Test Average Deviation
Asphalt Binder Content		
1.05	0.00-0.23	0.00-0.16
1.00	0.24-0.45	0.17-0.32
0.90	0.46-0.55	0.33-0.39
0.80	>0.55	>0.39
No. 8 Sieve		
1.05	0.00-2.25	0.00-1.59
1.00	2.26-4.50	1.60-3.18
0.90	4.51-5.50	3.19-3.89
0.80	>5.50	>3.89
No. 200 Sieve		
1.05	0.00-0.55	0.00-0.39
1.00	0.56-1.10	0.40-0.78
0.90	1.11-1.50	0.79-1.06
0.80	>1.50	>1.06
Air Voids (Coarse Mixes)		
1.05	0.00-0.55	0.00-0.39
1.00	0.56-1.10	0.40-0.78
0.90	1.11-2.00	0.79-1.41
0.80	2.01-2.25	1.42-1.59
0.70	2.26-2.50	1.60-1.77

Table 334-8 Small Quantity Pay Table		
Pay Factor	1 Sublot Test Deviation	2 Sublot Test Average Deviation
0.55	>2.50	>1.77
Air Voids (Fine Mixes)		
1.05	0.00-0.50	0.00-0.35
1.00	0.51-1.00	0.36-0.71
0.90	1.01-1.70	0.72-1.20
0.80	1.71-2.00	1.21-1.41
0.70	2.01-2.50	1.42-1.77
0.55	>2.50	>1.77
Density (Coarse Mixes) Note (1)		
1.05	0.00-0.50	0.00-0.35
1.00	0.51-1.00	0.36-0.71
0.95	1.01-1.50	0.72-1.06
0.90	>1.50	>1.06
Density (Fine Graded Mixtures) Note (1)		
1.05	0.00-0.50	0.00-0.35
1.00	0.51-1.00	0.36-0.71
0.95	1.01-2.00	0.72-1.41
0.90	2.01-3.00	1.42-2.12
0.80	>3.00	>2.12
Notes: (1) Each density test result is the average of five cores. The target density for coarse mixes is 94.50 percent of Gmm. The target density for fine mixes is 93.00 percent of Gmm (92.00 percent when compaction is limited to the static mode or for layers specified to be one inch thick).		

334-8.2.2 Three or More Sublot Test Results: When three or more sublot test results are available for a LOT, the variability-unknown, standard deviation method will be used to determine the estimated percentage of the LOT that is within specification limits. The number of significant figures used in the calculations will be in accordance with requirements of AASHTO R 11-82 (2002), Absolute Method.

334-8.2.2.1 Percent Within Limits: The percent within limits (PWL) and Pay Factors for the LOT will be calculated as described below. Variables used in the calculations are as follows:

x = individual test value (sublot)

n = number of tests (sublots)

s = sample standard deviation

$\Sigma(x^2)$ = summation of squares of individual test values

$(\Sigma x)^2$ = summation of individual test values squared

Q_U = upper quality index

USL = upper specification limit (target value plus upper specification limit from Table 334-9)

Q_L = lower quality index

LSL = lower specification limit (target value minus lower specification limit from Table 334-9)

P_U = estimated percentage below the USL
P_L = estimated percentage above the LSL

(1) Calculate the arithmetic mean $\left(\overline{X}\right)$ of the test values:

$$\overline{X} = \frac{\sum x}{n}$$

(2) Calculate the sample standard deviation (s):

$$s = \sqrt{\frac{n\sum\left(x^2\right) - \left(\sum x\right)^2}{n(n-1)}}$$

(3) Calculate the upper quality index (Q_U):

$$Q_U = \frac{\text{USL} - \overline{\text{X}}}{\text{s}}$$

(4) Calculate the lower quality index (Q_L):

$$Q_L = \frac{\overline{X} - LSL}{s}$$

(5) From Table 334-10, determine the percentage of work below the USL (P_U).

(6) From Table 334-10, determine percentage of work above the LSL (P_L) Note: If USL or LSL is not specified; percentages within (USL or LSL) will be 100.

(7) If Q_U or Q_L is a negative number, then calculate the percent within limits for Q_U or Q_L as follows: enter Table 334-10 with the positive value of Q_U or Q_L and obtain the corresponding percent within limits for the proper sample size. Subtract this number from 100.00. The resulting number is the value to be used in the next step (Step 8) for the calculation of quality level.

(8) Calculate the percent within limits (PWL) = (P_U + P_L) - 100

(9) Calculate the Pay Factor (PF) for each quality characteristic using the equation given in 334-8.2.2.2.

Table 334-9
Specification Limits

Quality Characteristic	Specification Limits
Passing No. 8 sieve (percent)	Target ± 3.1
Passing No. 200 sieve (percent)	Target ± 1.0

Table 334-9 Specification Limits	
Quality Characteristic	Specification Limits
Asphalt Content (percent)	Target ± 0.40
Air Voids - Coarse Mixes (percent)	4.00 ± 1.40
Air Voids - Fine Mixes (percent)	4.00 ± 1.20
Density - Coarse Mixes (percent of G_{mm}):	94.50 ± 1.30
Density - Fine Mixes (percent of G_{mm}):	93.00 + 2.00, - 1.20 (1)
Note (1): If the Engineer (or Contract Documents) limits compaction to the static mode only or for all one-inch thick lifts of SP-9.5 and FC-9.5 mixtures, compaction shall be in the static mode and the specification limits are as follows: 92.00 + 3.00, -1.20 percent of Gmm. No additional compensation, cost or time, shall be made.	

Table 334-10 Percent Within Limits				
Quality Index	Percent within Limits for Selected Sample Size			
	n = 3	n = 4	n = 5	n = 6
0.00	50.00	50.00	50.00	50.00
0.05	51.38	51.67	51.78	51.84
0.10	52.76	53.33	53.56	53.67
0.15	54.15	55.00	55.33	55.50
0.20	55.54	56.67	57.10	57.32
0.25	56.95	58.33	58.87	59.14
0.30	58.37	60.00	60.63	60.94
0.35	59.80	61.67	62.38	62.73
0.40	61.26	63.33	64.12	64.51
0.45	62.74	65.00	65.84	66.27
0.50	64.25	66.67	67.56	68.00
0.55	65.80	68.33	69.26	69.72
0.60	67.39	70.00	70.95	71.41
0.65	69.03	71.67	72.61	73.08
0.70	70.73	73.33	74.26	74.71
0.75	72.50	75.00	75.89	76.32
0.80	74.36	76.67	77.49	77.89
0.85	76.33	78.33	79.07	79.43
0.90	78.45	80.00	80.62	80.93
0.95	80.75	81.67	82.14	82.39
1.00	83.33	83.33	83.64	83.80
1.05	86.34	85.00	85.09	85.18
1.10	90.16	86.67	86.52	86.50
1.15	97.13	88.33	87.90	87.78

Table 334-10 Percent Within Limits				
Quality Index	Percent within Limits for Selected Sample Size			
	n = 3	n = 4	n = 5	n = 6
1.20	100.00	90.00	89.24	89.01
1.25	100.00	91.67	90.54	90.19
1.30	100.00	93.33	91.79	91.31
1.35	100.00	95.00	92.98	92.37
1.40	100.00	96.67	94.12	93.37
1.45	100.00	98.33	95.19	94.32
1.50	100.00	100.00	96.20	95.19
1.55	100.00	100.00	97.13	96.00
1.60	100.00	100.00	97.97	96.75
1.65	100.00	100.00	98.72	97.42
1.70	100.00	100.00	99.34	98.02
1.75	100.00	100.00	99.81	98.55
1.80	100.00	100.00	100.00	98.99
1.85	100.00	100.00	100.00	99.36
1.90	100.00	100.00	100.00	99.65
1.95	100.00	100.00	100.00	99.85
2.00	100.00	100.00	100.00	99.97
2.05	100.00	100.00	100.00	100.00
2.10	100.00	100.00	100.00	100.00
2.15	100.00	100.00	100.00	100.00
2.20	100.00	100.00	100.00	100.00
2.25	100.00	100.00	100.00	100.00
2.30	100.00	100.00	100.00	100.00
2.35	100.00	100.00	100.00	100.00
2.40	100.00	100.00	100.00	100.00
2.45	100.00	100.00	100.00	100.00
2.50	100.00	100.00	100.00	100.00
2.55	100.00	100.00	100.00	100.00
2.60	100.00	100.00	100.00	100.00
2.65	100.00	100.00	100.00	100.00

334-8.2.2.2 Pay Factors (PF): Pay Factors will be calculated by using the following equation:

Pay Factor = (55 + 0.5 x PWL) / 100

The PWL is determined from Step (8) of 334-8.2.2.1.

334-8.3 Composite Pay Factor (CPF): A Composite Pay Factor for the LOT will be calculated based on the individual Pay Factors (PF) with the following weighting applied: 35 percent Density (D), 25 percent Air Voids (V_a), 25 percent asphalt binder content (P_b), 10 percent Passing No. 200 (P_{-200}) and 5 percent Passing No. 8 (P_{-8}). Calculate the CPF by using the following formula:

$$CPF = [(0.350 \times PF\ D) + (0.250 \times PF\ V_a) + (0.250 \times PF\ P_b) + (0.100 \times PF\ P_{-200}) + (0.050 \times PF\ P_{-8})]$$

Where the Pay Factor (PF) for each quality characteristic is determined in either 334-8.2.1 or 334-8.2.2, depending on the number of sublot tests. Note that the number after each multiplication will be rounded to the nearest 0.01.

The pay adjustment shall be computed by multiplying the Composite Pay Factor for the LOT by the bid price per ton.

334-8.4 Payment: Payment will be made under:

Item No. 334- 1- Superpave Asphaltic Concrete - per ton.

SECTION 336
ASPHALT RUBBER BINDER

336-1 Description.

Produce asphalt rubber binder for use in Asphalt Concrete Friction Courses and Asphalt Rubber Membrane Interlayers.

336-2 Materials.

336-2.1 Superpave PG Asphalt Binder: For the particular grade of asphalt as specified in Table 336-1, meet the requirements of Section 916.

336-2.2 Ground Tire Rubber: For the type of ground tire rubber, meet the requirements of Section 919.

336-3 Asphalt Rubber Binder.

Thoroughly mix and react the asphalt binder and ground tire rubber in accordance with the requirements of Table 336-1. Use a rubber type that is in accordance with the verified mix design. Accomplish blending of the asphalt binder and ground tire rubber at the supplier's terminal or at the project site.

336-4 Equipment.

Use blending equipment that is designed for asphalt rubber binder and capable of producing a homogeneous mixture of ground tire rubber and asphalt binder meeting the requirements of Table 336-1. Use a batch type or continuous type blending unit that provides for sampling of the blended and reacted asphalt rubber binder material during normal production and provides for accurate proportioning of the asphalt binder and ground tire rubber either by weight or volume.

In order to meet specification requirements, keep the asphalt rubber uniformly blended while in storage. Equip storage tanks with a sampling device.

336-5 Testing and Certification Requirements.

336-5.1 Blending at Project Site: Monitor the ground tire rubber content in the asphalt rubber binder on a daily basis based on the following:

(1) the weight of the ground tire rubber used and the gallons of asphalt rubber binder produced, or (2) the weight of the ground tire rubber used and the number of gallons of asphalt binder used. Use the weight per gallon for the various types of asphalt rubber binder shown in Table 336-1 for the calculations in (1) above.

336-5.2 Blending at Supplier's Terminal: Where blending the asphalt rubber binder at the supplier's terminal, the supplier shall furnish certification on the bill of lading for each load delivered to the project site that includes: the quantity, the asphalt rubber binder type, the customer name, the delivery location, and a statement that the asphalt rubber binder has been produced in accordance with and meets the requirements of 336. In addition, include, with the certification, copies of the certifications for the asphalt binder and ground tire rubber, as specified in 916-1.3.6 and 919-6, respectively.

336-5.3 Asphalt Rubber Binder Blending Quality Control Records: Maintain adequate Quality Control records for the Engineers review of all blending activities. The Quality Control records shall include at a minimum the following information (for each batch of asphalt rubber binder produced): financial project number, shipping date, customer name and delivery location, asphalt rubber binder type, asphalt binder supplier (including QPL number and LOT), asphalt binder quantity in gallons, ground tire rubber supplier (including QPL number and LOT), ground tire rubber quantity in pounds, and viscosity results.

336-5.4 Testing of Asphalt Rubber Binder:

336-5.4.1 Quality Control Requirements: Test the asphalt rubber binder for the viscosity requirement of Table 336-1 at the following frequencies and situations:

1. One per batch (for batch blending) or two per day (for continuous blending) during blending at the project site or suppliers terminal.

2. Each load delivered to the project site when blended at the supplier's terminal.

3. Beginning of each day from the storage tank when storing the asphalt rubber binder at the project site, obtain the sample for testing from the discharge piping exiting the storage tank.

Obtain the viscosity testing equipment specified in FM 5-548 and make it available to the Engineer for verification purposes.

If the asphalt rubber binder does not meet the minimum viscosity requirement, make the appropriate adjustments in order to (1) correct the viscosity of the blended material, and (2) correct the blending operation. These corrective actions within the requirements of Table 336-1 may include increasing the ground tire rubber content, lowering the blending temperature, changing the supply of ground tire rubber or increasing the reaction time. In the event that the corrective actions taken fail to correct the problem, or the material consistently fails to meet the minimum viscosity requirement, stop all asphalt rubber production operations and solve the problem. Do not resume production

operations until the Engineer grants approval. The Engineer may require that any mix placed with low viscosity asphalt rubber binder be evaluated in accordance with 334-5.1.9.5. In the event that the viscosity of the asphalt rubber binder increases to the extent that plant production or paving operations of the mixture are adversely affected (i.e. density or texture problems occur), stop plant operations and resolve the problem to the Engineer's satisfaction.

336-5.4.2 Verification Requirements: The Engineer will test the asphalt rubber in accordance with FM 5-548 randomly on an as needed basis to ensure conformance with the minimum viscosity requirement as specified in Table 336-1.

Table 336-1

Asphalt Rubber Binder

Binder Type	ARB 5	ARB 12	ARB 20
Rubber Type	TYPE A (or B)*	TYPE B (or A)**	TYPE C (or B or A)**
Minimum Ground Tire Rubber (by weight of asphalt binder)	5%	12%	20%
Binder Grade	PG 67-22	PG 67-22	PG 64-22
Minimum Temperature	300°F	300°F	335°F
Maximum Temperature	335°F	350°F	375°F
Minimum Reaction Time	10 minutes	15 minutes (Type B)	30 minutes (Type C)
Unit Weight @ 60ºF***	8.6 lbs/gal	8.7 lbs/gal	8.8 lbs/gal
Minimum Viscosity ****	4.0 Poise @ 300°F	10.0 Poise @ 300°F	15.0 Poise @ 350°F

* Use of Type B rubber may require an increase in the mix temperature in order to offset higher viscosity values.

** Use of finer rubber could result in the reduction of the minimum reaction time.

*** Conversions to standard 60ºF are as specified in 300-9.3.

**** FM 5-548, Viscosity of Asphalt Rubber Binder by use of the Rotational Viscometer.

NOTE: The Contractor may adjust the minimum reaction time if approved by the Engineer depending upon the temperature, size of the ground tire rubber and viscosity measurement determined from the asphalt rubber binder material prior to or during production. Apply the asphalt rubber binder for use in membrane interlayers within a period of six hours, unless some form of corrective action such as cooling and reheating is approved by the Engineer.

336-6 Use of Excess Asphalt Rubber.

The Contractor may use excess asphalt rubber in other asphalt concrete mixes requiring the use of a PG 67-22 binder by blending with straight PG 67-22 binder so that the total amount of ground tire rubber in the binder is less than 2.0%. The Contractor may use excess asphalt rubber in asphalt concrete mixtures requiring the use of a recycling agent in a recycled mixture by blending with a recycling agent in such proportions that the total amount of ground tire rubber in the recycling agent is less than 1.0%.

336-7 Basis of Payment.

Payment for Asphalt Rubber Binder will be included in Sections 337 and 341, as appropriate.

SECTION 337
ASPHALT CONCRETE FRICTION COURSES

337-1 Description.

Construct an asphalt concrete friction course pavement with the type of mixture specified in the Contract, or when offered as alternates, as selected. This Section specifies mixes designated as FC-5, FC-9.5, and FC-12.5.

Meet the plant and equipment requirements of Section 320, as modified herein. Meet the general construction requirements of Section 330, as modified herein.

On projects with only Traffic Level A and/or B asphalt mixtures, select Option 1 or Option 2 Mixture Acceptance as specified in 337-6. The selection shall be indicated in the Contractor Quality Control Plan in accordance with Section 105 and shall apply to all mixes, including base, structural and friction course mixes, on the entire project. Traffic Level C, D and E mixtures will be accepted under Option 1 Mixture Acceptance only. On Contracts having both Traffic Level A or B and Traffic Level C, D or E asphalt mixtures, material will be accepted only under Option 1 Material Acceptance.

When Option 2 Mixture Acceptance is selected, the requirements of 330-2 will not apply, with the exception of the roadway requirements as defined in 330-2.2.

337-2 Materials.

337-2.1 General Requirements: Meet the requirements specified in Division III as modified herein. The Engineer will base continuing approval of material sources on field performance.

337-2.2 Asphalt Binder: Meet the requirements of Section 336, and any additional requirements or modifications specified herein for the various mixtures. When called for in the Contract Documents, use a PG 76-22 asphalt binder meeting the requirements of 916-1. For projects with a total quantity of FC-5, FC-9.5, or FC-12.5 less than 500 tons, the Contractor may elect to substitute a PG 76-22 for the ARB-12 or ARB-5, meeting the requirements of 916-1.

337-2.3 Coarse Aggregate: Meet the requirements of Section 901, and any additional requirements or modifications specified herein for the various mixtures.

337-2.4 Fine Aggregate: Meet the requirements of Section 902, and any additional requirements or modifications specified herein for the various mixtures.

337-2.5 Hydrated Lime: Meet the requirements of AASHTO M303 Type 1.

Provide certified test results for each shipment of hydrated lime indicating compliance with the specifications.

337-2.6 Fiber Stabilizing Additive (Required for FC-5 only): Use either a mineral or cellulose fiber stabilizing additive. Meet the following requirements:

337-2.6.1 Mineral Fibers: Use mineral fibers (made from virgin basalt, diabase, or slag) treated with a cationic sizing agent to enhance the disbursement of the fiber, as well as to increase adhesion of the fiber surface to the bitumen. Meet the following requirements for physical properties:

1. Size Analysis
   Average fiber length: 0.25 inch (maximum)
   Average fiber thickness: 0.0002 inch (maximum)
2. Shot Content (ASTM C612)
   Percent passing No. 60 Sieve: 90 - 100
   Percent passing No. 230 Sieve: 65 - 100

Provide certified test results for each batch of fiber material indicating compliance with the above tests.

337-2.6.2 Cellulose Fibers: Use cellulose fibers meeting the following requirements:

1. Fiber length: 0.25 inch (maximum)
2. Sieve Analysis
   a. Alpine Sieve Method
      Percent passing No. 100 sieve: 60-80
   b. Ro-Tap Sieve Method
      Percent passing No. 20 sieve: 80-95
      Percent passing No. 40 sieve: 45-85
      Percent passing No. 100 sieve: 5-40
3. Ash Content: 18% non-volatiles (±5%)
4. pH: 7.5 (±1.0)
5. Oil Absorption: 5.0 (±1.0) (times fiber weight)
6. Moisture Content: 5.0 (maximum)

Provide certified test results for each batch of fiber material indicating compliance with the above tests.

337-3 General Composition of Mixes.

337-3.1 General: Use a bituminous mixture composed of aggregate (coarse, fine, or a mixture thereof), asphalt rubber binder, and in some cases, fibers and/or hydrated lime. Size, uniformly grade and combine the aggregate fractions in such proportions that the resulting mix meets the requirements of this Section.

337-3.2 Specific Component Requirements by Mix:

337-3.2.1 FC-5:

337-3.2.1.1 Aggregates: Use an aggregate blend which consists of either 100% crushed granite, 100% crushed Oolitic limestone or 100% other crushed materials (as approved by the Engineer for friction courses per Rule 14-103.005, Florida Administrative Code).

Crushed limestone from the Oolitic formation may be used if it contains a minimum of 12% silica material as determined by FM 5-510 and the Engineer grants approval of the source prior to its use.

A list of aggregates approved for use in friction course may be available on the Department's website. The URL for obtaining this information, if available, is:
www.dot.state.fl.us/statematerialsoffice/quality/programs/qualitycontrol/materialslistings/sources/frictioncourse.pdf.

337-3.2.1.2 Asphalt Binder: Use an ARB-12 asphalt rubber binder. If called for in the Contract Documents, use a PG 76-22 asphalt binder.

337-3.2.1.3 Hydrated Lime: Add the lime at a dosage rate of 1.0% by weight of the total dry aggregate to mixes containing granite.

337-3.2.1.4 Fiber Stabilizing Additive: Add either mineral fibers at a dosage rate of 0.4% by weight of the total mix, or cellulose fibers at a dosage rate of 0.3% by weight of total mix.

337-3.2.2 FC-9.5 and FC-12.5:

337-3.2.2.1: Aggregates: Use an aggregate blend that consists of crushed granite, crushed Oolitic limestone, other crushed materials (as approved by the Engineer for friction courses per Rule 14-103.005, Florida Administrative Code), or a combination of the above. Crushed limestone from the Oolitic formation may be used if it contains a minimum of 12% silica material as determined by FM 5-510 and the Engineer grants approval of the source prior to its use. As an exception, mixes that contain a minimum of 60% crushed granite may either contain: 1) up to 40% fine aggregate from other sources or 2) a combination of up to 15% RAP and the remaining fine aggregate from other sources.

A list of aggregates approved for use in friction course may be available on the Department's website. The URL for obtaining this information, if available, is:
www.dot.state.fl.us/statematerialsoffice/quality/programs/qualitycontrol/materialslistings/sources/frictioncourse.pdf.

337-3.2.2.2: Asphalt Binder: Use an ARB-5 asphalt rubber binder. If called for in the Contract, use a PG 76-22 asphalt binder.

337-3.3 Grading Requirements:

337-3.3.1 FC-5: Use a mixture having a gradation at design within the ranges shown in Table 337-1.

Table 337-1
FC-5 Gradation Design Range

3/4 inch	1/2 inch	3/8 inch	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
100	85-100	55-75	15-25	5-10	--	--	--	--	2-4

337-3.3.2 FC-9.5: Meet the design gradation requirements for a SP-9.5 Superpave fine mix as defined in 334-3.2.2.

337-3.3.3 FC-12.5: Meet the design gradation requirements for a SP-12.5 Superpave fine mix as defined in 334-3.2.2.

337-4 Mix Design.

337-4.1 FC-5: The Department will design the FC-5 mixtures. Furnish the materials and all appropriate information (source, gradation, etc.) as specified in 334-3.2.7. The Department will have two weeks to design the mix.

The Department will establish the design binder content for FC-5 within the following ranges based on aggregate type:

Aggregate Type	Binder Content
Crushed Granite	5.5 - 7.0
Crushed Limestone (Oolitic)	6.5 - 8.0

337-4.2 FC-9.5 and FC-12.5: Provide a mix design conforming to the requirements of 334-3.2 unless otherwise designated in the plans. Develop the mix design using an ARB-5 or PG 76-22 asphalt binder if called for in the Contract Documents.

337-4.3 Revision of Mix Design: For FC-5, FC-9.5 and FC-12.5, meet the requirements of 334-3.3. For FC-5, all revisions must fall within the gradation limits defined in Table 337-1.

337-5 Contractor's Process Control.

For Option 1 Mixture Acceptance, provide the necessary process control of the friction course mix and construction in accordance with the applicable provisions of 330-2 and 334-4.

The Engineer will monitor the spread rate periodically to ensure uniform thickness. Provide quality control procedures for daily monitoring and control of spread rate variability. If the spread rate varies by more than 5% of the spread rate set by the Engineer in accordance with 337-8, immediately make all corrections necessary to bring the spread rate into the acceptable range.

337-6 Acceptance of the Mixture.

337-6.1 FC-9.5 and FC-12.5: For Option 1 Mixture Acceptance, meet the requirements of 334-5.1.

For Option 2 Mixture Acceptance, meet the requirements of 334-5.2**.**

337-6.2 FC-5:

337-6.2.1 Option 1 Mixture Acceptance: For Option 1 Mixture Acceptance, meet the requirements of 334-5.1 with the following exceptions:

1. The mixture will be accepted with respect to gradation ($P_{-3/8}$, P_{-4}, and P_{-8}), and asphalt binder content (P_b) only.

2. Testing in accordance with AASHTO T312-04 and FM 1-T 209 (and conditioning prior to testing) will not be required as part of 334-5.1.1.1.

3. The standard LOT size of FC-5 will be 2,000 tons, with each LOT subdivided into four equal sublots of 500 tons each.

4. Initial production requirements of 334-5.1.3 do not apply.

5. The Between-Laboratory Precision Values described in Table 334-6 are modified to include ($P_{-3/8}$, P_{-4}, and P_{-8}) with a maximum difference per FM 1-T 030 (Figure 2).

6. Table 334-5 (Master Production Range) is replaced by Table 337-2.

7. The mixture will be accepted on the roadway with respect to surface tolerance in accordance with 334-5.1.8. No density testing will be required for these mixtures.

Table 337-2 FC-5 Master Production Range	
Characteristic	Tolerance (1)
Asphalt Binder Content (%)	Target ± 0.60
Passing 3/8 inch Sieve (%)	Target ± 7.50
Passing No. 4 Sieve (%)	Target ± 6.00
Passing No. 8 Sieve (%)	Target ± 3.50
(1) Tolerances for sample size of n = 1 from the verified mix design	

337-6.2.1.1 Individual Test Tolerances for FC-5 Production: Terminate the LOT if any of the following Quality Control failures occur:

1) An individual test result of a sublot for asphalt binder content does not meet the requirements of Table 337-2,

2) Two consecutive test results for gradation on any of the following sieve sizes ($P_{-3/8}$, P_{-4}, and P_{-8}) do not meet the requirements of Table 337-2,

When a LOT is terminated due to a QC failure, stop production of the mixture until the problem is resolved to the satisfaction of the Quality Control Manager(s) and/or Asphalt Plant Level II technician(s) responsible for the decision to resume production after a quality control failure, as identified in 105-8.6.4. In the event that it can be demonstrated that the problem can immediately be or already has been resolved, it will not be necessary to stop production. When a LOT is terminated, make all necessary changes to correct the problem. Do not resume production until appropriate corrections have been made. Inform the Engineer of the problem and corrections made to correct the problem. After resuming production, sample and test the material to verify that the changes have corrected the problem. Summarize this information and provide it to the Engineer prior to the end of the work shift when production resumes.

In the event that a Quality Control failure is not addressed as defined above, the Engineer's approval will be required prior to resuming production after any future Quality Control failures.

Address any material represented by a failing test result in accordance with 334-5.1.9.5. Any LOT terminated under this Subarticle will be limited to a maximum Pay Factor of 1.00 (as defined in 337-12.3) for each quality characteristic.

337-6.2.2 Option 2 Material Acceptance: For Option 2 Mixture Acceptance, meet the requirements of 334-5.2 with the following exceptions:

1. The mixture will be accepted with respect to gradation ($P_{-3/8}$, P_{-4}, and P_{-8}), and asphalt binder content (P_b) only.

2. Testing in accordance with FM 1-T 209 will not be required as part of 334-5.2.2.

3. The Between-Laboratory Precision Values described in Table 334-6 are modified to include ($P_{-3/8}$, P_{-4}, and P_{-8}) with a maximum difference per FM 1-T 030 (Figure 2).

4. Table 334-7 (Acceptance Criteria for Traffic Level A and B Mixtures) is replaced by Table 337-3.

5. The mixture will be accepted on the roadway with respect to surface tolerance in accordance with the applicable requirements of 334-5.2.7. No density testing will be required for these mixtures.

Table 337-3
Acceptance Criteria for Traffic Level A and B Mixtures

Characteristic	Tolerance (1)	
	Column A	Column B
Asphalt Binder Content (%)	Target ± 0.60	Target ± 0.75
Passing 3/8 inch Sieve (%)	Target ± 7.50	Target ± 10.00
Passing No. 4 Sieve (%)	Target ± 6.00	Target ± 9.00
Passing No. 8 Sieve (%)	Target ± 3.50	Target ± 6.00

(1) Tolerances for sample size of n = 1 from the verified mix design.

337-7 Special Construction Requirements.

337-7.1 Hot Storage of FC-5 Mixtures: When using surge or storage bins in the normal production of FC-5, do not leave the mixture in the surge or storage bin for more than one hour.

337-7.2 Longitudinal Grade Controls for Open-Graded Friction Courses: On FC-5, use either longitudinal grade control (skid, ski or traveling stringline) or a joint matcher.

337-7.3 Temperature Requirements for FC-5:

337-7.3.1 Air Temperature at Laydown: Spread the mixture only when the air temperature (the temperature in the shade away from artificial heat) is at or above 65ºF. As an exception, place the mixture at temperatures lower than 65ºF, only when approved by the Engineer based on the Contractor's demonstrated ability to achieve a satisfactory surface texture and appearance of the finished surface. In no case shall the mixture be placed at temperatures lower than 60ºF.

337-7.3.2 Temperature of the Mix: Heat and combine the asphalt rubber binder and aggregate in a manner to produce a mix having a temperature, when discharged from the plant, meeting the requirements of 330-6.3. Meet all requirements of 330-9.1.2 at the roadway. The target mixing temperature shall be established at 320ºF.

337-7.4 Compaction of FC-5: Provide two, static steel-wheeled rollers, with an effective compactive weight in the range of 135 to 200 PLI, determined as follows:

$$\text{PLI} = \frac{\text{Total Weight of Roller (pounds)}}{\text{Total Width of Drums (inches)}}$$

(Any variation of this equipment requirement must be approved by the Engineer.) Establish an appropriate rolling pattern for the pavement in order to effectively seat the mixture without crushing the aggregate. In the event that the roller begins to crush the aggregate, reduce the number of coverages or the PLI of the rollers. If the rollers continue to crush the aggregate, use a tandem steel-wheel roller weighing not more than 135 lb/in (PLI) of drum width.

337-7.5 Temperature Requirements for FC-9.5 and FC-12.5:

337-7.5.1 Air Temperature at Laydown: Spread the mixture only when the air temperature (the temperature in the shade away from artificial heat) is at or above 45ºF.

337-7.5.2 Temperature of the Mix: Heat and combine the asphalt rubber binder and aggregate in a manner to produce a mix having a temperature, when discharged from the plant, meeting the requirements of 330-6.3. Meet all requirements of 330-9.1.2 at the roadway.

337-7.6 Prevention of Adhesion: To minimize adhesion to the drum during the rolling operations, the Contractor may add a small amount of liquid detergent to the water in the roller.

At intersections and in other areas where the pavement may be subjected to cross-traffic before it has cooled, spray the approaches with water to wet the tires of the approaching vehicles before they cross the pavement.

337-7.7 Transportation Requirements of Friction Course Mixtures: Cover all loads of friction course mixtures with a tarpaulin.

337-8 Thickness of Friction Courses.

337-8.1 FC-12.5 and FC-9.5: The thickness of the friction course layer will be the plan thickness as shown in the Contract Documents. For construction purposes, the plan thickness will be converted to spread rate as defined in 334-1.4.

Plan quantities are based on a G_{mm} of 2.540, corresponding to a spread rate of 110 lbs/yd^2-in. Pay quantities will be based on the actual maximum specific gravity of the mix being used.

337-8.2 FC-5: The total thickness of the FC-5 layer will be the plan thickness as shown in the Contract Documents. For construction purposes, the plan thickness will be converted to spread rate based on the combined aggregate bulk specific gravity of the asphalt mix being used as shown in the following equation:

Spread rate (lbs/yd^2) = t x G_{sb} x 40.5

Where: t = Thickness (in.) (Plan thickness)

G_{sb} = Combined aggregate bulk specific gravity from the verified mix design

The weight of the mixture shall be determined as provided in 320-2.2.

Plan quantities are based on a G_{sb} of 2.635, corresponding to a spread rate of 80 lbs/yd^2. Pay quantities will be based on the actual combined aggregate bulk specific gravity (G_{sb}) of the mix being used.

337-9 Special Equipment Requirements for FC-5.

337-9.1 Fiber Supply System: Use a separate feed system to accurately proportion the required quantity of mineral fibers into the mixture in such a manner that uniform distribution is obtained. Interlock the proportioning device with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes. Control the proportion of fibers to within plus or minus 10% of the amount of fibers required. Provide flow indicators or sensing devices for the fiber system, interlocked with plant controls so that the mixture production will be interrupted if introduction of the fiber fails.

When a batch plant is used, add the fiber to the aggregate in the weigh hopper or as approved and directed by the Engineer. Increase the batch dry mixing time by 8 to 12 seconds, or as directed by the Engineer, from the time the aggregate is completely emptied into the pugmill. Ensure that the fibers are uniformly distributed prior to the addition of asphalt rubber into the pugmill.

When a drum-mix plant is used, add and uniformly disperse the fiber with the aggregate prior to the addition of the asphalt rubber. Add the fiber in such a manner that it will not become entrained in the exhaust system of the drier or plant.

337-9.2 Hydrated Lime Supply System: For FC-5 mixes containing granite, use a separate feed system to accurately proportion the required quantity of hydrated lime into the mixture in such a manner that uniform coating of the aggregate is obtained prior to the addition of the asphalt rubber. Add the hydrated lime in such a manner that it will not become entrained in the exhaust system of the drier or plant. Interlock the proportioning device with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes and to ensure that all mixture produced is properly treated with hydrated lime. Control the proportion of hydrated lime to within plus or minus 10% of the amount of hydrated lime required. Provide and interlock flow indicators or sensing devices for the hydrated lime system with plant controls so that the mixture production will be interrupted if introduction of the hydrated lime fails. The addition of the hydrated lime to the aggregate may be accomplished by Method (A) or (B) as follows:

337-9.2.1 Method (A) - Dry Form: Add hydrated lime in a dry form to the mixture according to the type of asphalt plant being used.

When a batch plant is used, add the hydrated lime to the aggregate in the weigh hopper or as approved and directed by the Engineer. Increase the batch dry mixing time by eight to twelve seconds, or as directed by the Engineer, from the time the aggregate is completely emptied into the pugmill. Uniformly distribute the hydrated lime prior to the addition of asphalt rubber into the pugmill.

When a drum-mix plant is used, add and uniformly disperse the hydrated lime to the aggregate prior to the addition of the asphalt rubber. Add the hydrated lime in such a manner that it will not become entrained in the exhaust system of the drier or plant.

337-9.2.2 Method (B) - Hydrated Lime/Water Slurry: Add the required quantity of hydrated lime (based on dry weight) in a hydrated lime/water slurry form to the aggregate. Provide a solution consisting of hydrated lime and

water in concentrations as directed by the Engineer. Use a plant equipped to blend and maintain the hydrated lime in suspension and to mix it with the aggregates uniformly in the proportions specified.

337-9.3 Hydrated Lime Pretreatment: For FC-5 mixes containing granite, as an alternative to 337-9.2, pretreat the aggregate with hydrated lime prior to incorporating the aggregate into the mixture. Use a feed system to accurately proportion the aggregate and required quantity of hydrated lime, and mix them in such a manner that uniform coating of the aggregate is obtained. Control the proportion of hydrated lime to within ± 10% of the amount required. Aggregate pretreated with hydrated lime in this manner shall be incorporated into the asphalt mixture within 45 days of pretreatment.

337-9.3.1 Hydrated Lime Pretreatment Methods: Pretreat the aggregate using one of the following two methods:

Pretreatment Method A – Dry Form: Add the required quantity of hydrated lime in a dry form to the aggregate. Assure that the aggregate at the time of pretreatment contains a minimum of 3% moisture over saturated surface dry (SSD) conditions. Utilize equipment to accurately proportion the aggregate and hydrated lime and mix them in such a manner as to provide a uniform coating.

Pretreatment Method B – Hydrated Lime/Water Slurry: Add the required quantity of hydrated lime (based on dry weight) in a hydrated lime/water slurry form to the aggregate. Provide a solution consisting of hydrated lime and water in a concentration to provide effective treatment. Use equipment to blend and maintain the hydrated lime in suspension, to accurately proportion the aggregate and hydrated lime/water slurry, and to mix them to provide a uniform coating.

337-9.3.2 Blending Quality Control Records: Maintain adequate Quality Control records for the Engineer's review for all pretreatment activities. Include as a minimum the following information (for each batch or day's run of pretreatment): pretreatment date, aggregate certification information, certified test results for the hydrated lime, aggregate moisture content prior to blending, as-blended quantities of aggregate and hydrated lime, project number, customer name, and shipping date.

337-9.3.3 Certification: In addition to the aggregate certification, provide a certification with each load of material delivered to the HMA plant, that the material has been pretreated in conformance with these specifications. Include also the date the material was pretreated.

337-10 Failing Material.

For Option 1 Mixture Acceptance, meet the requirements of 334-5.1.9. For FC-5, use the Master Production Range defined in Table 337-2 in lieu of Table 334-5.

337-11 Method of Measurement.

For the work specified under this Section (including the pertinent provisions of Sections 320 and 330), the quantity to be paid for will be the weight of the mixture, in tons. The pay quantity will be based on the project average spread

rate, limited to a maximum of 105% of the spread rate determined in accordance with 337-8 or as set by the Engineer. The project average spread rate is calculated by totaling the arithmetic mean of the average daily spread rate values for each layer.

The bid price for the asphalt mix will include the cost of the asphalt binder (asphalt rubber (or polymer), asphalt cement, ground tire rubber, anti-stripping agent, blending and handling) and the tack coat application as directed in 300-8, as well as fiber stabilizing additive and hydrated lime (if required). There will be no separate payment or unit price adjustment for the asphalt binder material in the asphalt mix. The weight will be determined as provided in 320-2 (including the provisions for the automatic recordation system).

Prepare a Certification of Quantities, using the Department's current approved form, for the certified asphalt concrete friction course pay item. Submit this certification to the Engineer no later than Twelve O'clock noon Monday after the estimate cut-off or as directed by the Engineer, based on the quantity of asphalt produced and accepted on the roadway per Contract. The certification must include the Contract Number, FPID Number, Certification Number, Certification Date, period represented by Certification and the tons produced for each asphalt pay item.

337-12 Basis of Payment.

337-12.1 General: Price and payment will be full compensation for all the work specified under this Section (including the applicable requirements of Sections 320 and 330).

For Option 1 Material Acceptance, based upon the quality of the material, a pay adjustment will be applied to the bid price of the material as determined on a LOT by LOT basis. The pay adjustment will be assessed by calculating a Pay Factor for individual quality characteristics. The pay adjustment will be computed by multiplying a Composite Pay Factor for the LOT by the bid price per ton. Perform all calculations with the Department's Asphalt Plant - Pay Factor Worksheets (Form No. 675-030-22).

337-12.2 FC-9.5 and FC-12.5: For Option 1 Material Acceptance, meet the requirements of 334-8. For Option 2 Material Acceptance, meet the requirements of 334-5.2.

337-12.3 FC-5: For Option 1 Material Acceptance, meet the requirements of 334-8 with the following exceptions:

1. Pay factors will be calculated for asphalt binder content and the percentages passing the 3/8 inch, the No. 4, and the No. 8 sieves only.
2. Table 337-4 replaces Table 334-8.
3. Table 337-5 replaces Table 334-9.
4. The Composite Pay Factor equation in 334-8.3 is replaced with the following:

$$CPF = [(0.20 \times PF\ 3/8\ inch) + (0.30 \times PF\ No.\ 4) + (0.10 \times PF\ No.\ 8) + (0.40 \times PF\ AC)]$$

For Option 2 Material Acceptance, meet the requirements of 337-6.2.2.

Table 337-4 Small Quantity Pay Table for FC-5		
Pay Factor	1-Test Deviation	2-Test Average Deviation
Asphalt Binder Content (%)		
1.00	0.00-0.50	0.00-0.35
0.90	0.51-0.60	0.36-0.42
0.80	>0.60	>0.42
3/8 inch Sieve (%)		
1.00	0.00-6.50	0.00-4.60
0.90	6.51-7.50	4.61-5.30
0.80	>7.50	>5.30
No. 4 Sieve (%)		
1.00	0.00-5.00	0.00-3.54
0.90	5.01-6.00	3.55-4.24
0.80	>6.00	>4.24
No. 8 Sieve (%)		
1.00	0.00-3.00	0.00-2.12
0.90	3.01-3.50	2.13-2.47
0.80	>3.50	>2.47

Table 337-5 Specification Limits for FC-5	
Quality Characteristic	Specification Limits
Asphalt Binder Content (%)	Target ± 0.45
Passing 3/8 inch sieve (%)	Target ± 6.00
Passing No. 4 sieve (%)	Target ± 4.50
Passing No. 8 sieve (%)	Target ± 2.50

337-12.4 Payment: Payment will be made under:

Item No. 337- 7- Asphaltic Concrete Friction Course - per ton.

SECTION 338
VALUE ADDED ASPHALT PAVEMENT

338-1 Description.

Construct Value Added Asphalt Pavement consisting of Asphalt Concrete Structural Course and Asphalt Concrete Friction Course, subject to a three year warranty period.

For purposes of this Specification, Warranty" shall mean the Responsible Party, as designated herein, is responsible for performance of the Value Added Asphalt Pavement for a period of three years after final acceptance of the Contract in accordance with 5-11, including continued responsibility for

performing all remedial work associated with pavement distresses exceeding threshold values determined in accordance with 338-5, and as to which notice was provided to the Responsible Party within the three-year warranty period.

The work specified in this Section will not be paid for directly, but will be considered as incidental to other asphalt pay items.

338-2 Materials and Construction Requirements.

Meet the following requirements:

Hot Bituminous Mixtures - Plant, Methods and Equipment ....Section 320
Hot Bituminous Mixtures –
General Construction Requirements .....Section 330
Superpave Asphalt Concrete .....Section 334
Asphalt Concrete Friction Courses.....Section 337

338-3 Responsible Party.

Prior to any Value Added Asphalt Pavement being placed on the project, the Contractor shall designate a Responsible Party to accept responsibility for maintaining the Value Added Asphalt Pavement, when remedial work is required. When the scope of the asphalt work is only milling and resurfacing, and there is no construction of the embankment, subgrade or base below the pavement included in the Contract, the Responsible Party may be either the Contractor or the Department approved subcontractor performing the Value Added Asphalt Pavement work. When the construction of the embankment, subgrade or base below the pavement is included in the Contract, in addition to the construction of the Asphalt Concrete Structural Course and Asphalt Concrete Friction Course, the Contractor shall be considered as the Responsible Party.

When the Responsible Party is a subcontractor, the subcontractor must be pre-qualified with the Department in the category of asphalt, and such designation must be made to the Department by the Contractor. The proposed subcontractor must execute and deliver to the Department a form, provided by the Department, prior to or concurrent with the Contractor's request to sublet any Value Added Asphalt Pavement work, stipulating that the subcontractor assumes all responsibility as the Responsible Party for the Value Added Asphalt Pavement within the three-year warranty period. Failure to timely designate the Responsible Party will result in the Contractor being the Responsible Party unless otherwise agreed to in writing by the Department.

Upon final acceptance of the Contract in accordance with 5-11, the Contractor's responsibility for maintenance of all the work or facilities within the project limits of the Contract will terminate in accordance with 5-11; with the sole exception that the obligations set forth in this Section for Value Added Asphalt Pavement will continue thereafter to be the responsibility of the Responsible Party as otherwise provided in this Section.

338-4 Statewide Disputes Review Board.

The Statewide Disputes Review Board in effect for this Contract will resolve any and all disputes that may arise involving administration and enforcement of this Specification. The Responsible Party and the Department acknowledge that

use of the Statewide Disputes Review Board is required, and the determinations of the Statewide Disputes Review Board for disputes arising out of this Specification will be binding on both the Responsible Party and the Department, with no right of appeal by either party.

Meet the requirements of 8-3.

338-5 Pavement Evaluation and Remedial Work.

338-5.1 General: The Department's Flexible Pavement Condition Survey Program, along with observations by the Engineer, will be used as the basis for determining the extent and the magnitude of the pavement distresses occurring on the project. The Department will continuously monitor the pavement and may require remedial action at any time. For evaluation purposes, the project will be subdivided into LOTs of 0.1 mile per lane. When the segment is less than 0.1 mile, the segment will be called a partial LOT. The Department may conduct a Pavement Condition Survey of the value added pavement following the final acceptance of the project, and at intermediate times throughout the warranty period. The final survey, if determined by the Engineer to be necessary, will be conducted no later than 45 calendar days before the end of warranty period. The Department will be responsible for all costs associated with the surveys.

The Responsible Party will be advised if/when the Department believes remedial action is required. If the survey findings, intermediate or final, are to be disputed by the Responsible Party, written notification must be provided to the Engineer within 30 calendar days of the date of receipt of the survey.

During the warranty period, the Responsible Party may monitor the project using nondestructive procedures. The Responsible Party shall not conduct any coring, milling or other destructive procedures without prior approval by the Engineer.

338-5.2 Category 1 Pavement: For purposes of this Specification, "Category 1 Pavement" is defined as mainline roadways, access roads and frontage roads with a design speed of 55 mph and greater.

Threshold values and associated remedial work for Category 1 Value Added Asphalt Pavement are specified in Table 338-1.

TABLE 338-1
Category 1 Pavements

Type of Distress	Type of Survey	Threshold Values for Each LOT (0.1 Mile) per Lane.	Remedial Work
Rutting [1]	Any Survey	Depth ≤ 0.25 inch	None required
		Depth > 0.25 inch	Remove and replace the distressed LOT(s) to the full depth of all layers, and to the full lane width [2]

TABLE 338-1 Category 1 Pavements			
Type of Distress	Type of Survey	Threshold Values for Each LOT (0.1 Mile) per Lane.	Remedial Work
Ride [3]	Any Survey	RN < 3.5	Remove and replace the friction course for the full length and the full lane width of the distressed LOT(s)
Settlement/Depression[3A]	Any Survey	Depth ≥ 1/2 inch	Propose the method of correction to the Engineer for approval prior to beginning remedial work
Cracking [4]	Any Survey	Cumulative length of cracking > 30 feet for Cracks > 1/8 inch	Remove and replace the distressed LOT(s) to the full depth of all layers, and to the full lane width [5]
Raveling and/or Delamination affecting the Friction Course [6]	Any Survey	Individual length ≥ 10 feet.	Remove and replace the distressed area(s) to the full distressed depth and the full lane width, for the full distressed length plus 50' on each end
		Individual length < 10 feet.	Patch the distressed area(s) to the full distressed depth and to a minimum surface area of 150% of each distressed area, subject to performance at final survey [7]
Pot holes and Slippage Area(s) [6]	Any Survey	Observation by Engineer	Remove and replace the distressed area(s) to the full distressed depth, and to a minimum surface area of 150% of each distressed area OR temporarily patch the distressed area(s) AND, prior to the final survey, remove and replace the distressed area(s) to the full distressed depth, and to a minimum surface area of 150% of each distressed area

TABLE 338-1 Category 1 Pavements			
Type of Distress	Type of Survey	Threshold Values for Each LOT (0.1 Mile) per Lane.	Remedial Work
Bleeding [8]	Any Survey	Loss of surface texture due to excess asphalt, individual length ≥10 feet and ≥1 foot. in width.	Remove and replace the distressed area(s) to the full distressed depth, and to a minimum surface area of 150% of each distressed area

(1) Rutting: Rut depth to be determined by Laser Profiler in accordance with the Flexible Pavement Condition Survey Handbook. For any LOT that cannot be surveyed by Laser Profiler, rut depth to be determined manually in accordance with the Flexible Pavement Condition Survey Handbook, with the exception that the number of readings per LOT will be one every 50 feet. For a partial LOT, a minimum of three measurements not exceeding 50 feet apart will be made. When the average of the measurements by manual straightedge exceeds a 0.30 inch threshold value, the remedial work is needed. (2) Remedial Work for Rutting: The Contractor may propose removal and replacement of less than the full depth of all layers by preparation and submittal of a signed and sealed engineering analysis report, demonstrating the actual extent of the distressed area(s). Remedial work must be performed in accordance with Table 338-1 unless the Engineer approves the proposal.
(3) Ride: Ride Number (RN) to be established by Laser Profiler in accordance with FM 5-549. As a condition of project final acceptance in accordance with 5-11, correct all deficiencies in accordance with acceptance criteria for pavement smoothness in accordance with 330-12.6.
(3a)Settlement/Depression: Depth of the settlement/depression to be determined by a 6 foot manual straightedge.
(4) Cracking: Beginning and ending of 1/8 inch cracking will be determined as the average of three measurements taken at one foot intervals. The longitudinal construction joint at the lane line will not be considered as a crack.
(5) Remedial Work for Cracking: The Contractor may propose removal and replacement of less than the full depth of all layers by preparation and submittal of a signed and sealed engineering analysis report, demonstrating the actual extent of the distressed area(s). Remedial work must be performed in accordance with Table 338-1 unless the Engineer approves the proposal.
(6) Raveling, Delaminating, Pot holes, Slippage: As defined and determined by the Engineer in accordance with the examples displayed at the following URL:
www.dot.state.fl.us/specificationsestimates/pavement.aspx
(7) Patched Areas: At the time of final survey, patched areas must be performing to the satisfaction of the Engineer. If the Engineer determines patched areas are not performing satisfactorily, remove and replace the distressed area(s) to the full distressed depth, and to a minimum surface area of 150% of each distressed area.
(8) Bleeding: Bleeding to be determined as defined and determined by the Engineer in accordance with the examples displayed at the following URL:
www.dot.state.fl.us/specificationsestimates/pavement.aspx

338-5.3 Category 2 Pavement: For purposes of this Specification, "Category 2 Pavement" is defined as mainline roadways, access roads and frontage roads with a design speed less than 50 mph; approach transition and merge areas at toll booths; ramps; acceleration and deceleration lanes (including

tapers); and turn lanes, parking areas; rest areas; weigh stations; and agricultural inspection stations.

Threshold values and associated remedial work for Category 2 Value Added Asphalt Pavement are specified in Table 338-2.

TABLE 338-2
Category 2 Pavements

Type of Distress	Type of Survey	Threshold Values	Remedial Work
Rutting	Automated Measurement	See Table 338-1	See Table 338-1
	Manual Measurement (1)	Depth > 0.4 inch	Remove and replace 1.5 inch the full lane width for the area plus 50 feet with rutting equal to or greater than 0.4 inch.
Cracking	Any Survey	Cumulative length of cracking > 300 feet for Cracks > 1/8 inch	See Table 338-1
Surface Deterioration (2)	Any Survey	See Table 338-1	See Table 338-1
Settlement/Depression(3)	Any Survey	Depth ≥ 1/2 inch	Propose the method of correction to the Engineer for approval prior to beginning remedial work

(1) Rutting: Rut depth to be determined manually in accordance with the Flexible Pavement Condition Survey Handbook. For any LOT that cannot be surveyed by the Laser Profiler, the rut depth will be determined manually in accordance with the Flexible Pavement Condition Survey Handbook, with the exception that the number of readings per LOT will be one every 20 feet. For partial LOT, minimum of three measurements not exceeding 20 feet apart will be checked. When the average of the measurements by manual straightedge exceeds 0.6 inch, the remedial work is needed. When any individual measurement exceeds 0.6 inch, the remedial work is needed.
(2) Surface Deterioration: As used in Table 338-2, Surface Deterioration includes Raveling and/or Delamination affecting the Friction Course, Pot holes, Slippage Area(s), Segregated Area(s) and Bleeding; all as defined and footnoted in Table 338-1.
(3)Settlement/Depression: Depth of the settlement/depression to be determined by a 6 foot manual straightedge.

338-5.4 Category 3 Pavement: For purposes of this Specification, "Category 3 Pavement" is defined as median crossovers and shoulders.

Threshold values and associated remedial work for Category 3 Value Added Asphalt Pavement are specified in Table 338-3.

TABLE 338-3
Category 3 Pavements

Type of Distress	Type of Survey	Threshold Values	Remedial Work

TABLE 338-3 Category 3 Pavements			
Type of Distress	Type of Survey	Threshold Values	Remedial Work
Rutting	N/A	N/A	N/A
Cracking	Any Survey	Cumulative length of cracking > 500 feet for Cracks > 1/8 inch	See Table 338-1
Surface Deterioration (1)	Any Survey	See Table 338-1	See Table 338-1
Settlement/Depression(2)	Any Survey	Depth ≥ 1/2 inch	Propose the method of correction to the Engineer for approval prior to beginning remedial work
(1) Surface Deterioration: As used in Table 338-3, Surface Deterioration includes Raveling and/or Delamination affecting the Friction Course, Pot holes, Slippage Area(s), Segregated Area(s) and Bleeding; all as defined and footnoted in Table 338-1. (2) Settlement/Depression: Depth of the settlement/depression to be determined by a 6 foot manual straightedge.			

338-5.5 Remedial Work: During the warranty period, the Responsible Party will perform all necessary remedial work described within this Section at no cost to the Department. Should an impasse develop in any regard as to the need for remedial work or the extent required, the Statewide Disputes Review Board will render a final decision by majority vote.

Remedial work will not apply if any one of the following factors is found to be beyond the scope of the Contract:

a. Determination that the pavement thickness design is deficient. The Department will make available a copy of the original pavement thickness design package and design traffic report to the Responsible Party upon request.

b. Determination that the Accumulated ESALs (Number of 18 Kip Equivalent Single Axle Loads in the design lane) have increased by 25% or more over the Accumulated ESALs used by the Department for design purposes for the warranty period. In calculating ESALs, the Average Annual Daily Traffic (AADT) will be obtained from the Department's traffic count data and the T24 (Percent Heavy Trucks during a 24 hour period) will be obtained from the Department's traffic classification survey data.

c. Determination that the deficiency was due to the failure of the existing underlying layers that were not part of the Contract work.

d. Determination that the deficiency was the responsibility of a third party or its actions, unless the third party was performing work included in the Contract.

If a measured distress value indicates remedial action is required per Table 338-1, Table 338-2 and/or Table 338-3, the Responsible Party must begin remedial work within 45 calendar days of notification by the Department or a

ruling of the Statewide Disputes Review Board. The Disputes Review Board will determine the allowable duration for the completion of the remedial work, but not to exceed 6 months.

In the event remedial action is necessary and forensic information is required to determine the source of the distress, the Department may core and/or trench the pavement. The Responsible Party will not be responsible for damages to the pavement as a result of any forensic activities conducted by the Department.

As applicable to distress criteria for rutting, ride and cracking for Category 1 and Category 2 pavements, when two LOTs requiring remedial action are not separated by three or more LOTs that otherwise require no remedial action, the remedial work shall be required for the total length of all such contiguous LOTs, including the intermediate LOTs otherwise requiring no remedial action.

Additionally, for Category 1 and Category 2 pavements, where the limits of remedial action are defined as 150% of the distressed area, and where such areas of remedial action required due to rutting, raveling, cracking, slippage or bleeding are not separated by 1,000 feet, the remedial work will be required for the entire area contiguous to the distressed areas, including intermediate areas otherwise requiring no remedial action.

The Responsible Party has the first option to perform all remedial work that is determined by the Department to be their responsibility. If, in the opinion of the Engineer, the problem poses an immediate danger to the traveling public and the Responsible Party cannot begin remedial work within 72 hours of written notification, the Engineer has the authority to have the remedial work performed by other forces. The Responsible Party is responsible for all incurred costs of the work performed by other forces should the problem (remedial work) be determined to be the responsibility of the Responsible Party. Remedial work performed by other forces does not alter any of the requirements, responsibilities or obligations of the Responsible Party.

The Responsible Party must complete all remedial work to the satisfaction of the Engineer. Any disputes regarding the adequacy of the remedial work will be resolved by the Statewide Disputes Review Board. Approval of remedial work does not relieve the Responsible Party from continuing responsibility under the provisions of this Specification.

Notify the Engineer in writing prior to beginning any remedial work. Meet the requirements of the Department's Standard Specifications for Road and Bridge Construction and implemented modifications thereto when performing any remedial work. Perform all signing and traffic control in accordance with the current edition of the Department's Design Standards for Design, Construction, Maintenance and Utility Operations on the State Highway System. Provide Maintenance of Traffic during remedial work at no additional cost to the Department. Lane closure restrictions listed in the original Contract will apply to remedial work. Written request(s) to obtain permission for lane closure(s) for either forensic investigation or remedial work must be made to the Engineer 48 hours in advance of any lane closures. Do not perform any lane closures until written permission is given by the Engineer.

If remedial work necessitates a corrective action to overlying asphalt layers, pavement markings, signal loops, adjacent lane(s), roadway shoulders, or other affected Contract work, perform these corrective actions using similar products at no additional cost to the Department.

338-6 Responsible Party's Failure to Perform.

Should the Responsible Party fail to timely submit any dispute to the Statewide Disputes Review Board, fail to satisfactorily perform any remedial work, or fail to compensate the Department for any remedial work performed by the Department and determined to be the Responsible Party's responsibility in accordance with this Specification, the Department will suspend, revoke or deny the Responsible Party's certificate of qualification under the terms of Section 337.16(d)(2), Florida Statutes, for a minimum of 6 months or until the remedial work has been satisfactorily performed (or full and complete payment for remedial work performed by others made to the Department), whichever is longer. Should the Responsible Party choose to challenge the Department's notification of intent for suspension, revocation or denial of qualification and the Department's action is upheld, the Responsible Party will have its qualification suspended for an additional minimum of 6 months.

The remedial work is not an obligation of the Contractor's bond required by Section 337.18, Florida Statutes.

SECTION 339
MISCELLANEOUS ASPHALT PAVEMENT

339-1 Description.

Construct asphalt pavement in areas where vehicular traffic does not travel, such as pavement under guardrail, bicycle paths, median pavement, sidewalks, etc.

Also, chemically treat the underlying soil to prevent plant growth.

339-2 Materials.

For the pavement, use any plant-mixed hot bituminous mixture meeting the requirements of a mix design verified by the Engineer, except do not use open-graded friction course (FC-5). For bicycle paths, use a mixture that produces a finished pavement which will not distort or mar under bicycle or mower wheel loads.

In general, the Engineer will accept the mixture on the basis of visual inspection with no further testing required.

339-3 Foundation and Soil Treatment.

Shape the soil in areas where pavement is to be constructed, to a surface true to the lines, grades and typical cross-sections shown in the plans. Compact the soil to a firm state.

Immediately before placing the pavement, uniformly apply a pre-emergent herbicide in accordance with the requirements of 7-1.7, to the foundation soil.

Ensure that the herbicide carries an approved label for use under paved surfaces, and that herbicide is applied in accordance with directions on the label.

Prevent damage to any adjacent vegetation during herbicide application. Replace, at no expense to the Department, any plants damaged as the result of soil treatment outside designated areas.

339-4 Placing Mixture.

Uniformly place the hot bituminous mixture by machine or hand methods at the rate of spread or dimensions indicated in the plans or as otherwise directed by the Engineer. If posts are to be constructed within the pavement area, the Contractor may cut holes for installation through the completed pavement. After completing installation of posts and compaction of the backfill material, patch the area around each post with fresh hot bituminous mixture.

If directed by the Engineer, place miscellaneous asphalt pavement prior to placement of the final surface course.

339-5 Compacting Mixture.

Uniformly compact the hot bituminous mixture with lightweight rollers or vibratory compactors as directed by the Engineer. The Contractor may use hand tamps for compaction in areas which are inaccessible to other compaction equipment.

The Engineer will not require a specific density.

339-6 Surface Requirements.

Provide a finished surface that is reasonably smooth, of uniform texture, and shaped so as to drain without ponding of water.

Upon completion of the pavement, shape the surface of the adjacent earth to match the pavement edges.

339-7 Method of Measurement.

The quantity to be paid for will be the weight, in tons, determined by an electronic weighing system as described in 320-2.2. The pay quantity will be based on the average spread rate of the area shown on the plans or authorized by the Engineer or dimensions for the project, limited to a maximum of 105% of the plan thickness quantity. For calculation, a weight of 100 lbs/yd^2 per inch thickness of asphalt will be used.

Prepare a Certification of Quantities, using the Department's current approved form, for the certified miscellaneous asphalt pavement pay item. Submit this certification to the Engineer no later than Twelve O'clock noon Monday after the estimate cut-off or as directed by the Engineer, based on the quantity of asphalt produced and accepted on the Contract. The certification must include the Contract Number, FPID Number, Certification Number, Certification Date, period represented by Certification and the tons produced for each asphalt pay item.

339-8 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including shaping and compacting the foundation, soil sterilization

treatment, furnishing of the bituminous material used in the mixture, and shaping of adjacent earth surfaces.

Payment will be made under:

Item No. 339- 1-	Miscellaneous Asphalt Pavement - per ton.

SECTION 341
ASPHALT RUBBER MEMBRANE INTERLAYER

341-1 Description.

Construct an asphalt rubber membrane interlayer composed of a separate application of asphalt rubber binder covered with a single application of aggregate.

341-2 Materials.

341-2.1 Asphalt Rubber Binder: Use ARB-20 meeting the requirements of Section 336.

341-2.2 Cover Material: Use Size No. 6 stone, slag, or gravel meeting the requirements of Section 901.

341-3 Equipment.

341-3.1 Power Broom: Provide a power broom for cleaning the existing pavement capable of removing all loose material from the surface.

341-3.2 Spreading Equipment: Provide a self-propelled aggregate spreader that can be adjusted to accurately apply the cover material at the specified rate and that spreads the material uniformly.

341-3.3 Rollers: Provide self-propelled, pneumatic-tired traffic type rollers equipped with at least 7 smooth-tread, low-pressure tires, and capable of carrying a gross load of at least 8 tons. Maintain a minimum tire inflation pressure of 90 psi, or as specified by the manufacturer, such that in no two tires the air pressure varies more than 5 psi. Load the traffic roller as directed by the Engineer.

341-3.4 Mixing Equipment: Use mixing equipment for asphalt rubber binder designed for that purpose and capable of producing and maintaining a homogeneous mixture of rubber and asphalt cement at the specified temperature.

341-3.5 Pressure Distributor: Use a pressure type distributor to apply asphalt rubber binder capable of maintaining a homogeneous mixture of rubber and asphalt cement at the specified temperature and consistently apply the material in a uniform manner.

341-4 Contractor's Quality Control.

Provide the necessary quality control of the asphalt rubber binder and construction in accordance with the Contract requirements. Provide in the Quality Control Plan procedures for monitoring and controlling of rate of application. If the rate of application varies by more than 5% from the rate set by the Engineer in accordance with 341-6, immediately make all corrections

necessary to bring the spread rate into the acceptable range. The Engineer may take additional measurements at any time. The Engineer will randomly check the Contractor's measurement to verify the spread rate.

341-5 Preparation of Asphalt Rubber Binder.

Combine the materials as rapidly as possible for such a time and at such a temperature that the consistency of the binder approaches that of a semi-fluid material. Use the time and temperature for blending of the asphalt rubber binder as specified in Table 336-1. The Engineer will be the sole judge of when the material has reached application consistency and will determine if an extender oil or diluent is needed for that purpose. After reaching the proper consistency, proceed with application immediately. Never hold the mixture at temperatures over 350ºF for more than six hours after reaching that temperature.

341-6 Construction Procedure.

341-6.1 Preparation of Surface: Prior to application of the asphalt rubber binder, clean the existing pavement as specified in 300-5.

341-6.2 Application of Asphalt Rubber Binder: Apply the asphalt rubber binder only under the following conditions:

a. The air temperature is above 50ºF and rising.

b. The pavement is absolutely dry.

c. The wind conditions are such that cooling of the asphalt rubber binder will not be so rapid as to prevent good bonding of the aggregate.

Uniformly apply the asphalt rubber binder, at the rate of 0.6 to 0.8 gal/yd^2 as directed by the Engineer. Use an application rate based on the unit weight as shown in Table 336-1. For conversions to standard 60ºF, refer to 300-9.3. Determine the rate of application after each application operation.

341-6.3 Application of Cover Material: Immediately after application of the asphalt rubber binder, uniformly spread the cover material at a rate of 0.26 and 0.33 ft^3/yd^2. The Engineer will set the exact rate. Determine the application rate at the beginning of each day's production, and as needed to control the operation, a minimum of twice per day. Maintain an application rate such that the pavement is covered uniformly with aggregate, and is one aggregate layer thick. For the cover material, use aggregate that is reasonably free of any adherent coatings and that does not contain excessive moisture. Immediately after the application of cover material, check the surface to ensure a uniform distribution of cover material and a smooth surface.

Do not separate the application of the asphalt rubber binder and the application of the cover material by more than 300 feet, unless approved by the Engineer.

341-6.4 Rolling: In order to ensure maximum embedment of the aggregate, cover the entire width of the mat immediately by traffic rollers. For the first coverage, provide a minimum of three traffic rollers in order to accomplish simultaneous rolling in echelon of the entire width of the spread.

After initial rolling, immediately correct all portions of the completed surface that the Engineer deems are defective (not properly covered by aggregates, fat spots, excessive free aggregate, etc.).

Following the first coverage, make additional coverages with traffic rollers as directed by the Engineer.

341-6.5 Traffic Control: For the normal sequence of construction operations, place the first course of asphalt concrete overlay over the membrane prior to opening to traffic.

341-7 Unacceptable Asphalt Rubber Membrane Interlayer.

If the asphalt rubber membrane interlayer is unacceptable due to incorrect blending, application rate, or not meeting the requirements of this Section, or damaged prior to placement of the asphalt concrete layer, remove and replace it as directed by the Engineer at no additional cost to the Department. Do not apply excessive amounts of asphalt rubber binder.

341-8 Placement of Asphalt Concrete Overlay.

Ensure that the thickness and temperature of the initial layer of asphalt concrete placed on top of the asphalt rubber membrane interlayer are such that the overlay bonds to the interlayer and the underlying layer without voids or excessive binder. Core the asphalt overlay as directed by the Engineer to evaluate the binder and aggregate spread rates, as well as the effectiveness of the asphalt concrete overlay in producing a well-bonded interlayer.

341-9 Method of Measurement.

341-9.1 Asphalt Rubber Membrane Interlayer: The quantity to be paid for will be plan quantity, in square yards, completed and accepted.

341-9.2 Bituminous Material (Asphalt Rubber Binder-Interlayer): The quantity will be the volume, in gallons, determined as provided in 300-8.

341-9.3 Submittal of Certification of Quantities for Bituminous Material: Prepare a Certification of Quantities, using the Department's current approved form, for the quantity of bituminous material placed and accepted. Submit this certification to the Engineer no later than Twelve O'clock noon Monday after the monthly estimate cutoff date or as directed by the Engineer. The certification must include the Contract Number, FPID Number, State Project Number, Certification Number and period represented by the Certification.

341-10 Basis of Payment.

341-10.1 Asphalt Rubber Membrane Interlayer: Price and payment will be full compensation for all work specified in this Section, including furnishing cover materials, handling, spreading, rolling, bituminous material, and other incidental work necessary to complete this item.

341-10.2 Bituminous Material (Asphalt Rubber Binder-Interlayer): Payment will be included in the price of the asphalt rubber membrane interlayer and will be full compensation for furnishing asphalt cement, ground tire rubber, blending and handling.

341-10.3 Payment Items: Payment will be made under:

Item No. 341- 70-	Asphalt Rubber Membrane Interlayer - per square yard.

SECTION 346
PORTLAND CEMENT CONCRETE

346-1 Description.

Use concrete composed of a mixture of portland cement, aggregate, water, and, where specified, admixtures, pozzolan and ground granulated blast furnace slag. Deliver the portland cement concrete to the site of placement in a freshly mixed, unhardened state.

Obtain concrete from a plant that is currently on the list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3. If the concrete production facility's Quality Control Plan is suspended, the Contractor is solely responsible to obtain the services of another concrete production facility with an accepted Quality Control Plan or await the re-acceptance of the affected concrete production facility's Quality Control Plan prior to the placement of any further concrete on the project. There will be no changes in the contract time or completion dates. Bear all delay costs and other costs associated with the concrete production facility's Quality Control Plan acceptance or re-acceptance.

346-2 Materials.

346-2.1 General: Meet the following requirements:

Coarse Aggregate .....Section 901
Fine Aggregate* .....Section 902
Portland Cement .....Section 921
Water .....Section 923
Admixtures** .....Section 924
Pozzolans and Slag .....Section 929

*Use only silica sand except as provided in 902-5.2.3.

**Use products listed on the Department's Qualified Products List (QPL).

Do not use materials containing hard lumps, crusts or frozen matter, or that is contaminated with dissimilar material.

346-2.2 Types of Cement: Unless a specific type of cement is designated elsewhere, use Type I, Type IP, Type IS, Type II, or Type III cement in all classes of concrete.

Use only the types of cements designated for each environmental condition in structural concrete. A mix design for a more aggressive environment may be substituted for a lower aggressive environmental condition.

TABLE 1			
BRIDGE SUPERSTRUCTURES			
Component	Slightly Aggressive Environment	Moderately Aggressive Environment	Extremely Aggressive Environment
Precast Superstructure and	Type I or Type III	Type I or Type III with Fly Ash and/or	Type II with Fly Ash or Slag

TABLE 1			
BRIDGE SUPERSTRUCTURES			
Component	Slightly Aggressive Environment	Moderately Aggressive Environment	Extremely Aggressive Environment
Prestressed Elements		Slag, Type II, Type IP, or Type IS	
Cast In Place	Type I	Type I with Fly Ash and/or Slag, Type II, Type IP, or Type IS	Type II with Fly Ash or Slag
BRIDGE SUBSTRUCTURE, DRAINAGE STRUCTURES AND OTHER STRUCTURES			
Component	Slightly Aggressive Environment	Moderately Aggressive Environment	Extremely Aggressive Environment
All Elements	Type I or Type III	Type I with Fly Ash and/or Slag, Type II, Type IP, or Type IS	Type II with Fly Ash or Slag

346-2.3 Pozzolans and Slag: Use as desired, on an equal weight replacement basis, fly ash, silica fume, ultrafine fly ash, metakaolin, or slag materials as a cement replacement in all classes of concrete, with the following limitations:

(1) Mass Concrete:

a. Fly Ash - Ensure that the quantity of cement replaced with fly ash is 18% to 50% by weight, except where the core temperature is expected to rise above 165° F. In that case, ensure that the percentage of fly ash is 35% to 50% by weight.

b. Slag - Ensure that the quantity of cement replaced with slag is 50% to 70% by weight. Ensure that slag is 50% to 55% of total cementitious content by weight when used in combination with silica fume, ultrafine fly ash and/or metakaolin.

c. Slightly and Moderately Aggressive Environments - Ensure that there is at least 20% fly ash by weight and 40% portland cement by weight for mixes containing portland cement, fly ash and slag.

(2) Drilled Shaft:

a. Fly Ash - Ensure that the quantity of cement replaced with fly ash is 33% to 37% by weight.

b. Slag - Ensure that the quantity of cement replaced with slag is 58% to 62% by weight.

(3) Precast Concrete – Ensure that the precast concrete has a maximum of 25% fly ash or a maximum of 70% slag. In Extremely Aggressive Environments, ensure that the precast concrete has a minimum of 18% fly ash or a minimum of 50% slag.

(4) For all other concrete uses not covered in (1), (2) and (3) above,

a. Fly Ash - Ensure that the quantity of cement replaced with fly ash is 18% to 22% by weight.

b. Slag - Ensure that the quantity of cement replaced with slag is 25% to 70% for Slightly and Moderately Aggressive Environments and 50% to 70% by weight when used in Extremely Aggressive Environments. Ensure that slag is 50% to 55% of total cementitious content by weight when used in combination with silica fume, ultra fine fly ash and/or metakaolin.

c. As an option for Slightly and Moderately Aggressive Environments ensure that there is at least 20% fly ash by weight and 40% portland cement by weight for mixes containing portland cement, fly ash and slag.

d. Class I and Class II concrete, excluding Class II (Bridge Deck), are not required to meet the minimum fly ash or slag requirements. The fly ash content shall be less than or equal to 25% by weight of cement and the slag content shall be less than or equal to 70% by weight of cement.

(5) Type IS - Ensure that the quantity of slag in Type IS is less than or equal to 70% by weight.

(6) Silica Fume, Metakaolin and Ultrafine Fly Ash:

a. Silica Fume - Ensure that the quantity of cementitious material replaced with silica fume is 7% to 9% by weight.

b. Metakaolin - Ensure that the quantity of cementitious material replaced with metakaolin is 8% to 12% by weight.

c. Ultrafine Fly Ash - Ensure that the quantity of cementitious material replaced with ultrafine fly ash is 8% to 12% by weight.

d. Cure in accordance with the manufacturer's recommendation and as approved by the Engineer.

346-2.4 Coarse Aggregate Gradation: Produce all concrete using Size No. 57, 67 or 78 coarse aggregate. With the Engineer's approval, Size No. 8 or Size No. 89 may be used either alone or blended with Size No. 57, 67 or 78 coarse aggregate. The Engineer will consider requests for approval of other gradations individually. Submit sufficient statistical data to establish production quality and uniformity of the subject aggregates, and establish the quality and uniformity of the resultant concrete. Furnish aggregate gradations sized larger than nominal maximum size of 1.5 inch as two components.

For Class I and Class II, excluding Class II (Bridge Deck), the coarse and fine aggregate gradation requirements set forth in Sections 901 and 902 are not applicable and the aggregates may be blended; however, the aggregate sources must be approved by the Department. Do not blend the aggregate if the size is smaller than Size No. 78.

346-2.5 Admixtures: Use admixtures in accordance with the requirements of this subarticle. Chemical admixtures not covered in this subarticle may be approved by the Department. Submit statistical evidence supporting successful laboratory and field trial mixes which demonstrate improved concrete quality or handling characteristics.

Use admixtures in accordance with the manufacturer's recommended dosage rate. Do not use admixtures or additives containing calcium chloride

(either in the raw materials or introduced during the manufacturing process) in reinforced concrete.

346-2.5.1 Water-Reducer/Water-Reducer Retardant Admixtures: When a water-reducing admixture is used, meet the requirements of a Type A. When a water-reducing and retarding admixture is used, meet the requirements of a Type D.

346-2.5.2 Air Entrainment Admixtures: Use an air entraining admixture in all concrete mixes except counterweight concrete. For precast concrete products, the use of air entraining admixture is optional for Class I and Class II concrete.

346-2.5.3 High Range Water-Reducing Admixtures:

346-2.5.3.1 General: When a high range water-reducing admixture is used, meet the requirements of a Type F or Type I. When a high range water-reducing and retarding admixture is used, meet the requirements of a Type G or Type II. Do not use Type I, II, F or G admixtures in drilled shaft concrete. When silica fume or metakaolin is incorporated into a concrete mix design, the use of a high range water-reducing admixture Type I, II, F or G is mandatory.

346-2.5.3.2 Flowing Concrete Admixtures for Precast/Prestressed Concrete: Use a Type I, II, F or G admixture for producing flowing concrete. If Type F or G admixture is used, verify the distribution of aggregates in accordance with ASTM C 1610 except allow for minimal vibration for consolidating the concrete. The maximum allowable difference between the static segregation is less than or equal to 15 percent. Add the flowing concrete admixtures at the concrete production facility.

346-2.5.4 Corrosion Inhibitor Admixture: Use only with concrete containing Type II cement, Class F fly ash or slag, and a water-reducing retardant admixture, Type D, or High Range Water-Reducer retarder admixture, Type G, to normalize the setting time of concrete. Ensure that all admixtures are compatible with the corrosion inhibitor admixture.

346-2.5.5 Accelerating Admixture for Precast Concrete: The use of non-chloride admixtures Type C and Type E is allowed in the manufacturing of precast concrete products that are used in Slightly Aggressive Environments.

346-3 Classification, Strength, Slump and Air Content.

346-3.1 General: The separate classifications of concrete covered by this Section are designated as Class I, Class II, Class III, Class IV, Class V and Class VI. Strength, slump, and air content of each class are specified in Table 2.

Substitution of a higher class concrete in lieu of a lower class concrete may be allowed, if approved by the Engineer. When the compressive strength acceptance data is less than the minimum compressive strength of the higher design mix, notify the Engineer. Acceptance is based on the requirements in Table 2 for the lower class concrete.

TABLE 2

Class of Concrete	Specified Minimum Strength (28-day) (psi)	Target Slump (inches) (c)	Air Content Range (%)

STRUCTURAL CONCRETE			
I (a)	3,000	3 (b)	1.0 to 6.0
I (Pavement)	3,000	2	1.0 to 6.0
II (a)	3,400	3 (b)	1.0 to 6.0
II (Bridge Deck)	4,500	3 (b)	1.0 to 6.0
III (e)	5,000	3 (b)	1.0 to 6.0
III (Seal)	3,000	8	1.0 to 6.0
IV	5,500	3 (b) (d)	1.0 to 6.0
IV (Drilled Shaft)	4,000	8.5	0.0 to 6.0
V (Special)	6,000	3 (b) (d)	1.0 to 5.0
V	6,500	3 (b) (d)	1.0 to 5.0
VI	8,500	3 (b) (d)	1.0 to 5.0

(a) For precast drainage systems that are manufactured at the precast plant, apply the chloride content limits specified in 346-4.2 to all box culverts. For precast box culverts and precast drainage structures, the target air content will not apply and maximum slump shall be 6 inches. The Contractor is permitted to use concrete meeting the requirements of ASTM C 478 4,000 psi in lieu of Class I or Class II concrete for precast drainage systems.

(b) The Engineer may allow higher target slump, not to exceed 7 inches, when a Type F, G, I or II admixture is used.

(c) The Engineer may approve a reduction in the target slump for slip-form operations.

(d) When the use of silica fume, ultrafine fly ash, or metakaolin is required as a pozzolan in Class IV, Class V, Class V (Special) or Class VI concrete, ensure that the concrete exceeds a resistivity of 29 KOhm-cm at 28 days, when tested in accordance with FM 5-578. Submit three 4 x 8 inch cylindrical test specimens to the Engineer for resistivity testing before mix design approval. Take the resistivity test specimens from the concrete of the laboratory trial batch or from the field trial batch of at least 3 yd^3. Verify the mix proportioning of the design mix and take representative samples of trial batch concrete for the required plastic and hardened property tests. Cure the field trial batch specimens similar to the standard laboratory curing methods. Submit the resistivity test specimens at least 7 days prior to the scheduled 28 day test. The average resistivity of the three cylinders, eight readings per cylinder, is an indicator of the permeability of the concrete mix.

(e) When precast box culverts or precast drainage products require a Class III concrete, the minimum cementitious materials will be 470 lb/yd^3. The air content range and target slump will not apply.

346-3.2 Drilled Shaft Concrete: When drilled shaft concrete is placed in any wet shaft, provide concrete in accordance with the following specified slump loss requirements.

Test each load of concrete for slump to ensure the concrete is within the limits of Table 6. Ensure that the slump loss is gradual as evidenced by slump loss tests described below. The concrete elapsed time is the sum of the mixing and transit time, the placement time, the time required for removal of any temporary casing that causes or could cause the concrete to flow into the space previously occupied by the temporary casing and bolt/embedment installation.

346-3.2.1 Slump Loss Test Requirements: Provide slump loss tests before drilled shaft concrete operations begin, demonstrating that the drilled shaft concrete maintains a slump of at least 5 inches throughout the concrete elapsed time. Inform the Engineer at least 48 hours before performing such tests. Perform slump loss testing of the drilled shaft mix using personnel meeting the requirements of Section 105.

Perform the following procedures for slump loss tests:

(1) Begin all elapsed times when water is initially introduced into the mixer.

(2) The slump loss test is performed at a temperature consistent with the highest ambient and concrete temperatures expected during actual concrete placement.

(3) Ensure that the mix is at least 3 cubic yards and is mixed in a truck mixer.

(4) After initial mixing, determine the slump, ambient and concrete temperatures, and air content. Ensure that the concrete properties are within the required specification target range.

(5) Verify the water to cementitious materials ratio and that other delivery ticket data meet design mix requirements.

(6) Mix the concrete intermittently for 30 seconds every 5 minutes at the manufacture recommended mixing speed. Agitate the mixer when concrete is not being mixed).

(7) Determine slump, ambient and concrete temperatures at 30 minute intervals until the slump is 5 inches or less. Remix the mix for one minute at the mixing speed of the mixer before these tests are run.

(8) Ensure that the concrete maintains a slump of at least 5 inches for the anticipated elapsed time.

(9) Cast cylinders to determine when 500 psi compressive strength is obtained for the purpose of transporting field samples to the laboratory.

(10) Obtain the Engineer's approval of slump loss test results in terms of elapsed time before concrete placements.

346-3.3 Mass Concrete: When mass concrete is designated in the Contract Documents, provide an analysis of the anticipated thermal developments in the mass concrete elements for all expected project temperature ranges using the selected mix design, casting procedures, and materials.

Use a Specialty Engineer competent in the design and temperature control of concrete in mass elements. The Specialty Engineer shall follow the procedure outlined in Section 207 of the ACI Manual of Concrete Practice to formulate, implement, administer and monitor a temperature control plan, making adjustments as necessary to ensure compliance with the Contract

Documents. The Specialty Engineer shall select the concrete design mix proportions that will generate the lowest maximum temperatures possible to ensure that a 35°F differential temperature between the concrete core and the exterior surface is not exceeded. The mass concrete maximum allowable temperature is 180°F. If either the differential temperature or the maximum allowable temperature is exceeded, the Specialty Engineer shall be available for immediate consultation.

Describe the measures and procedures intended for use to maintain a temperature differential of 35°F or less between the interior core center and exterior surface(s) of the designated mass concrete elements during curing. Submit both the mass concrete mix design and the proposed mass concrete plan to monitor and control the temperature differential to the Engineer for acceptance. Provide temperature monitoring devices to record temperature development between the interior core center and exterior surface(s) of the elements in accordance with the accepted mass concrete plan.

The Specialty Engineer, or a qualified technician employed by the Specialty Engineer, must personally inspect and approve the installation of monitoring devices and verify that the process for recording temperature readings is effective for the first placement of each size and type mass component. Submit to the Engineer for approval the qualification of all technicians employed to inspect or monitor mass concrete placements. For placements other than the first, designate an employee(s) approved by the Specialty Engineer, as qualified to inspect monitoring device installation, to record temperature readings, to be in contact at all times with the Specialty Engineer if adjustments must be made as a result of the temperature differential or the maximum allowable temperature being exceeded, and to immediately implement adjustments to temperature control measures as directed by the Specialty Engineer. Read the monitoring devices and record the readings at intervals no greater than 6 hours. The readings will begin when the mass concrete placement is complete and continue until the maximum temperature differential and the temperature is reached and a decreasing temperature differential is confirmed as defined in the temperature control plan. Do not remove the temperature control mechanisms until the core temperature is within 35°F of the ambient temperature. Furnish a copy of all temperature readings to the Engineer as they are recorded, the determined temperature differentials and a final report within three days of completion of monitoring of each element.

If the 35°F differential or the 180°F maximum allowable temperature has been exceeded, take immediate action as directed by the Specialty Engineer to retard further growth of the temperature differential. Describe methods of preventing thermal shock in the temperature control plan. Use a Specialty Engineer to revise the previously accepted plan to ensure compliance on future placements. Do not place any mass concrete until the Engineer has accepted the mass concrete plan(s). When mass concrete temperature differentials or maximum allowable temperature has been exceeded, provide all analyses and test results deemed necessary by the Engineer for determining the structural integrity and durability of the mass concrete element, to the satisfaction of the Engineer.

The Department will make no compensation, either monetary or time, for the analyses or tests or any impacts upon the project.

346-3.4 Flowing Concrete for Precast/Prestressed Concrete: Produce flowing concrete mix with target slump of 9 inches.

Subsequent to the laboratory trial batch, perform a field demonstration of the proposed mix design by production and placement of at least three batches, 3 yd^3 minimum size each, of concrete containing flowing concrete HRWR admixture. Take representative samples from each batch and perform slump, air content, density (unit weight), and temperature tests on these samples. Cast specimens from each sample for compressive strength tests. Record the ambient air temperature during the test. Ensure that the concrete properties are within the required specification limits. The plants that are producing concrete with batch sizes of less than 3 yd^3 are required to produce and place at least a total amount of 9 yd^3 and perform the aforementioned tests on at least three randomly selected batches.

Determine the workability of the demonstration concrete batches by performing the slump tests on the samples taken at 15 minute intervals from each batch. Continue sampling and testing until the slump measures 6 inches or less. From the plot of slump versus time, determine the time for each batch when the slump is at 7.5 inches. The shortest time period determined from three consecutive batches, at 7.5 inches slump, is considered the cutoff time of the proposed concrete mix. For production concrete, ensure that the time between the batching and depositing of each load of concrete is less than the cutoff time of the mix and also does not exceed the allowable time limit specified in this Section.

Ensure that the demonstration concrete is mixed, delivered, placed, consolidated and cured in accordance with the proposed method and sequence. Produce the flowing concrete batches at slumps between 7.5 inches to 10.5 inches.

Perform inspection of the demonstration concrete during batching, delivery, placement and post placement. During placement, ensure that the concrete batches meet all plastic property requirements of the specifications and maintain their cohesive nature without excessive bleeding, segregation, or abnormal retardation.

Dispose of concrete produced for demonstration purposes at no expense to the Department. Subject to the Engineer's approval, the Contractor may incorporate this concrete into non-reinforced concrete items and may be included for payment, provided it meets Contract requirements for slump, entrained air, and strength.

After removal of the forms, perform the post-placement inspection of the in-place concrete. Observe for any signs of honeycombs, cracks, aggregate segregation or any other surface defects and ensure that the hardened concrete is free from these deficiencies. The Engineer may require saw cutting of the mock-up products to verify the uniform distribution of the aggregates within the saw cut surfaces and around the reinforcing steel and prestressing strands. The Engineer will require saw cutting of the demonstration mock-up products for plants that are demonstrating the use of the flowing concrete for the first time.

Obtain core samples from different locations of mock-up products to inspect the aggregate distribution in each sample and compare it with the aggregate distribution of other core samples. Perform surface resistivity tests on the core samples or test cylinders at 28 days.

Submit the results of the laboratory trial batch tests and field demonstration of verified test data and inspection reports to the Engineer, along with certification stating that the results of the laboratory trial batch tests and field demonstration tests indicate that the proposed concrete mix design meets the requirements of the specifications. For the proposed mix design, state the anticipated maximum time limit between the batching and when the concrete of each batch is deposited during the production.

Upon the review and verification of the laboratory trial batch, field demonstration test data, inspection reports and contractor's certification statement, the Department will approve the proposed mix design.

The Department may approve proposed flowing concrete mixes, centrally mixed at the placement site, without the production of demonstration batches, provided that the proposed mix meets the following two criteria:

(1) A previously approved flowing concrete mix of the same class has demonstrated satisfactory performance under the proposed job placing conditions with a minimum of fifteen consecutive Department acceptance tests, which met all plastic and hardened concrete test requirements.

(2) The cementitious materials and chemical admixtures, including the flowing concrete HRWR admixture, used in the proposed mix are the same materials from the same source used in the previously approved mix, (1) above.

Do not produce or place concrete until the design mixes have been approved.

346-4 Composition of Concrete.

346-4.1 Master Proportion Table: Proportion the materials used to produce the various classes of concrete in accordance with Table 3:

TABLE 3

Class of Concrete	Minimum Total Cementitious Materials Content lb/yd3	*Maximum Water to Cementitious Materials Ratio lb/lb
I	470	0.53
I (Pavement)	470	0.50
II	470	0.53
II (Bridge Deck)	611	0.44
III	611	0.44
III (Seal)	611	0.53
IV	658	0.41**
IV (Drilled	658	0.41

TABLE 3		
Class of Concrete	Minimum Total Cementitious Materials Content lb/yd3	*Maximum Water to Cementitious Materials Ratio lb/lb
Shaft)		
V (Special)	752	0.37**
V	752	0.37**
VI	752	0.37**

*The calculation of the water to cementitious materials ratio (w/cm) is based on the total cementitious material including cement and any supplemental cementitious materials that are used in the mix.

**When the use of silica fume or metakaolin is required, the maximum water to cementitious material ratio will be 0.35. When the use of ultrafine fly ash is required, the maximum water to cementitious material ratio will be 0.30.

346-4.2 Chloride Content Limits for Concrete Construction:

346-4.2.1 General: Use the following maximum chloride content limits for the concrete application and/or exposure environment shown:

TABLE 4		
Application/Exposure Environment		Maximum Allowable Chloride Content, lb/yd^3
Non Reinforced Concrete		No Test Needed
Reinforced Concrete	Slightly Aggressive Environment	0.70
	Moderately or Extremely Aggressive Environment	0.40
Prestressed Concrete		0.40

Ensure that the chloride content of all produced reinforced concrete does not exceed the maximum allowable limits specified in Table 4. When the source of any component material, including admixtures, for the concrete is changed, sampling for chloride determination shall restart the first day of production of the mix with the new component material.

Ensure the chloride test results from the testing lab are submitted to the concrete production facility within fourteen calendar days.

346-4.2.2 Certification: Certify for each mix design from the first day of production and every 30 calendar days or less thereafter to the Department that all concrete produced for the Department meets the requirements of this Section. Include in the certification all pertinent chloride test data. The Department will require properly executed certifications showing the chloride content within the required limits for acceptance of all concrete produced. Include all the chloride certificates that apply with the monthly certification of compliance as required in Section 105.

346-4.2.3 Control Level for Corrective Action:

If chloride test results exceed the limits of Table 4, suspend concrete delivery immediately for every mix design represented by the failing test results, until corrective measures are made. Reject all concrete placed from the last passing chloride test to the present, or perform an engineering analysis to demonstrate that the material meets the intended service life of the structure. In the event that an engineering analysis is proposed, supply this information within 30 business days of the failing test results from a Professional Engineer registered in the State of Florida and knowledgeable in the areas of corrosion and corrosion control. A written request for time to develop the engineering analysis may be provided to the Engineer; however, the Engineer has the sole option to accept or reject this request.

346-5 Sampling and Testing Methods.

Perform concrete sampling and testing in accordance with the following methods:

TABLE 5	
Description	Method
Slump of Hydraulic Cement Concrete	ASTM C 143
Air Content of Freshly Mixed Concrete by the Pressure Method*	ASTM C 231
Air Content of Freshly Mixed Concrete by the Volumetric Method*	ASTM C 173
Making and Curing Test Specimens in the Field	ASTM C 31
Compressive Strength of Cylindrical Concrete Specimens**	ASTM C 39
Obtaining and Testing Drilled Core and Sawed Beams of Concrete	ASTM C 42
Early Sampling of Fresh Concrete from Revolving Drum Truck Mixers or Agitators	FM 5-501
Low Levels of Chloride in Concrete and Raw Materials	FM 5-516
Density (Unit Weight), Yield and Air Content (Gravimetric) of Concrete	ASTM C 138
Temperature of Freshly Mixed Portland Cement Concrete	ASTM C 1064
Sampling Freshly Mixed Concrete	ASTM C 172
Static Segregation of Self Consolidating Concrete using Column Techniques	ASTM C 1610
Slump Flow of Self Consolidating Concrete	ASTM C 1611
Passing Ability of Self Consolidating Concrete by J-Ring	ASTM C 1621
Concrete Resistivity as an Electrical Indicator of its Permeability	FM 5-578

TABLE 5	
Description	Method
*Use the same type of meter for QC tests as the Department uses for Verification testing. When using pressure type meters, use an aggregate correction factor determined by the concrete producer for each mix design to be tested. Record and certify test results for correction factors for each type of aggregate at the concrete production facility. **Use 4 x 8 or 6 x 12 inch cylinders for determination of the compressive strength.	

346-6 Control of Quality.

346-6.1 General: Develop a Quality Control Plan (QCP) as specified in Section 105. Meet the requirements of the approved QCP and Contract Documents. Ensure the QCP includes the necessary requirements to control the quality of the concrete.

Perform QC activities to ensure materials, methods, techniques, personnel, procedures and processes utilized during production meet the specified requirements. For precast/prestressed operations, ensure that the QC testing is performed by the producer.

Accept the responsibility for QC inspections on all phases of work. Ensure all materials and workmanship incorporated into the project meet the requirements of the Contract Documents.

When concrete plastic properties (slump, air content and temperature) could be significantly affected by handling between the point of delivery and the point of final placement, including the use of pumps, conveyor belts, troughs, chutes, barge transport or other means, include provisions in the QCP to sample the plastic concrete for all testing at the point of final placement.

Ensure the QCP includes any anticipated requirements for adjusting the concrete at the placement site. Include the testing procedures that will be implemented to control the quality of the concrete and ensure that concrete placed is within the target range. Also, include provisions for the addition of water to concrete delivered to the placement site at designated level areas, to ensure the allowable amount of water stated on the concrete delivery ticket or the maximum water to cementitious materials ratio on the approved design mix are not exceeded. Ensure the anticipated ranges of jobsite water additions are described and the proposed methods of measuring water for concrete adjustments are included.

Failure to meet the requirements of this Specification or the QCP will automatically void the concrete portion of the QCP. To obtain QCP re-approval, implement corrective actions as approved by the Engineer. The Engineer may allow the Contractor to continue any ongoing concrete placement but the Engineer will not accept concrete for any new placement until the QCP re-approval is given by the Engineer.

346-6.2 Concrete Design Mix: Provide concrete that has been produced in accordance with a Department approved design mix, in a uniform mass free from balls and lumps. Discharge the concrete in a manner satisfactory to the Engineer. Perform demonstration batches to ensure complete and thorough placements in complex elements, when requested by the Engineer.

Do not place concretes of different compositions such that the plastic concretes may combine, except where the plans require concrete both with and without silica fume, ultrafine fly ash, metakaolin or calcium nitrite in a continuous placement. Produce these concretes using separate design mixes. For example, designate the mix with calcium nitrite as the original mix and the mix without calcium nitrite as the redesigned mix. Ensure that both mixes contain the same cement, fly ash or slag, coarse and fine aggregates and compatible admixtures. Submit both mixes for approval as separate mix designs, both meeting all requirements of this Section. Ensure that the redesigned mix exhibits plastic and hardened qualities which are additionally approved by the Engineer as suitable for placement with the original mix. The Engineer will approve the redesigned mix for commingling with the original mix and for a specific project application only. Alternately, place a construction joint at the location of the change in concretes.

346-6.3 Delivery Certification: Ensure that an electronic delivery ticket is furnished with each batch of concrete before unloading at the placement site. The delivery ticket may be proprietary software or in the form of an electronic spreadsheet, but shall be printed. Ensure that the materials and quantities incorporated into the batch of concrete are printed on the delivery ticket. Include the following information on the Delivery Ticket:

(1) Arrival time at jobsite,
(2) Time that concrete mix has been completely discharged,
(3) Number of revolutions upon arrival at the jobsite,
(4) Total gallons of water added at the jobsite,
(5) Additional mixing revolutions when water is added,
(6) Total number of revolutions at mixing and agitating speed.

Items 3 through 6 do not apply to non-agitating concrete transporting vehicles.

Ensure the batcher responsible for production of the batch of concrete signs the delivery ticket, certifying the batch of concrete was produced in accordance with the Contract Documents.

Sign the delivery ticket certifying that the design mix maximum specified water to cementitious materials ratio was not exceeded due to any jobsite adjustments to the batch of concrete, and that the batch of concrete was delivered and placed in accordance with the Contract Documents.

346-6.4 Tolerances: Meet the following tolerances from target values for plastic concrete properties specified in 346-3.1:

TABLE 6

Property	Target Range	Tolerance
Slump (Non-Drilled Shaft Concrete without HRWR)	± 0.75 inch	± 1.5 inch
Slump (Non-Drilled Shaft Concrete with HRWR)	± 1.0 inch	± 1.5 inch
Slump (Drilled Shaft Concrete)	± 1.0 inch	± 1.5 inch

Air Content	As shown in the range in Table 2

Reject concrete with slump or air content exceeding the above tolerances. Do not allow concrete to remain in a transporting vehicle to reduce slump. Water may be added only upon arrival of the concrete to the jobsite and not thereafter.

If the slump varies from the target range as described in Table 6, immediately adjust the concrete mixture to correct the slump of succeeding batches. The Engineer will allow a reasonable time for adjustment. Test each load to ensure only concrete meeting the specification is placed. The Engineer will take into consideration trucks already in route from the concrete production facility after the facility has been notified. If the Contractor does not implement adjustments at the earliest possible time, the Engineer may reject the concrete and terminate further production until the Contractor makes corrections.

346-7 Mixing and Delivering Concrete.

346-7.1 General Requirements: Operate all concrete mixers at speeds and volumes per the manufacturer's design or recommendation as stipulated on the mixer rating plate.

346-7.2 Transit Mixing: When water is added at the jobsite, mix the concrete 30 additional drum mixing revolutions. When the total number of drum mixing revolutions exceeds 160, do not make additional mix adjustments. Discharge all concrete from truck mixers before total drum revolutions exceed 300. Seek approval from the Engineer prior to using a central mixer and depositing the batch into a truck mixer.

346-7.3 Mixing at the Site: Use a mixer of sufficient capacity to prevent delays that may be detrimental to the quality of the work. Ensure that the accuracy of batching equipment is in accordance with requirements of this Section.

346-7.4 Concreting in Cold Weather: Do not mix concrete when the air temperature is below 45ºF and falling. The Contractor may mix and place concrete when the air temperature in the shade, and away from artificial heat, is 40ºF and rising. Protect the fresh concrete from freezing until the concrete reaches a minimum compressive strength of 1,500 psi unless the concrete is to be heat cured. The requirements of concreting in cold weather are not applicable to precast concrete placement operations occurring in a temperature controlled environment.

346-7.5 Concreting in Hot Weather: Hot weather concreting is defined as the production, placing and curing of concrete when the concrete temperature at placing exceeds 85ºF but is less than 100ºF.

Unless the specified hot weather concreting measures are in effect, reject concrete exceeding 85ºF at the time of placement. Regardless of special measures taken, reject concrete exceeding 100ºF. Predict the concrete temperatures at placement time and implement hot weather measures to avoid production shutdown.

346-7.6 Transit Time: Ensure compliance with the following maximum allowable time between the initial introduction of water into the mix and depositing the concrete in place:

TABLE 7	
Non-Agitator Trucks	Agitator Trucks
45 minutes	60 minutes
75 minutes*	90 minutes*
*When a water-reducing and retarding admixture (Type D, Type G or Type II) is used.	

346-7.7 Adding Water to Concrete at the Placement Site: Perform an initial slump before the addition of water at the jobsite. If the slump is delivered within the target range, no water will be added to the load. If the slump is outside the target range but is within the tolerance range, that load may be adjusted. After adjusting the slump, perform a test to confirm that the slump of the concrete is within the target range as defined in Table 6. Confirm with another test that the next load is within the target range. Maintain the slump within the target range on successive loads. Repeated incidents of concrete being placed outside the target range may result in revocation of that portion of the QCP. Do not place concrete represented by slump test results outside of the tolerance range.

346-7.8 Sample Location: Describe concrete placement and sampling methods in the QCP. Obtain samples from the point of final placement.

Where concrete buckets are used to discharge concrete directly to the point of final placement or into the hopper of a tremie pipe, samples will be obtained from the discharge of the bucket. When the concrete is discharged directly from the mixer into the bucket, within 25% of the total allowable transit time before discharge of the bucket, samples may be obtained from the discharge of the mixer.

Where conveyor belts, troughs, pumps, or chutes are used to transport concrete directly to the point of final placement or into the hopper of a tremie pipe, samples will be obtained from the discharge end of the entire conveyor belt, trough, pump, or chute system.

Where concrete is placed in a drilled shaft or other element using a tremie pipe and a concrete pump, samples will be obtained from the discharge of the pump line at the location of the tremie hopper.

Where a concrete pump is used to deposit concrete directly into a drilled shaft which is a wet excavation without the use of a tremie, or other applications as approved by the Engineer, ensure the discharge end of the pump line remains immersed in the concrete at all times after starting concrete placement, and the following sampling correlation procedure is followed:

a. Develop a comparative sampling correlation between the discharge of the mixer and the end of the pump line for slump and air results. Obtain five samples from the discharge of the pump line using the full length of pump line and five samples from the discharge of the mixer. Average the five samples from each sample location and compare the two averages to establish the

comparative sampling correlation. Ensure the plastic properties of the concrete sampled from the pump line are within the target range.

b. Once the comparative sampling correlation is established, and approved by the Engineer, apply this correlation to the plastic properties tolerances for samples obtained from the discharge of mixer.

c. Obtain all other samples from the discharge of the mixer delivering concrete to the pump. Ensure the plastic properties of the concrete being delivered to the pump compare with the comparative sampling correlation.

d. If the ambient temperature changes by more than 15 °F, or the configuration of the pumping system changes, the Engineer may require a new comparative sampling correlation.

346-8 Plastic Concrete Sampling and Testing.

QC tests include air content, temperature, slump, and preparing compressive strength cylinders for testing at later dates. In addition, calculate the water to cementitious materials ratio in accordance with FM 5-501 for compliance to the approved mix design.

Ensure that each truck has a valid mixer identification card issued by the Department, the revolution counter on the mixer is working properly, and calibration of the water dispenser has been performed within the last twelve months and verify batch weights within required limits of the mix design. Reject any concrete batches that are delivered in trucks that do not have mixer identification cards. The Contractor may remove the mixer identification cards when a truck mixer is discovered to be in noncompliance. When the mixer identification card is removed for noncompliance, forward the card to the District Materials Engineer in the District where the plant is located.

Perform plastic concrete tests on the initial delivery of each concrete design mix each day. Ensure QC technicians meeting the requirements of Section 105 are present and performing tests throughout the placement operation. Ensure one technician is present and performing tests throughout the placement operation at each placement site. If a placement site has multiple concrete trucks, identify the number of technicians in the Quality Control Plan. If a placement site has multiple trucks placing concrete, then have at least two technicians present at that site. Ensure that the equipment used for delivery, placement and finishing meets the requirements of this Specification. Do not proceed with the placement operation until QC tests confirm that the delivered concrete complies with the plastic properties specified. When a truck designated for QC testing arrives at the site of discharge, subsequent trucks may not discharge until QC testing results are known. Reject non-complying loads at the jobsite. Ensure that corrections are made on subsequent loads.

Furnish sufficient concrete of each design mix as required by the Engineer for verification testing. When the Engineer's verification test results do not compare with the QC plastic properties test results, within the limits defined by the Independent Assurance (IA) checklist comparison criteria, located in Materials Manual Chapter 5, disposition of the concrete will be at the option of the Contractor.

If any of the QC plastic properties tests fail, reject the remainder of that load, terminate the LOT and notify the Engineer. Make cylinders representing that LOT from the same sample of concrete.

Following termination of a LOT, obtain samples from a new load, and perform plastic properties tests until such time as the water to cementitious materials ratio, air content, temperature and slump comply with the Specification requirements. Initiate a new LOT once the testing indicates compliance with Specification requirements.

Suspend production when three consecutive LOTs, or when any five LOTs in two days of production of the same design mix are outside the specified tolerances. Make the necessary revisions to concrete operations and increase the frequency of QC testing in the QCP to bring the concrete within allowable tolerances. Obtain the Engineer's approval of the revisions before resuming production. After production resumes, obtain the Engineer's approval before returning to the normal frequency of QC testing.

If concrete placement stops for more than 90 minutes, perform initial plastic properties testing on the next batch and continue the LOT. Cylinders cast for that LOT will represent the entire LOT.

The Department may perform Independent Verification testing to verify compliance with specification requirements.

When the Department performs Independent Verification, the Contractor may perform the same tests on the concrete at the same time. The Department will compare results based on the Independent Assurance Checklist tolerances.

When the Department's Independent Verification test results do not meet the requirements of this Section, the Engineer may require the Contractor to revise the QCP.

346-9 Acceptance Sampling and Testing.

346-9.1 General: Perform plastic properties tests in accordance with 346-8 and cast a set of three QC cylinders (either 4 inch by 8 inch or 6 inch by 12 inch cylinders are acceptable), for all structural concrete incorporated into the project. Take these acceptance samples randomly as determined by a random number generator (acceptable to the Department). The Department will independently perform verification plastic properties tests and cast a set of verification cylinders. The verification cylinders will be the same size cylinder selected by the Contractor, from a separate sample from the same load of concrete as the Contractor's QC sample.

The Department may perform inspections in lieu of plastic properties tests of the precast plants producing Class I and II concrete.

For each set of QC cylinders verified by the Department, cast one additional cylinder from the same sample, and identify it as the QC "hold" cylinder. The Department will also cast one additional "hold" cylinder from each Verification sample. Provide curing facilities that have the capacity to store all QC, Verification, "hold" and Independent Verification cylinders simultaneously for the initial curing. All cylinders will be clearly identified. Deliver the QC samples, including the QC "hold" cylinder to the final curing facility in accordance with ASTM C 31. At this same time, the Department will deliver the

Verification samples, including the Verification "hold" cylinder, to their final curing facility.

Test the QC laboratory cured samples for compressive strength at the age of 28 days, or any other specified age, in a laboratory meeting and maintaining at all times the qualification requirements listed in Section 105.

The QC testing laboratory will input the compressive strength test results into the Department's sample tracking database within 24 hours. When the QC testing laboratory cannot input the compressive strength test results into the Department's sample tracking database within 24 hours, the QC testing laboratory will notify the Verification testing laboratory within 24 hours of testing the cylinder and provide the Verification testing laboratory the compressive strength test results. Ensure the compressive strength results are input into the Department's sample tracking database within 72 hours of determining the compressive strength of the cylinders.

The Department will average the QC compressive strength test data, average the Verification compressive strength test data, and compare the averages. In the event that one set of compressive strength data for a set of cylinders falls outside the range of the other set of cylinders, use the lower Range of Average Compressive Strength to determine the comparison criteria. Based on this comparison, the Department will determine if the Comparison Criteria as shown in Table 8 has been met. When the difference between QC and Verification are less than or equal to the Comparison Criteria, the QC data is verified. When the difference between QC and Verification data exceeds the Comparison Criteria, the Engineer will initiate the resolution procedure.

Table 8	
Range of Average Compressive Strength	Comparison Criteria
Less than 3500 psi	420 psi
3,501 – 4,500 psi	590 psi
4,501 – 6,500 psi	910 psi
6,501 – 8,500 psi	1,275 psi
Greater than 8,500 psi	1,360 psi

346-9.2 Sampling Frequency for Quality Control Tests:

As a minimum, sample and test concrete of each design mix for water to cementitious materials ratio, air content, temperature, slump and compressive strength once per LOT as defined by Table 9. When more than one concrete production facility is used for the same mix design, describe the method of sampling, testing and LOT numbering in the QC Plan. The Engineer will randomly verify one of every four consecutive LOTs of each design mix based on a random number generator, and may perform additional Independent Verification tests. All QC activities, calculations, and inspections will be randomly confirmed by the Department.

TABLE 9	
Class Concrete	Maximum LOT Size
I	one day's production
I (Pavement)	250 lane ft, or one day's production, whichever is less
II (Bridge Deck), III, IV, V (Special), V, VI	50 yd^3, or one day's production, whichever is less
IV (Drilled Shaft)	50 yd^3, or two hours between placements, whichever is less
III (Seal)	Each Seal placement

346-9.2.1 Reduced Frequency for Acceptance Tests: When ten consecutive strength test results from the same mix design for a Class IV or higher class of concrete are produced at the same concrete production facility, on a given Contract have all been verified and have attained an average strength greater than two standard deviations above the specified minimum, then the LOT may represent a maximum production quantity of 100 yd^3. When five consecutive strength test results from the same mix design for a Class III or lower class of concrete is produced at the same concrete production facility on a given Contract have all been verified and have attained an average strength greater than two standard deviations above the specified minimum, the LOT may represent a maximum production quantity of 100 yd^3.

The average of the consecutive compressive strength test results, based on the class of concrete, can be established using historical data from the previous project. The data must also represent the same prime/subcontractor. The last tests from the previous job must be within the last 60 calendar days or may also be established by a succession of samples on the current project. Only one sample can be taken from each LOT. Test data must be from a laboratory meeting the requirements of Section 105.

If at any time a strength test is not verified and/or the average strength of the previous ten or five consecutive samples based on the class of concrete described above, from the same mix design and the same production facility is less than the specified minimum plus two standard deviations, the maximum production quantity represented by the LOT will return to 50 yd^3. In order to reinitiate reduced frequency, a new set of strength test results will be required.

346-9.3 Strength Test Definition: The strength test of a LOT is defined as the average of the compressive strengths tests of three cylinders cast from the same sample of concrete from the LOT.

346-9.4 Acceptance of Hardened Concrete: Hardened concrete will be accepted or rejected on the basis of strength test results as defined in 346-9.3. Do not discard a cylinder strength test result based on low strength (strength below the specified minimum strength as per the provisions of 346-3 and 346-9). When QC strength test results are verified, the Engineer will accept the concrete based

on QC test results. The Engineer will accept at full pay only LOTs of concrete represented by strength test results which equal or exceed the respective specified minimum strength.

When one of the three QC cylinders from a LOT is lost, damaged or destroyed, determination of compressive strength will be made by averaging the remaining two cylinders. If more than one QC cylinder from a LOT is lost, damaged or destroyed, the Contractor will core the structure at no additional expense to the Department to determine the compressive strength. Acceptance of LOT may be based on verification data at the discretion of the Engineer. Obtain the approval of the Engineer to core, and of the core location prior to coring.

For each QC cylinder that is lost, damaged or destroyed, payment for that LOT will be reduced by $750.00 per 1,000 psi of the specified design strength [Example: loss of two Class IV (Drill Shaft) QC cylinders that has no verification data will require the element to be cored and a penalty will be assessed (4,000 psi / 1,000 psi) x $750 x 2 = $6,000. This reduction will be in addition to any pay adjustment for low strength.

When QC compressive strength test results are not verified, the resolution procedure will be used to accept or reject the concrete. Maintain the "hold" cylinders until the verification of the compressive strength test results.

346-9.5 Resolution Procedure: The Department may initiate an IA review of sampling and testing methods. The resolution procedure may consist of, but need not be limited to, a review of sampling and testing of fresh concrete, calculation of water to cementitious materials ratio, handling of cylinders, curing procedures and compressive strength testing. Core samples of the hardened concrete may be required.

The Engineer will determine through the resolution procedure whether the QC strength test results or the verification strength test results can be relied upon. When the Engineer cannot determine that either the QC or verification strength test results are in error, the concrete represented by the four consecutive LOTs will be evaluated based on the QC data. The Engineer will inform the QC and the Verification lab within four working days of the acceptance compressive strength test to transport their "hold" cylinders to the resolution lab. The QC and Verification laboratories will transport their own hold cylinder to the resolution testing laboratory within 72 hours after the Engineer notifies the Contractor that a resolution is required. In addition, the Engineer will ensure that the QC and verification "hold" cylinders are tested within seven days of the acceptance strength tests.

The resolution investigation will determine the strength test results for each of the four or less LOTs. When the QC strength test results are deemed to be the most accurate, the QC strength test results will represent the four or less consecutive LOTs and the Department will pay for the resolution testing and investigation. When the verification strength test results are deemed to be the most accurate, the Department will assess a 5 percent reduction of payment for the quantity represented by the Resolution Investigation.

The results of the resolution procedure will be forwarded to the Contractor within five days after completion of the investigation. If the Department finds deficiencies based on the Contractor's QCP, the Engineer may

suspend that part of the QCP. When the QC plan is suspended, submit corrective actions for approval to the Engineer. The Engineer may take up to five working days to review corrective actions to the QCP. The Engineer will not allow changes to contract time or completion dates. Incur all delay costs and other costs associated with QC plan suspension and re-approval.

346-9.6 Small Quantities of Concrete: When a project has a total plan quantity of less than 50 yd^3, that concrete will be accepted based on the satisfactory compressive strength of the QC cylinders. Provide certification to the Engineer that the concrete was batched and placed in accordance with the Contract Documents. Submit a quality control plan for the concrete placement operation in accordance with Section 105. In addition, the Engineer may conduct Independent Verification (IV) testing as identified in 346-9. Evaluate the concrete in accordance with 346-10 at the discretion of the Engineer. On concrete placements consisting of only one load of concrete, perform initial sampling and testing in accordance with this Section. The acceptance sample and plastic properties tests may be taken from the initial portion of the load.

346-10 Investigation of Low Strength Concrete for Structural Adequacy.

346-10.1 General: When a concrete acceptance strength test result falls more than 10% or 500 psi below the specified minimum strength, whichever is the greater deviation from the specified minimum strength, and the Department determines that an investigation is necessary, make an investigation into the structural adequacy of the LOT of concrete represented by that acceptance strength test result at no additional expense to the Department. The Engineer may also require the Contractor to perform additional strength testing as necessary to determine structural adequacy of the concrete.

Furnish either a structural analysis performed by the Specialty Engineer to establish strength adequacy or drilled core samples as specified in 346-10.3 to determine the in-place strength of the LOT of concrete in question at no additional expense to the Department. Obtain the Engineer's approval before taking any core samples. When the concrete is deemed to have low strength, obtain and test the cores and report the data to the Engineer within 14 days of the 28 day compressive strength tests. Core strength test results obtained from the structure will be accepted by both the Contractor and the Department as the in-place strength of the LOT of concrete in question. The core strength test results will be final and used in lieu of the cylinder strength test results for determination of structural adequacy and any pay adjustment. The Department will calculate the strength value to be the average of the compressive strengths of the three individual cores. This will be accepted as the actual measured value.

346-10.2 Determination of Structural Adequacy: If core strength test results are less than 500 psi or 10%, whichever is greater, below the specified minimum strength, consider the concrete represented by the cores structurally adequate. If the core strength test results are more than 10% or 500 psi, whichever is greater, below the specified minimum strength, the Department will consider the concrete represented by the cores structurally questionable. Submit a structural analysis performed by the Specialty Engineer. If the results of the

structural analysis indicate adequate strength to serve its intended purpose with adequate durability, and is approved by the Department, the Contractor may leave the concrete in place subject to the requirements of 346-11, otherwise, remove and replace the LOT of concrete in question at no additional expense to the Department.

346-10.3 Coring for Determination of Structural Adequacy: Furnish three undamaged core samples taken from the same approximate location where the questionable concrete is represented by the low strength concrete test cylinders. Select the location of the drilled cores so that the structure is not impaired and does not sustain permanent damage after repairing the core holes. Obtain the Engineer's approval of the core location prior to coring.

346-10.4 Core Conditioning and Testing: The Department will test the cores in accordance with ASTM C 42. The Engineer will make the determination whether to test the cores in a dry or wet condition. If the Engineer decides to test the cores in a wet condition, immerse the cores in water for at least 40 hours, and test the cores wet. The cores will be tested after obtaining the samples within three days for wet cores and within six days for dry cores.

346-11 Pay Adjustments for Low Strength Concrete.

346-11.1 General: Any LOT of concrete failing to meet the specified minimum strength as defined in 346-3, 346-9, 346-10 and satisfactorily meeting all other requirements of the Contract Documents, including structural adequacy, the Engineer will individually reduce the price of each low strength LOT in accordance with this Section.

346-11.2 Basis for Pay Adjustments: When an acceptance strength test result falls more than 10% or 500 psi, whichever is greater, below the specified minimum strength, core samples may be obtained in accordance with ASTM C 42 from the respective LOT of concrete represented by the low acceptance strength test result for determining pay adjustments. Price adjustment will be applied to the certified invoice price the Contractor paid for the concrete or the precast product.

Do not core hardened concrete for determining pay adjustments when the 28 day acceptance cylinder strength test results are less than 500 psi or 10%, whichever is greater, below the specified minimum strength.

Submit acceptable core samples to the Engineer for testing for determination of payment reductions based upon the results of the strength tests. The results of strength tests of the drilled cores, subject to 346-11.5 and 346-11.6, will be accepted as final and will be used in lieu of the cylinder strength test results for determining pay adjustments.

In precast operations, excluding prestressed, ensure that the producer submits acceptable core samples to the Engineer for testing. The producer may elect to use the products in accordance with 346-11. Otherwise, replace the concrete in question at no additional cost to the Department. For prestressed concrete, core sample testing is not allowed for pay adjustment. The results of the cylinder strength tests will be used to determine material acceptance and pay adjustment.

346-11.3 Coring for Determination of Pay Adjustments: Obtain the cores in accordance with 346-10.3.

346-11.4 Core Conditioning and Testing: The Department will test the cores in accordance with 346-10.4.

346-11.5 Core Strength Representing Equivalent 28 Day Strength: For cores tested no later than 42 days after the concrete was cast, the Engineer will accept the core strengths obtained as representing the equivalent 28-day strength of the LOT of concrete in question. The Engineer will calculate the strength value to be the average of the compressive strengths of the three individual cores. The Engineer will accept this strength at its actual measured value.

346-11.6 Core Strength Adjustments: For cores tested later than 42 days after the concrete was cast, the Engineer will establish the equivalency between 28 day strength and strength at ages after 42 days based on test data developed by a Department approved testing laboratory to relate strength at the actual test age to 28 day strength for the particular class of concrete and design mix represented by the cores. Obtain such data at no additional expense to the Department. When such data is not available and cannot be produced, as determined by the Department, the Engineer will determine the equivalent 28 day strength by adjusting the tested core strengths according to the following relationship:

346-11.6.1 Portland Cement Concrete without Pozzolan or Slag:

Equivalent 28-Day Strength, f'c (28) = 1/F (Average Core Strength) x 100,

where:

F = 4.4 + 39.1 (ln x) -3.1 (ln x)^2 (Type I Cement)

F = -17.8 + 46.3 (ln x) -3.3 (ln x)^2 (Type II Cement)

F = 48.5 + 19.4 (ln x) -1.4 (ln x)^2 (Type III Cement)

x = number of days since the concrete was placed

ln = natural log

346-11.6.2 Pozzolanic-Cement Concrete:

Equivalent 28 day compressive strength = $f'_c(28)$, where:

$$f_c'(28) = 0.490\ x f_c'(t)\, x e^{\left(\frac{8.31}{t}\right)^{0.276}}$$ (Type I Cement)

$$f_c'(28) = 0.730\ x f_c'(t)\, x e^{\left(\frac{2.89}{t}\right)^{0.514}}$$ (Type II Cement)

$$f_c'(28) = 0.483\ x f_c'(t)\, x e^{\left(\frac{5.38}{t}\right)^{0.191}}$$ (Type III Cement)

$f'_c(t)$ = Average Core Strength at time t (psi)

t = time compressive strength was measured (days)

346-11.6.3 Slag-Cement Concrete:

Equivalent 28-day compressive strength = $f'_c(28)$, where:

$$f_c'(28) = 0.794\ x f_c'(t)\, x e^{\left(\frac{7.06}{t}\right)^{1.06}}$$ (Type I Cement)

$$f_c'(28) = 0.730 \; x f_c'(t) \; xe^{\left(\frac{6.02}{t}\right)^{0.747}}$$ (Type II Cement)

$$f_c'(28) = 0.826 \; x f_c'(t) \; xe^{\left(\frac{2.36}{t}\right)^{0.672}}$$ (Type III Cement)

$f'_c(t)$ = Average Core Strength at time t (psi)

t = time compressive strength was measured (days)

346-11.7 Calculating Pay Adjustments: The Engineer will determine payment reductions for low strength concrete accepted by the Department and represented by either cylinder or core strength test results below the specified minimum strength, in accordance with the following:

Reduction in Pay is equal to the reduction in percentage of concrete cylinder strength (specified minimum strength minus actual strength divided by specified minimum strength).

For the elements that payments are based on the per foot basis, the Engineer will adjust the price reduction from cubic yards basis to per foot basis, determine the total linear feet of the elements that are affected by low strength concrete samples and apply the adjusted price reduction accordingly.

SECTION 347
PORTLAND CEMENT CONCRETE - CLASS NS

347-1 Description.

The requirements of this Section are applicable to concrete designated as Class NS hereinafter referred to as concrete. Use concrete composed of a mixture of portland cement, aggregates, and water, with or without chemical admixtures, slag, or pozzolanic materials. Deliver concrete to placement site in a freshly mixed, unhardened state. Ensure the concrete is placed and cured in a manner to ensure that the strength and durability of the concrete is maintained.

347-2 Materials.

347-2.1 General: Certify that all materials used in concrete are from Department approved sources, and free from frozen or other detrimental matter.

Meet the following requirements:

Portland Cement*	Section 921
Coarse Aggregate	Section 901
Fine Aggregate	Section 902
Water	Section 923
Chemical Admixtures	Section 924
Pozzolans and Slag	Section 929

*The heat of hydration requirements of Section 921 is not applicable to nonstructural concrete. Portland cements meeting the requirements of AASHTO M-85 or ASTM C-150 are allowed for nonstructural concrete.

347-2.2 Admixture Requirements: Chemical admixtures may be added at the dosage rates recommended by the manufacturer.

347-2.3 Substitution of Materials: Approved material sources may be substituted for similar materials indicated on the originally approved mix design. Use originally approved mix components and proportions, when unsatisfactory test results are obtained from the use of the substituted material(s).

347-2.4 Material Storage: Use a concrete production facility that meets the following requirements:

347-2.4.1 Cementitious Materials Storage: Provide a separate and clearly labeled weatherproof facility to store each brand or type of cementitious material without mixing or contamination. Provide a suitable, safe and convenient means of collecting cementitious material samples at each storage facility.

347-2.4.2 Aggregate Storage: Provide suitable bins, stockpiles or silos to store and identify aggregates without mixing, segregating or contaminating different grades or types of materials. Identify Department approved pit number and aggregate type/gradation. Handle the aggregates in a manner to minimize segregation and meet the specification requirements when recovered from storage. Continuously and uniformly sprinkle coarse aggregate with water, for 24 hours preceding introduction into the concrete mix. Maintain stored aggregates in a well-drained condition to minimize free water content. Provide access for the Engineer to sample the aggregates from the recovery side of the storage facility.

347-3 Production, Mixing and Delivery.

347-3.1 Concrete Production Requirements: Deliver concrete from a production facility that is certified by the National Ready-Mixed Concrete Association (NRMCA) or approved by the District Materials Office. The District Materials Office may inspect the concrete production facility's to verify compliance with the Specifications. Produce concrete utilizing equipment that is in good operating condition and operated in a manner to ensure a consistent product. Within two hours prior to each day's batching, ensure that the concrete production facility determines the free moisture for the coarse and fine aggregates. On concrete placements expected to exceed three hours, perform an additional moisture test approximately half way through the batching operations and adjust batch proportions accordingly.

Ensure that the calibration of the measuring devices of the concrete production facilities meets the requirements of Chapter 531 of the Florida Statutes. At least quarterly, ensure that all scales, meters and other weighing or measuring devices are checked for accuracy by a qualified representative of a scale company registered with the Bureau of Weights and Measures of the Florida Department of Agriculture. Have the accuracy of admixture measuring dispensers certified annually by the admixture supplier.

When Volumetric Mixers are used, deliver concrete in accordance with the requirements of Volumetric Mixer Manufactures Bureau (VMMB) and ensure that the vehicle has a VMMB registered rating plate.

347-3.2 Mixers: Ensure that mixers are capable of combining the components of concrete into a thoroughly mixed and uniform mass, free from balls or lumps of cementitious materials, and capable of discharging the concrete

uniformly. Operate concrete mixers at speeds per the manufacturer's design. Do not exceed the manufacturer's rated capacity for the volume of mixed concrete in the mixer, mixing drum, or container.

347-3.3 Delivery: The maximum allowable mixing and agitation time of concrete is 120 minutes.

347-3.4 Small Quantities of Concrete: With approval of the District Materials Engineer, small quantities of concrete, less than 3 yd^3 placed in one day and less than 0.5 yd^3 placed in a single placement may be accepted using a pre-bagged mixture. The Engineer will verify that the pre-bagged mixture is prepared in accordance with the manufactures recommendations and will meet the requirements of this Specification.

347-4 Control of Quality.

347-4.1 Concrete Mix Design: Before producing any concrete, submit the proposed mix design to the Engineer on a form provided by the Department. Use only concrete mix designs having prior approval of the Engineer.

Materials may be adjusted provided that the theoretical yield requirement of the approved mix design is met. Show all required original approved design mix data and batch adjustments and substituted material on the Department concrete delivery ticket. The Engineer may disqualify any concrete production facility for non-compliance with Specification requirements.

347-4.2 Sampling and Testing: The Engineer may sample and test the concrete at their discretion to verify its quality. The minimum 28-day compressive strength requirement for this concrete is 2,500 psi.

347-4.3 Records: Maintain the following records for review for at least three years after final acceptance of the project:

1. Approved concrete mix designs.
2. Materials source (delivery tickets, certifications, certified mill test reports).
3. A copy of the scale company or testing agency report showing the observed deviations from quantities checked during calibration of the scales and meters.
4. A copy of the documentation certifying the admixture weighing/measuring devices.
5. Recent NRMCA, VMMB or Department inspection records certifying the plant or truck can produce concrete and documentation showing that action has been taken to correct deficiencies noted during the inspections.

347-5 Certification and Acceptance.

347-5.1 General: Furnish a Delivery Ticket with each batch of concrete before unloading at the placement site. The Department will provide an example of the Delivery Ticket Form. The concrete producer may use an alternate form provided that it contains the required information. Record material quantities incorporated into the mix on the Delivery Ticket. Ensure that the Batcher responsible for producing the concrete certifies that the batch was produced in accordance with Specification requirements, signs the Delivery Ticket. Sign the

Delivery Ticket certifying that the concrete was batched, delivered and placed in accordance with these Specifications.

Acceptance by the Department will be by Certification on the Delivery Ticket, as described herein, by the Batcher and the Contractor. The Engineer will hold the Contractor responsible for rejecting loads of concrete that do not meet the minimum compressive strength requirements. Delineate and replace, at no cost to the Department, all concrete that does not meet the 28-day compressive strength requirements or has any cracking greater than 1/4 inch in width or 1/4 inch in vertical displacement. Any spalling or flaking off of the surface layer that exposes the rough, pitted aggregate surface in excess of 10 square inches is to be removed and replaced in accordance with 347-5.2. Sidewalk, ditch pavement, slope pavement, Traffic Separator, or curb and gutter having any intersecting cracks visible in the dry concrete (regardless of size) will be removed and replaced in accordance with 347-5.2.

At the sole option of the Department, the Engineer may accept concrete at a reduced pay when it is determined that the concrete will serve its intended function.

If any uncontrolled cracks appear during the life of the Contract unacceptable to the Engineer, remove and replace the concrete in accordance with 347-5.2 at no expense to the Department.

347-5.2 Remedial Action: Remedial action will be the removal and replacement of all concrete to the full depth and width.

Sidewalk, Curb and Gutter, Ditch Pavement and Traffic Separator: Begin saw cutting 2 1/2 feet either side or above and below the crack or at the nearest joint, remove and replace the 5 foot section encompassing the crack.

Slope Pavement: Saw cut each scored joint above and below the crack and replace the entire section between the saw cuts, ensuring the section removed and replaced encompasses the crack.

SECTION 350
CEMENT CONCRETE PAVEMENT

350-1 Description.

Construct Portland cement concrete pavement in one course, on a prepared subgrade. Use either the fixed-form or the slip-form method of construction. When reinforced cement concrete pavement is specified or required, use concrete reinforced with steel bars or steel fabric, in accordance with details shown in the plans. The Engineer may require a demonstration of equipment and paving operations.

If any uncontrolled cracks appear during the life of the Contract, remove and replace the cracked at no expense to the Department. Investigate and implement immediate effective solutions to eliminate further cracks, in consultation with, and subject to the approval of the Engineer.

Furnish the following information in the Quality Control Plan (QCP) as required in Section 105:

1. A detailed sequence and schedule of concrete placement operations including, but not limited to, width of pavement to be placed, proposed equipment, production rates, working hours, concrete hauling, and placement, curing, sawing, and sealing methods. Identify backup equipment and the procedures that will be followed in the case of a breakdown of equipment.

2. A method to ensure the proper placement of reinforcing steel, tie bars and dowel bars.

3. A traffic control plan that includes provisions for the placement and maintenance of barriers required to protect the pavement from traffic, for a minimum of 14 days after concrete placement.

4. Defined provisions for adequate lighting for all work done at night, including finishing, curing, and sawing joints.

5. A method for ensuring pavement thickness is met and a consolidation procedure is identified.

6. If forms are to be utilized define the material, dimensions, type, connections, and staking of the forms.

7. Define the procedure for the protection of the fresh concrete pavement from inclement weather.

350-2 Materials.

Meet the following requirements:

Concrete, Class I (Pavement)	Section 346
Grinding Concrete Pavement	Section 352
Curing Materials	Section 925
Embedded Items	Section 931
Joint Seal	Section 932

350-3 Equipment.

350-3.1 General: Ensure the equipment and tools that are to be used meet the following:

The capability of handling materials and performing all parts of the work.

To be of such capacity that the paver operates continuously and at a constant rate of production, with starting and stopping held to a minimum.

When equipment operates on the side forms, use scraping devices to clean accumulations from the top of the forms and wheels.

The forms will be a rigid material and mortar tight. Ensure that the alignment and grade of all forms are in accordance with the contract documents, prior to the placing of concrete.

350-3.2 Slip-Form Paver: Provide a slip-form paver that is self-propelled and equipped to spread, strike-off, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the equipment, in such a manner that a minimum amount of hand-finishing will be necessary to provide a dense and homogeneous pavement. Ensure that the equipment is of such dimensions and arrangement as to cover the full width of the pavement strip being placed. Use equipment that is adjustable as to crown and superelevation and that can shape and compact the concrete into a dense and stable mass, to the required cross-

section. Ensure that the crown adjustment is readily controllable for accuracy in crown transitions.

Operate the paver on tracks having sufficient contact area to prevent track slippage under load. Ensure that the length of ground contact per track and the arrangement of tracks are adequate to meet the straightedge and other riding-quality requirements specified.

Accomplish screeding by either: (1) oscillating screeds, (2) an extrusion device, or (3) a combination of both.

If necessary, in order to produce a pavement of the required cross-section and meeting the surface requirements, equip the slip-form paver with traveling side forms of sufficient dimension and strength and of proper shape to support the concrete laterally for a sufficient length of time during placing and finishing.

If using trailing forms, provide forms that are rigidly supported laterally.

Equip the slip-form paver with automatic guidance and grade controls which operate by sensing from a taut line set true to line and grade. Erect and maintain the taut line.

Automatic grade controls are not required on the paver when the tracks of the slip-form paver are operating on previously placed concrete pavement. The Engineer may waive the use of automatic grade controls on the paver when the entire width of the tracks of the slip-form paver are operating on a subgrade which has been consistently trimmed to a tolerance of 1/8 inch above or below true grade as established by the taut line set for that purpose.

350-3.3 Vibratory Units: Consolidate the concrete for the full width of the strip being placed with either surface pan type or internal type vibrators. Use a vibration method with sufficient intensity and duration to ensure complete consolidation of the concrete without causing segregation of the materials.

For the surface vibrators, use a frequency of not less than 3,500 impulses per minute. For internal type vibrators, use a frequency of not less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators. When using spud-type internal vibrators adjacent to forms, either hand-operated or attached to spreaders or finishing machines, use a frequency of not less than 3,500 impulses per minute. Measure the frequency of internal vibrators in plastic concrete. Mount spud vibrators such that the free tip trails, and space spud vibrators at a maximum interval of 30 inches.

Provide an amplitude of vibration with spud vibrators that is sufficient for the vibration to be perceptible on the surface of the concrete along the entire width of the strip being placed. Furnish a device for measuring and indicating the actual frequency of vibrations. Control all vibration by the forward movement of the spreader or finishing machine so that vibration automatically ceases when stopping the forward movement of the spreader.

350-3.4 Device for Application of Membrane Curing Compound: Provide equipment for applying membrane curing compound that is self-propelled and capable of uniformly applying the curing compound at the specified rate. Use equipment that continuously stirs the curing compound, by effective mechanical means, and that thoroughly atomizes the curing compound during the spraying operation so that the finished surface of the fresh concrete will not be marred. Cover the entire surface of the pavement and, with slip-form type paving, the

vertical faces by a single pass of the machine. Only use spray nozzles that are equipped with appropriate wind guards to ensure uniform application.

Power-spray equipment may be used to apply curing compound to areas where it is impracticable to operate the self-propelled equipment.

350-3.5 Equipment for Paving Small or Narrow Areas: For variable width areas, other than mainline, ramps, and shoulders, the Engineer will not require the full paving train as specified for the standard run of paving. Use such equipment that is approved by the Engineer.

350-3.6 Hand Finishing Tools: Provide straightedges that have a blade length of 10 feet. Use long-handled floats that have flat blades, approximately 4 feet long by 5 to 8 inches wide, and that are designed so as to remain straight and true. Use a handle for both types of tool with a length that exceeds 1/2 the width of the strip being placed by 3 feet.

350-4 Subgrade Preparation.

Keep construction of the subgrade completed for a distance of at least 500 feet ahead of the paving operation. Maintain the finished subgrade in a smooth, compact condition, and restore any areas which are disturbed prior to placing the concrete. Do not place concrete on a frozen subgrade.

Ensure that the subgrade is within two percent of the optimum moisture content while placing the concrete. Uniformly apply water ahead of the paving operations, as directed by the Engineer.

Do not allow vehicles to travel on the prepared subgrade between the subgrade trimming machine and the paving operations unless specifically authorized.

Accurately trim the subgrade to the required elevation. Trim high areas to proper elevation. Fill low areas with suitable material, compacted to the specified density, or with concrete placed integrally with the pavement. When slip-form paving, include in the width to be trimmed the areas on which the tracks of the paver will operate.

Remove material planed from the subgrade before placing any concrete. The Engineer may waive the use of the planer for small or isolated areas or any areas where its use would be impracticable.

350-5 Setting Forms.

350-5.1 General: Accurately set the forms to line and grade and such that they rest firmly, throughout their entire length, upon the subgrade surface. Join forms neatly and tightly, and brace them to resist the pressure of the equipment operating on the forms. Obtain the Engineer's approval of the alignment and grade of all forms before and immediately prior to the placing of concrete.

Fill any subgrade that is below the established grade at the form line to grade with granular material, in lifts of 1/2 inch or less, for a distance of 18 inches on each side of the pavement edge, and thoroughly compact the material. As an exception, when placing forms on a cement-treated subgrade, the Contractor may use wedging, provided that the wedging system used adequately supports the forms without causing detrimental deflection under the weight of the paving equipment.

350-5.2 Tamping: When placing forms on other than a cement-treated subgrade, adequately tamp the materials below and adjacent to the forms with form-tamping machines.

350-5.3 Advance Preparation of Forms: Keep sufficient forms on hand at all times, and set forms so that at least 500 feet of forms on each side of the roadway will be accurately set, and maintained true to line and grade, in advance of the point where concrete is being placed. Provide sufficient forms so that it is not necessary to remove them in less than 12 hours after placing the concrete.

350-5.4 Cleaning and Oiling Forms: Thoroughly clean and oil the forms after each use and before placing concrete against them.

350-6 Protection from Weather.

Inclement weather may include, but is not limited to, periods when the air temperature may fall below 35ºF, periods when the air temperature may rise above 85ºF, high winds, heavy rains and other conditions that might affect the final durability of the pavement. When rain appears imminent, stop all paving operations, and cover the surface of the unhardened concrete with the protective covering.

350-7 Placement of Reinforcement.

350-7.1 General: Where the plans call for reinforced concrete pavement, place the steel reinforcement in the pavement slab in accordance with the details shown in the plans. At the time of the concrete placement, ensure that the reinforcing steel is free from any of the following which could impair bonding of the steel with the concrete: dirt, oil, paint, grease, mill scale, and any loose or thick rust. Place the reinforcement as provided below.

350-7.2 Fabric: Place fabric reinforcement at right angles to the centerline of the pavement and accurately to the position and location shown in the plans. Lap adjacent sheets of fabric not less than 6 inches. Make the laps only in the longitudinal members.

350-7.3 Bars: Place bar reinforcement as shown in the plans. Securely wire together transverse and longitudinal bars at their intersections. Lap splices not less than 20 times the nominal diameter of the bar, and only in the longitudinal members.

350-8 Placing Concrete.

350-8.1 Distribution: Distribute the concrete on the subgrade to such depth that, when it is consolidated and finished, the slab thickness required by the plans will be obtained at all points. The surface will at no point be below the grade specified for the finished surface. Place the concrete on the subgrade in a manner which will require as little rehandling as possible.

Place concrete as near to expansion and contraction joint assemblies as possible without disturbing them. Ensure that workers do not walk in the freshly placed concrete with their boots or shoes coated with earth or other deleterious substances.

350-8.2 Use of Spreader: Place concrete on the subgrade by an approved spreading device. Do not place concrete from the discharge bucket or hopper

onto an assembly without centering the bucket or hopper directly over the assembly.

A spreader is not required in areas where the width of slab varies, intersections, and small or isolated areas where it would be impractical to use a spreader. Perform the necessary hand spreading with shovels (not with rakes or hoes).

350-8.3 Placement Widths: The Contractor may construct the pavement either in lanes as determined by the longitudinal joints shown in the plans, or for the full width in one operation. Construct the pavement to the full width of the lane or slab in a single construction operation. When constructing pavement in separate lanes, do not deviate the junction line from the true line shown on the plans by more than 1/2 inch at any point. Tool the edges of the junction to the radius shown in the plans.

When constructing pavement in separate lanes, place the lanes adjacent to the low edge of the pavement, as shown on the typical section, first.

350-8.4 Consolidation Along Forms and Joints: Thoroughly consolidate concrete against and along the faces of all forms, and along the full length on both sides of all joint assemblies, by means of hand-operated, spud-type vibrators. Do not allow vibrators to come in contact with a joint assembly, reinforcement, the subgrade or a side form.

350-8.5 Slip-Form Paver: When placing concrete with a slip-form paver, operate the paver with a continuous forward movement. If for any reason it is necessary to stop the forward movement of the paver, immediately stop operation of the vibrating or tamping elements. Do not apply tractive force to the paving machine except that which is controlled from the machine.

In case of an emergency, have available for use at the project site at least 100 feet of forms.

Do not insert steel tie-bars into the unsupported side of the freshly formed slab. The Contractor may place tie-bars into position prior to extrusion from the paver by insertion through the forms, by insertion through a temporary support form placed against the form slab, or by other means approved by the Engineer. Use a method that results in placement of the tie-bars at the specified locations with no damage or disruption of the concrete.

350-9 Striking-off, Consolidating, and Finishing Concrete.

350-9.1 General Requirements: Immediately after placing the concrete, strike-off, consolidate, and finish it to produce a finished pavement in accordance with the cross-section, width, and surface finish required by the Contract Documents. Perform the sequence of operations as follows: strike-off; vibratory consolidation; screeding; floating; removal of laitance; straightedging; and final surface finish. Except as specified, perform strike-off, consolidation, screeding, and floating by the machine method.

Use equipment that is fully and accurately adjustable to produce a pavement meeting project requirements. Use equipment that is capable of operating in a consistent and smooth manner under all conditions of use.

Provide a concrete surface true to grade and crown, and free of irregularities. If the Engineer permits adding water to assist the finishing operations, apply water as a fog spray by means of approved spray equipment.

As soon as possible after screeding while the concrete is plastic, correct all flaws such as cavities, blemishes, marks, or scratches that will not be removed by planing. Apply moisture to the concrete surface only if required and only in the immediate vicinity of the irregularity. The quantity of moisture applied should not exceed what is needed to facilitate correction of the irregularity.

350-9.2 Machine Method: Operate the machine over each area of pavement as few times and at such intervals as is necessary to give proper consolidation and to leave a surface of uniform texture. Avoid excessive operation over a particular area.

Perform strike-off, consolidation, and finishing in a manner such as to avoid damage to, or misalignment of, joint assemblies, reinforcing steel, dowels, and other embedded items. Smooth the surface of the concrete and remove the excess mortar from the surface. Carry a small amount of mortar ahead of the float device as it moves on the surface of the concrete. Operate the machine over the surface of the concrete as many times as required to obtain an acceptable surface, meeting the requirements specified herein. Discard excess mortar beyond the edge of the slab.

350-9.3 Hand Methods:

350-9.3.1 Conditions under which Allowed: Use hand methods in areas of narrow width or irregular dimensions, where operation of mechanical equipment is impracticable.

350-9.3.2 Strike-off and Screeding: Use a portable screed of an approved design, constructed either of metal or of other suitable material shod with metal, to strike-off and screed the concrete. Use a screed that is sufficiently rigid to retain its shape and is at least 2 feet longer than the maximum width of the strip to be screeded.

350-9.3.3 Consolidation: Use hand-operated spud-type vibrators to consolidate.

350-9.3.4 Floating: Use long-handled floats to float the concrete. Take the necessary care to avoid creating depressions or ridges during this operation.

350-9.4 Work Bridges: Provide work bridges or other devices necessary for access to the pavement surface for the purpose of inspection, finishing, straightedging, and performing corrective work.

350-10 Final Finish.

350-10.1 Finishing: As the water sheen disappears from the surface of the pavement and just before the concrete achieves its initial set, drag a seamless length of damp burlap that extends the full width of the strip of the constructed pavement, longitudinally along the surface to produce a uniform gritty texture.

Use a burlap drag that consists of two layers of medium weight burlap with the trailing edge of the lower layer extending approximately 2 inches behind the upper layer. Support the burlap drag in a manner so that a length of at least 3 feet of burlap is in contact with the pavement.

Except in areas where using hand methods to construct the pavement, support the lead end of the burlap drag by a traveling bridge. Maintain the drag clean and free from encrusted mortar. Replace the burlap with new material as necessary.

350-10.2 Edging: After applying the final finish, but before the concrete has become nonplastic, carefully round the edges to a 1/4 inch radius on each side of transverse expansion joints and construction joints and along any structure extending into the pavement. Produce a well-defined and continuous radius, and obtain a smooth, dense mortar finish. Completely remove all concrete from the top of the joint filler.

Check all joints with a straightedge before the concrete has become nonplastic, and, if one side of the joint is higher than the other or the entire joint is higher or lower than the adjacent slabs, make corrections as necessary.

350-11 Curing.

350-11.1 General: After completing the finishing operations and as soon as the concrete has hardened sufficiently to not mar the surface, cover and cure the entire surface and, when the slip-form method is used, cover and cure the edges of the newly placed concrete in accordance with one or more of the methods described below. In cases where curing requires the use of water, ensure that curing has prior right to use all water supplies. If the Contractor fails to provide sufficient curing materials to adequately cure the concrete in place in a timely manner, that portion of the concrete pavement section addressed in the QCP will be suspended. Do not leave the concrete exposed for a period in excess of 30 minutes between stages of curing or during the curing period.

Continuously cure the freshly placed concrete for a period of 72 hours, exclusive of any periods when the temperature of the surface of the concrete falls below 50ºF.

350-11.2 White-Pigmented Curing Compound: Under this method, uniformly apply white-pigmented curing compound to the surfaces to be cured, in a single coat, continuous film, at the minimum rate of 1 gallon to every 200 ft^2, by a mechanical sprayer.

At the time of use, thoroughly mix the compound in accordance with the manufacturer's recommendation.

Do not apply curing compound during periods of rainfall. Do not apply curing compound to the inside faces of joints to be sealed. Should the film become damaged from any cause within the required curing period, repair the damaged portions immediately with additional compound. If using side forms, upon their removal, immediately coat the sides of the slabs exposed to provide a curing treatment equal to that provided for the surface.

350-11.3 Burlap Mats: Thoroughly saturate the mats with water before placing them. Use mats of such dimensions that as laid they extend to at least 2 feet beyond the edges of the strip of concrete placed. Place and weigh down the mats throughout the curing period to ensure contact with the surface being cured. Maintain the mats fully moist and in position for the entire portion of the required curing period.

350-11.4 Removal of Forms: Do not remove forms from freshly placed concrete for at least 12 hours after placement. Remove forms carefully so as to avoid damage to the pavement. After removing the forms, immediately cure the sides of the slab in the same manner as the surface of the pavement.

350-12 Joints.

350-12.1 General: Construct joints at the locations and in accordance with the details shown in the Design Standards, Index Nos. 305 and 306 and the Contract Documents.

350-12.2 Longitudinal Joints:

350-12.2.1 Longitudinal Construction Joints: Where the pavement is poured in strips less than the full width of the pavement, construct longitudinal construction joints in accordance with the details shown in the plans.

350-12.2.2 Longitudinal Lane-tie Joints: Construct longitudinal lane-tie joints within the limits of a strip of pavement, in accordance with the details shown in the plans. Construct the plane of weakness by sawing a groove in the hardened concrete. Complete sawing as soon as possible but in no case longer than 72 hours after placing the concrete.

350-12.2.3 Tie Bars and Bolt Assemblies: Place deformed steel tie bars or tie bolt assemblies at the required depth, parallel to the finished surface, at right angles to the joint and at the uniform spacing specified or required in the plans. Place them in the plastic concrete using approved equipment, or rigidly support them on the subgrade by approved devices capable of preventing displacement prior to placing of the concrete. Do not paint or coat the bars with any material before placing them in the concrete.

If placing tie bars along a longitudinal construction joint using the method of inserting bars with a 90 degree bend in the edge of the plastic concrete and after the concrete hardens straightening these bars, use Grade 40 reinforcing steel for such tie bars. Replace any bar broken while being straightened in an approved manner.

350-12.3 Transverse Joints:

350-12.3.1 Transverse Construction Joints: Construct transverse construction joints at the end of all pours and at other locations where the paving operations are stopped for as long as 30 minutes. Do not place construction joints, however, within 10 feet of any other transverse joint or within 10 feet of either end of a section of pavement. If sufficient concrete has not been placed to form a slab at least 10 feet long, remove the excess concrete, back to the last preceding joint. Form the joints by placing a wood or metal bulkhead accurately and securely in place, in a plane perpendicular to the profile and centerline of the pavement. Install dowel bars at the construction joints. Saw or form construction joints, in a manner similar to contraction joints, so that a groove will be formed for holding the joint sealing compound.

350-12.3.2 Transverse Contraction Joints: Construct transverse contraction joints at the interval indicated in the plans consisting of planes of weakness created by sawing a groove in the surface of the hardened concrete. Place the groove perpendicular to the surface of the pavement. Install load transfer devices in transverse contraction joints.

Ensure that the sawing equipment does not damage the pavement, and saw the transverse contraction joints as soon as the pavement has hardened to the degree that tearing and raveling are not excessive and before uncontrolled shrinkage cracking begins.

Accomplish the joint sawing in two steps. Make the initial cut 1/8 inch wide by a depth at least 1/3 of the pavement thickness and as soon as possible but in no case longer than 12 hours after placing the concrete. Make a second saw cut, to provide the joint dimensions indicated in the plans, just prior to sealing the load transfer device.

In cases where a strip of pavement is being placed immediately adjacent to a previously constructed strip of pavement, construct transverse contraction joints using extreme care to time sawing so as to prevent uncontrolled cracks.

Repair any uncontrolled cracks at no expense to the Department by removing and replacing the pavement across the full width of all affected lanes or shoulders and to the nearest transverse joint in each direction.

After the final sawing, clean the joint, install the bond breaker, and seal the joint.

350-12.3.3 Transverse Expansion Joints: Form transverse expansion joints using preformed joint filler, and provide them with dowel load transfer, in accordance with the details shown on the Design Standards, or in the plans.

Form the joints during the placing of the concrete, by securely staking a metal bulkhead accurately in place at the joint location or by other methods which will securely brace and support the joint filler. Where using approved devices to keep the expansion joint filler and dowels securely in place, the Engineer will not require a bulkhead. Protect all transverse expansion joints at the bottom and side edges by a sheet metal strip as specified in 931-2.1 and as shown in the Contract Documents.

Cut the filler to the crown and shape of the slab cross-section and extended it to the subgrade. After installation, ensure that the top is not less than 1 inch, and not more than 1.25 inches, below the finished surface. Furnish the joint filler in lengths not less than the lane widths being poured, except that the Engineer will not require lengths greater than 12 feet. Where more than one section is allowed and used in a joint, securely lace or clip the sections together.

Place the filler normal to the pavement surface. Stake the assembly into position in such a way as to hold the assembly securely in position throughout construction. Ensure that the assembly is true to the line prescribed, subject to a tolerance of 1/4 inch in the width of the slab. Obtain the Engineer's approval of the assembly and its installation before placing any concrete against it. Obtain the Engineer's approval of the cross-section and length of the stakes.

When laying the pavement in partial width slabs, place transverse joints in the succeeding slab in line with the like joints in the first slab. In the case of widening existing pavement, place transverse joints in line with like joints in the existing pavement or as otherwise shown in the plans.

350-12.4 Load-Transfer Devices: Provide dowel load-transfer devices in all transverse joints. Firmly hold dowel bars in a position parallel to the surface and the centerline of the slab, by approved steel supports and spacers of a type shown

in the plans. The Engineer may approve the use of dowel bar supports or assemblies other than those specifically detailed in the plans. Allow the dowels to be free to move in one slab as the concrete contracts and expands. Paint each dowel with one coat of approved zinc rich paint (listed on the Qualified Products List), and grease one end with an approved lubricant, to prevent the concrete from bonding to the dowel. Provide a cap for the free end of expansion joint dowels.

Position each dowel such that its final deviation from parallel to the surface of the pavement and parallel to the longitudinal centerline of the pavement does not exceed 1/2 inch. Position each dowel such that its final deviation from being centered on the joint does not exceed 2 inches. Position each dowel such that at no point in its length does it deviate from the surface of the pavement as shown in the plans in excess of 1 inch. Confirm the position of dowel bars by suitable means acceptable to the Engineer, which may include non-destructive testing methods.

350-12.5 Expansion Joints Around Structures:

350-12.5.1 Expansion Joints at Manholes, Meter Boxes and other Projections: Form expansion joints by placing premolded expansion joint material about all structures and features projecting through, into or against the pavement. Ensure that such joints are 1/2 inch in width.

350-12.5.2 Bridge Approach Expansion Joints: Construct in accordance with Design Standards, Index No. 306.

350-12.6 Cleaning Joints and Cracks:

350-12.6.1 Cleaning Joints in New Pavement:

350-12.6.1.1 Sawed Joints: Immediately after sawing the joints which require sealing, completely remove the resulting slurry from the joint and the immediate area by flushing with a jet of water under pressure and by using other tools as necessary.

After flushing, blow out the joints with compressed air. After the flushed joints have dried, sandblast the joint faces to thoroughly remove all foreign material. Perform sandblasting in two passes, once for each face.

Patch all spalled edges with an epoxy compound.

Immediately prior to joint seal installation, clean the joints using compressed air to remove all traces of debris and dust within and on the joint surfaces.

350-12.6.1.2 Non-Sawed Joints: Thoroughly clean joints which require sealing of all foreign material for the full depth of the seal installation.

With the exception of slurry removal due to sawing, meet the cleaning requirements as specified for sawed joints.

350-12.6.2 Cleaning Joints in Existing Pavement: Remove all existing joint-sealing material and foreign material for the full depth of the new joint seal by sawing, wire brushing, sandblasting, or other methods approved by the Engineer.

Remove any existing sealant or parting strip material below the tape or backer rod bond breaker and replace it with additional bond breaker. When conditions require removal and replacement with additional bond breaker below the new joint seal, obtain the Engineer’s approval of the type of bond breaker and

its installation procedure. Perform cleaning by any method or combination of methods, as detailed in the plans.

Flush the joint with a pressurized jet of water, and use other tools as necessary, to remove loose remnants and debris.

After flushing, blow out the joints with compressed air. After the flushed joints have dried, sandblast the joint faces to thoroughly remove all foreign material. Perform sandblasting in two passes, once for each face.

Patch all spalled edges with an epoxy compound.

Immediately prior to joint seal installation, clean the joints using compressed air to remove all traces of debris and dust within and on the joint surfaces.

350-12.6.3 Cleaning Random Cracks in Existing Pavement: Do not begin cleaning random cracks in existing pavement until all other concrete pavement repairs have progressed to the point where those operations will not adversely affect the installation of the new seal.

Cut the random cracks to be repaired and sealed into grooved joints to the depth and width detailed in the plans. Clean the joints as specified in 350-12.6.2.

350-12.7 Sealing Joints and Cracks: Seal joints in new pavement before allowing any traffic or construction equipment on the pavement. Complete sealing within 72 hours (weather permitting) of sawing. If traffic is going to be on the pavement prior to any grinding, then seal the joints with a temporary material acceptable to the Engineer.

When using silicone and non-silicone sealants in the transverse and longitudinal joints, respectively, always use the silicone sealants first to prevent contamination at the intersection of the joint faces. Remove non-silicone sealant 1 foot in each direction from the transverse joints, and replace it with silicone sealant.

Use equipment equipped with nozzles that discharge the sealant at the bottom of the groove. Ensure that the apparatus develops sufficient pressure to extrude the joint sealer from the nozzles satisfactorily and to control the rate of application so as to completely fill the joint to within 1/4 inch of the surface of the pavement without spillage. Use an apparatus so constructed that it maintains the proper temperature of the sealing material within the manufacturer's recommendation.

350-12.7.1 Hot-Poured Type Sealant: When the plans require hot poured sealant for specific joints, fill the joint thoroughly, without trapping air, ensuring the sealant is recessed below the pavement surface as required, and control the pouring rate to avoid spilling of sealant onto the adjacent pavement surface. If any spilling of sealant occurs, immediately remove and clean the entire surplus amount from the pavement surface. Place poured material when the ambient air temperature is 50ºF or greater.

Use an indirect heating or double boiler type heating kettle that uses oil as a heat transfer medium, for hot poured sealer. Use a heating kettle that has a thermostatically controlled heat source, a built-in automatic agitator, and thermometers installed to indicate both the temperature of the melted sealing material and that of the oil bath.

350-12.7.2 Low Modulus Silicone Sealant: Use low modulus silicone sealant of either Type A (non-self-leveling silicone sealant), or Type B and/or Type C (self-leveling silicone sealant). Because Type A will not flow into the proper shape under its own weight, install and tool it so that the sealant is in firm contact with the joint faces and is formed into the appropriate shape as specified. Types B and C will normally flow into the proper shape without tooling. Exercise care to provide the required depth of recess above the sealant surface and below the pavement surface. Install the silicone sealant at temperatures above 40ºF.

350-13 Surface Requirements.

Produce, by grinding in accordance with Section 352, a pavement surface that is true to grade and uniform in appearance with a longitudinal line type texture.

350-14 Thickness Determinations.

350-14.1 General: After completing the concrete pavement, including any corrective work to meet ride requirement, determine the thickness by one of following methods. The Engineer will select the locations for testing and make the determination of thickness. Sample locations will be taken at various points on the cross-section so that each test represents an area not exceeding 2,500 yd^2. Provide traffic control, non-destructive equipment, coring equipment, and operator to obtain the samples.

350-14.1.1 Core Borings: To determine the actual thickness, drill cores from the pavement and measure thickness in accordance with ASTM C-174. Replace the portions of the pavement removed by the borings at no expense to the Department.

350-14.1.2 Non-destructive Testing: For a determination using the impact-echo method, measure the thickness of the pavement in accordance with ASTM C-1383. The initial thickness measurement will be validated by having a core boring taken at that location in compliance with 350-14.1.1. If the results from the impact-echo test vary by ± 0.15 inches from the core boring, then the non-destructive test method cannot be used on the pavement. In such case, the core boring will be used for acceptance of that LOT of concrete. The Engineer has the option to verify the accuracy of the results at any time.

350-14.2 Method of Calculating Average Thickness: The Department will determine the average thickness of the pavement by using the following method of calculation:

(a) The Department will not take into account in the calculation, any areas of pavement which are left in place, but for which no payment will be made.

(b) When the thickness of the pavement is more than 1/2 inch greater than the specified thickness, the Department will consider it in the calculation as the specified thickness plus 1/2 inch.

(c) The Department will calculate the average thickness for the entire job as a unit.

350-15 Deficient Thickness.

350-15.1 General: The Department will not pay for any pavement which is more than 1/2 inch less than the specified thickness. Any deficient pavement will be just cause for that portion of the concrete pavement addressed in the quality control plan to be suspended until the corrections are to the satisfaction of the Engineer. When the pavement contains no longitudinal construction joint, the Department will not pay for the area of such pavement that is the product of the full width of the strip placed as a unit times the sum of the distances each way from the short core or cores to the cores on each side which show measurements within the tolerance limits. When the pavement contains longitudinal construction joints, for the width, the Department will use the width between longitudinal construction joint and the edge of pavement.

350-15.2 Deficient Pavement Requiring Removal: The Engineer will evaluate areas of pavement found deficient in thickness by more than 1/2 inch and if, in his judgment, the deficiency is enough to seriously impair the anticipated service life of the pavement, remove such areas and replace them with concrete of the thickness shown in the plans. The Department will not pay for the area of pavement removed or for the materials or labor involved in its removal. When removing a section of pavement, remove the full length between transverse joints.

350-15.3 Deficient Pavement Left in Place: If the Engineer determines that the deficiency will not seriously impair the anticipated service life of the pavement, the pavement may be left in place, at no compensation.

350-15.4 Additional Borings: If the number of cores taken is not sufficient to indicate the thickness of the pavement, additional boring locations may be requested, with prior approval from the Engineer at no additional cost to the Department.

350-16 Opening Pavement to Traffic.

Construct an earth berm along each edge of the pavement within 36 hours of finishing any newly placed concrete pavement. Build the berm to the full height of the pavement and at least 18 inches wide, and sufficiently compacted to prevent underwash of the pavement. Maintain the berm until the final shoulders are complete.

Except as provided below, keep the pavement closed to traffic for a minimum period of 14 calendar days after placement of the concrete. The Engineer may permit opening of a section of pavement to traffic at an earlier time provided that representative test cylinders, made in accordance with ASTM C-31 and tested in accordance with ASTM C-39, indicate a compressive strength of at least 2200 psi. Cure these test cylinders in a manner identical to the corresponding section of pavement.

Protect the pavement from all traffic, including construction operations, until the specified period of time has elapsed. Protect the pavement from ambient temperatures below 50°F for the calendar days or until the required compressive strength has been attained.

350-17 Method of Measurement.

350-17.1 Concrete Pavement: The quantities to be paid for will be the plan quantity, in square yards, of Plain Cement Concrete Pavement and of Reinforced Cement Concrete Pavement, omitting any areas not allowed for payment under the provisions of 350-15.3 and adjusted for average thickness as provided herein.

For purposes of payment, the average thickness of pavement will determine the final pay quantities for this pavement as follows:

The area of pavement represented by the difference between the calculated average thickness and the specified thickness will be converted into equivalent square yards of specified thickness pavement, and the quantity thereby obtained will be added to, or deducted from, the quantity of pavement to be paid for, subject to the limitation that the maximum average of over-thickness permitted in the adjustment of the quantity of pavement to be paid for will be 1/4 inch.

Where the plans call for cement concrete pavement that is to be covered with asphalt concrete surface course, payment will be made for the total thickness of the combination as Plain Cement Concrete Pavement.

In such cases, price and payment will also include all costs of the asphalt concrete surface course constructed in accordance with Section 334. Reinforcing steel, placed and accepted, will be measured and paid for as provided in Section 415.

350-17.2 Joints and Cracks: Include the cost for Cleaning and Sealing Joints in the cost of the newly constructed pavement for: (1) transverse and longitudinal joint construction for new pavement; and (2) abutting joints between existing pavement and new pavement.

For replacing joint seals and sealing random cracks in existing portland cement concrete pavement, the quantity to be paid for will be as specified below:

(a) The length of pavement joint satisfactorily cleaned and sealed in existing portland cement concrete pavement, as determined by field measurement along the joints, will be paid for at the Contract unit price per foot for Cleaning and Resealing Joints.

(b) The length of random cracks in existing portland cement concrete pavement that have been satisfactorily cut, cleaned, and sealed, as determined by field measurement along the joints, will be paid for at the Contract unit price per foot for Cleaning and Sealing Random Cracks.

350-17.3 Bridge Approach Expansion Joint: The quantity to be paid for will be plan quantity, in feet of bridge approach expansion joint installed in accordance with Design Standards, Index No. 306, calculated across the pavement at right angles to the centerline of the roadway pavement, completed and accepted.

350-18 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including any preparation of the subgrade not included in the work to be paid for under another Contract item; all transverse and longitudinal joint construction, including tie-bars and dowel bars; the furnishing of test specimens; repair of core holes; and all incidentals necessary to complete the work.

Payment will be made under:

Item No. 350- 1-	Plain Cement Concrete Pavement - per square yard.
Item No. 350- 2-	Reinforced Cement Concrete Pavement - per square yard.
Item No. 350- 72-	Cleaning and Resealing Joints - per foot.
Item No. 350- 78-	Cleaning and Sealing Random Cracks - per foot.
Item No. 370- 1-	Bridge Approach Expansion Joint - per foot.

SECTION 352
GRINDING CONCRETE PAVEMENT

352-1 Description.

Grind Portland cement concrete pavement to substantially eliminate joint faulting and to restore proper drainage, ride characteristics, and skid resistance to the pavement surface.

352-2 Equipment.

Identify all equipment for grinding concrete pavement in the Quality Control Plan (QCP) as required in Section 105. Provide a power driven self-propelled machine that is specifically designed to grind portland cement concrete pavement with diamond-impregnated grinding blades. Provide, operate, and maintain in working condition all necessary equipment to ensure performance of the work in the allotted time. Use equipment of the size, shape, and dimensions that does not restrict the movement of traffic in areas outside the designated limits of construction. The equipment will be of a size that can cut or plane at least 3 feet wide or as approved by the Engineer. Use equipment that is capable of grinding specified surfaces without causing spalls at cracks, joints, or other locations. The equipment will be capable of removing any slurry or residue resulting from the grinding operation.

352-3 Construction Methods.

Grind the areas of pavement surfaces designated on the plans. Do not grind roadway shoulders unless indicated on the plans or required to promote drainage.

Schedule and proceed with the construction operation in a manner that produces a uniform finished surface. Grind in a manner that eliminates joint or crack faults while providing positive lateral drainage by maintaining a constant cross-slope between grinding extremities in each lane. Grind transition, auxiliary or ramp lane as required from the mainline edge to provide positive drainage and an acceptable riding surface.

Grind the entire area designated by the plans parallel to the centerline until the pavement surfaces of adjacent sides of transverse joints and cracks are in the same plane. Grind the concrete pavement to eliminate the faulting at joints and cracks, maintain the overall smoothness within the limits specified, and texture

over the majority of the pavement surface. Take all necessary precautions to minimize the number of minor depressions in the first place and only resolve to grind such areas if necessary. Continue grinding if accumulated total areas of minor depressions exceed 30% of the total area of a 0.1 mile section or if directed by the Engineer. Maintain the cross slope of the pavement as shown in the plans.

Establish and obtain the Engineer's approval for a means to continuously remove grinding residue.

Remove solid residue from pavement surfaces before traffic action or wind blows such residue. Do not allow residue to flow across lanes or shoulders used by public traffic or into gutters or other drainage facilities. Do not allow the discharge of any residue runoff into adjacent rivers, streams, lakes, ponds, or other bodies of water.

352-4 Final Surface Finish.

Use a grinding process that produces a pavement surface that is true to grade and uniform in appearance with a longitudinal line type texture. Provide a line type texture that contains parallel longitudinal corrugations that present a narrow ridge with a corduroy type appearance. Provide a surface finish with the peaks of the ridges approximately 1/32 inch higher than the bottoms of the grooves and with approximately 60 evenly spaced grooves per foot.

Grind to produce areas of uniform and neat surface appearance for the full width of the travel lane(s) being corrected, beginning and ending at lines perpendicular to the pavement centerline.

352-5 Acceptance Testing for Surface Tolerance.

Test the pavement surface for smoothness with either a 10 foot long straightedge, a 10 foot long rolling straightedge, or a California Type Profilograph while the Engineer observes the operations. For pavement surfaces not meeting the smoothness requirements, provide corrective work and retesting to ensure conformity approved by the Engineer.

(a) Testing with a 10 foot straightedge: Use this straightedge for longitudinal profiling, parallel to centerline, within 15 feet of a bridge approach or existing pavement which is being joined. Use it for all transverse profiling of cross slopes, approaches, and as otherwise directed with respect to (b) or (c) below.

Furnish and operate a 10 foot straightedge. When portland cement concrete pavement abuts bridge approaches or pavement not under this Contract, ensure that the longitudinal slope deviations of the finished pavement do not exceed 1/8 inch in 10 foot length.

Produce transverse slope deviations of the finished pavement that do not exceed 1/8 inch with the straightedge laid in a direction perpendicular to the centerline.

(b) Testing with a 10 foot rolling straightedge: Use this straightedge for longitudinal profiling of short pavement sections up to 250 feet long, including mainline and non-mainline sections on tangent sections and on horizontal curves with a centerline radius of curve less than 1,000 feet and the pavement within the

superelevation transition of such curves, turn lanes, ramps, tapers, and other non-mainline pavements as directed.

Furnish and operate the straightedge. Provide and operate a 10 foot rolling straightedge of a design acceptable to the Engineer, able to accurately measure surface irregularities exceeding 1/8 inch in a 10 foot effective length of the straightedge.

When tested with a straightedge, ensure that the finished pavement profile provides a uniform surface with no deviation greater than 1/8 inch in a 10 foot length. Perform the profiling in lines parallel to the centerline, at not more than 4 foot transversal spacing, and extending across the transverse joints.

The Contractor may confine checking through traffic lanes with the straightedge to joints and obvious irregularities as directed.

(c) Testing With a California Type Profilograph:

1. General: Use the profilograph on all longitudinal profiling of mainline full width pavement lanes longer than 250 feet and as otherwise directed.

The following terms are defined:

a. Profilograph: A longitudinal profile testing apparatus used to measure a pavement's surface profile deviations.

b. Profile Trace or Profilogram: A surface profile record generated along the individual wheel paths using a profilograph. Such a record is analyzed to determine the rate of roughness (or smoothness) and to identify changes in the longitudinal pavement surface elevation that exceed a specified threshold along the pavement length traversed by the profilograph.

c. Profile Index (PI): A profile measurement is a series of numbers representing elevation relative to a specified reference. A Profile Index (PI) is a summary value calculated from these numbers above and below a blanking band over a specified length of pavement.

d. Blanking Band: A band of 0.2 inch uniform height with its longitudinal center positioned optimally between the highs and the lows of the profilogram depicting at least 100 ft of pavement.

2. Equipment: Furnish, calibrate, and operate a California Type Profilograph device in accordance with FM 5-558E. The electronic model of a California Type Profilograph performs computerized data analysis, and is manufactured by Cox and Sons, Inc. of Colfax, California - Model CS 8200 or better.

3. Surface Test: Produce a riding surface meeting the requirements of FM 5-558E and having a Profile Index meeting the requirements herein. Start and terminate the profile 15 feet from each bridge approach or existing pavement, which is being joined.

Take at least two pavement profile traces with bump option turned on. Locate the position of the profiles in the traffic wheel paths. Take the profiles in the direction of the traffic and parallel to and approximately 3 feet from the outside edges of each traffic lane. The Contractor may take additional profiles to define the limits of an out-of-tolerance surface variation.

Upon completion of each day's testing, submit the profilograms to the Engineer for review to determine the pavement section in compliance with

these requirements. The Engineer will retain those profilograms meeting these requirements. The Engineer will return profilograms with deficiencies to the Contractor for use to correct section deficiencies. The Engineer will retain the corrected profilograms, along with the deficient profilograms, for comparison purposes of the circumstances between the two profilograms.

Ensure that pavement tested meets the Profile Index requirements and is applicable to the profilogram for each profile trace:

a. Ensure that pavement on tangent alignment and horizontal curves having a centerline radius of curve 2,000 feet or more has a Profile Index of 5 inches per mile or less.

b. Ensure that pavement on horizontal curves having a centerline radius of curve 1,000 feet or more but less than 2,000 feet and pavement within the superelevation transition of such curves has a Profile Index of 7 inches per mile or less.

c. Ensure that the pavement riding surfaces have all deviations in excess of 0.3 inch in 25 feet removed.

The Engineer will evaluate the pavement in 0.1 mile consecutive sections. Grind all areas represented by individual points having deviations in excess of 0.3 inch in 25 feet or less pavement length, until such points do not exceed 0.3 inch.

After removing all individual deviations in excess of 0.3 inch in 25 feet, perform additional grinding as necessary to reduce the Profile Index to the specified requirements.

Surface smoothness tests with a California Type Profilograph on bridges are specified in 400-15. Ensure that the pavement within 15 feet of a bridge approach (or existing pavement which is being joined) complies with the testing requirements of a 10 foot straightedge.

Visually inspect transverse joints and random cracks to ensure that the adjacent surfaces are in the same plane. Where misalignment of the planes of the surfaces on adjacent sides of the joints or cracks is in excess of 1/16 inch, grind the pavement until the surfaces are flush.

352-6 Surface Corrections.

After the curing period, test the surface for pavement surface smoothness in accordance with 352-5. Plainly mark all variations from the required tolerances. Where pavement surfaces do not meet the smoothness requirements, the Engineer will require corrective work and retesting to ensure conformity.

Eliminate high spots exceeding 1/8 inch in 10 feet, but not in excess of 0.3 inch in 25 feet, by grinding either with an approved machine or with a carborundum brick and water. Do not use bush-hammering or other destructive means for removing irregularities. As directed by the Engineer, retexture corrected high areas to give skid resistance comparable to the surrounding area.

Operate all milling, cutting, or grinding equipment to produce a reasonably uniform finished surface without spalling the pavement joints within corrected areas. The Engineer will not require extra grinding to eliminate minor depressions in order to provide 100% texturing of the pavement surface.

Maintain the cross slope of the pavement as shown in the plans. Repair all joint seals destroyed by grinding at no expense to the Department.

Remove and replace any area of pavement which, after grinding, still shows a deviation in excess of the allowable tolerance. Ensure that the area removed and replaced is the full length between transverse joints and the full width of the lane involved. Replace any area of concrete pavement with concrete that meets the requirements of Sections 353 or 354.

Bear the costs of all surface corrections required and of all required removal and replacement of defective surface concrete. If the grinding operation removes more than a total length of 100 consecutive feet of the grooves, then re-groove the entire width of the pavement for the deficient area.

352-7 Method of Measurement.

The quantity to be paid for will be the area, in square yards, completed and accepted.

352-8 Basis of Payment.

Price and payment will be full compensation for all work and materials specified in this Section, including furnishing all labor, materials, tools, equipment, testing, and incidentals and for doing all work involved in grinding the existing surface, removing residue, and cleaning the pavement, including necessary disposal of residue and furnishing any water or air used in cleaning the pavement.

Contract Unit Price adjustments will be made in accordance with the following schedule(s).

Average Profile Index (inches/mile) per 0.1 mile Section		Contract Unit Price Adjustments Percent of Pavement Unit Bid Price
Curvature Radius ≥2,000 ft	1,000 ft ≤ Curvature Radius < 2,000 ft	
PI ≤ 2	PI ≤ 4	103
2 < PI ≤ 5	4 < PI ≤7	100
PI > 5	PI > 7	Corrective work required

Pay (Price) Adjustments for Incentives will be based on the initial measured average Profile Index, prior to any corrective work.

The Unit Bid Adjusted Price will be computed using the plan surface area of grinding cement concrete pavement. This Unit Bid Price will apply to the total area of the 0.1 mile section for the lane width represented by the profilograms for the average Profile Index.

Payment will be made under:

Item No. 352- 70- Grinding Concrete Pavement - per square yard.

SECTION 353
CONCRETE PAVEMENT SLAB REPLACEMENT

353-1 Description.

Replace the existing defective area of concrete pavement with portland cement concrete. Repair the damaged area of adjacent slabs, caused by slab removal at no cost to the Department.

353-2 Materials.

353-2.1 General: Meet the following requirements:

Portland Cement Concrete (Class I Paving)*	Section 346
Coarse Aggregate	Section 901
Fine Aggregate	Section 902
Portland Cement	Section 921
Water	Section 923
Admixtures	Section 924
Curing Materials	Section 925
Epoxy Compounds	Section 926
Embedded Items	Section 931
Calcium Chloride	AASHTO M-144, Type 1

* Concrete will meet the requirements of Section 346 (Class I Paving) with the changes described in this Section.

Concrete pavement containing only dowel bars will be considered non-reinforced concrete.

353-3 Composition of Concrete.

353-3.1 Mixture Proportions: Designate the actual proportions to be used to produce a concrete with a minimum 6-hour compressive strength of 2,200 psi and a minimum 24-hour compressive strength of 3,000 ps.

Prior to producing concrete, submit the design mix for approval on a form acceptable to the Department. Ensure the 24-hour acceptance strength has a minimum over design of 400 psi. Indicate slump before and after addition of accelerator. Use mixes approved by the Department and from an approved concrete production facility meeting the requirements of Chapter 9.2 of the Materials Manual - Concrete Production Facilities Guidelines.

When an accelerating admixture is used in solution, the amount of water in the solution is considered to be part of the mixing water. Make necessary adjustment to the concrete mix-water to account for the amount of water in the accelerating admixture solution. Test the concrete for consistency subject to the following values from the approved mix design values:

Slump Tolerance**	±1.5 inches
Entrained Air**	1% to 6%

Temperature not to exceed 100 ºF

**For values as specified in the approved Design Mix prior to the addition of accelerating admixture.

353-3.2 Certification: Provide certification in accordance with 346-6.3.

353-3.3 Demonstration Slab: Prior to batching production concrete, demonstrate the ability to furnish replacement slabs by constructing a demonstration slab on site. Demonstrate production techniques for slab removal, dowel installation, concrete placement, finishing, slab curing, sample preparation and curing, and proper timing of joint sawing. Demonstrate the ability to achieve the required compressive strengths. Demonstrate the ability of the slabs to achieve the maturity needed for opening to traffic within the required time. Schedule construction of the demonstration slab during the same time period specified in the Contract Documents. If the Engineer determines that elements of the demonstration slab fail to meet requirements of the Contract Documents, propose adjustments to the construction processes and/or materials for the Engineer's approval. The Engineer may require additional demonstration slabs until a demonstration slab conforms with the Contract Documents.

353-4 Batching and Mixing Concrete.

Obtain concrete that meets the requirements of 346-7 with the following additional requirements:

Add all the concrete ingredients, excluding the accelerator to the truck mixer at the plant. Mix each batch at the plant at the mixing speed for 70-100 revolutions of the drum.

Agitate the concrete en route to the job site at a speed of no more than three revolutions per minute. Add the accelerator to the concrete at the job site. Mix the concrete for 40 additional revolutions at mixing speed after the accelerator is added to the mixer. Do not add accelerator to any concrete which has attained the age of 60 minutes, measured from the beginning of the initial mixing at the plant.

Incorporate the accelerator into the concrete design mix in accordance with the recommendations of the admixture supplier.

353-5 Test Requirements.

Perform concrete sampling and testing in accordance with Section 346-5. Perform the plastic property tests in accordance with 346-8, except when the mix design contains an accelerator; perform the plastic property tests prior to the addition of the accelerator. The requirements of 346-9 apply to this Section with the following modification: 28-day requirements will be replaced with 24-hours and if the design mix includes an accelerator, then the compressive strength cylinders will be fabricated after all ingredients, including the accelerator, are added.

Make a minimum of four test cylinders from the last slab for each day of placement to assess strength for protection and opening to traffic (protection set). Cure the protection set of cylinders by methods identical to those used in curing the concrete replacement slabs. Cure the acceptance set of cylinders identical to the protection set of cylinders for the first 6-hours, then by laboratory cured conditions thereafter until the 24-hour strength test. Provide a location and curing facility for initial curing of verification cylinders.

Test two cylinders from the protection set within 6-hours of sampling and consider the average compressive strength of these two tests to be the 6-hour compressive strength. If the compressive strength is below 2,200 psi, test the

remaining 2 cylinders from the protection set no longer than 6-hours from sampling. The Maturity Method specified in 353-10.2 may be used as an alternate to the protection set of concrete cylinders.

Test the acceptance and verification cylinders at 24-hours from the time of sampling.

353-6 Concrete Slab Acceptance.

Reject any Concrete not meeting the plastic property requirements of 353-5. Acceptance will be based on plastic properties, achieving the 2,200 psi compressive strength prior to opening the slabs to traffic and the 24-hour compressive strength.

If the compressive strength of any set of test cylinders fails to meet the strength requirements, take immediate corrective measures to ensure that concrete placed in the future meets the specified strength requirements. The Engineer will evaluate the particular circumstances in each instance where a strength deficiency occurs. If the Engineer determines that there will be a significant effect on the service life of the replacement slab, replace the concrete at no expense to the Department.

If any uncontrolled cracks appear during the life of the contract, remove and replace the cracked slab at no expense to the Department. Repair by removing and replacing the pavement across the full width of all affected lanes or shoulders and to the nearest transverse joint in each direction. Investigate and implement immediate effective solutions to eliminate further cracks, in consultation with, and subject to the approval of, the Engineer.

353-7 Placing, Striking Off, Consolidating and Finishing Concrete.

Place concrete as specified in 350-8.

The requirements of 350-9 and 350-10 are applicable to this Section.

Perform straight edging while the concrete is still in plastic state after floating is completed and the excess water removed. Furnish and operate a 10 foot straightedge meeting the requirements of 350-3.6. Hold the straightedge in successive positions parallel to the road centerline, in contact with the surface, testing until the replacement slab is straight edged from one side to the other. Advance along the road in successive stages of not more than one-half the length of the straightedge. Fill any depressions immediately with freshly mixed concrete, strike-off, consolidate and refinish. Cut down and refinish any high areas. Continue straightedge testing and surface correction until the entire surface conforms to the required grade and cross section. Ensure that transverse slope deviations of the finished pavement do not exceed 1/8 inch with the straightedge laid in a direction perpendicular to the centerline. When portland cement concrete pavement abuts bridge approaches or pavement not under this Contract, ensure that the longitudinal slope deviations of the finished pavement do not exceed 1/8 inch in 10 foot length. Produce a uniform, gritty textured final finish longitudinally along the pavement by dragging a broom or seamless strip of damp burlap, having at least 3 feet in contact with the pavement.

When required in the Contract Documents, produce a pavement surface that is true to grade and uniform in appearance with a longitudinal line type texture by grinding in accordance with Section 352.

353-8 Curing.

Cure the slab as specified in 350-11, except for time and temperature restrictions. Use curing compounds as specified in 350-11.2 after completing the finishing operations. After the curing compound has been applied, cover the surface and exposed edges with two layers of white burlap-polyethylene curing blanket conforming to Section 925 or insulating blankets approved by the Engineer. Cover the slab with the curing materials as soon as the slab hardens enough to resist marring the concrete surface. Continue curing the slab until the concrete achieves the required 6-hour strength.

353-9 Joints.

353-9.1 General: Construct transverse joints as specified in 350-12 and as shown on the Design Standards, except that dowels bars are installed per 353-9.2. Tie bars will not be placed along the longitudinal joints unless shown in the Contract Documents. Apply a liquid bond breaker recommended by the manufacturer for the intended application to all vertical faces of the adjacent slabs.

353-9.2 Dowel Bars: Provide dowel bars in accordance with the details shown in the Contract Documents.

353-9.2.1 Dowel Bars at Transverse Joint Between two Replacement Slabs: Follow the requirements of 350-12 when providing dowel bars at a transverse joint between two freshly placed replacement slabs.

353-9.2.2 Dowel Bars at Transverse Joints Between Existing and Replacement Slabs: Follow the requirements of 350-12, except drill holes and install dowel bars into the sawed face or end of the existing slab. Develop load transfer between existing and freshly placed replacement slab. The dowels shall be free to move inside the replacement slab and epoxy-bonded into the existing slab.

353-9.2.3 Dowel Bar Installation: Install dowel bars in accordance with Section 416 except as modified herein. Use a gang drill (several drills mounted parallel in a rigid frame), when enough operating space is available. Drill parallel to the centerline of the concrete pavement.

Inject epoxy into the hole after cleaning and prior to dowel insertion. Start injection at the back of the hole to force the epoxy to move forward during dowel insertion. Twist the dowel a minimum of one full turn during the insertion to ensure that the epoxy completely surrounds the dowel. The injection process and viscosity of the epoxy shall be adequate to insure that the space between the surface of the dowel and the inside of the hole is completely filled with epoxy.

Do not allow the epoxy to escape from the front of the hole after inserting the dowel in the hole. Use a grout retention disk 1/8 inch thick, fabricated from nylon or plastic, to hold epoxy in the hole during dowel insertion.

353-10 Protection and Opening to Traffic.

353-10.1 General: The requirements of 350-6 apply to this Section. Keep the slab closed to traffic until the compressive strength requirement of 2,200 psi is achieved. Verify the achievement of the required strength by cylinder testing as specified in 353-5 or the use of the maturity method test as described in 353-10.2. Provide documentation that 6-hour strength was achieved prior to opening to traffic, by either a cylinder test report or a printed maturity meter monitoring record.

Protect the pavement from all traffic, including construction vehicles, until the specified 2,200 psi strength has been obtained. Include in the Quality Control Plan (QCP) what actions will be used to protect the pavement. The protective measures shall be arranged so as not to interfere with traffic lanes being utilized for required maintenance of traffic.

353-10.2 Maturity Method Testing: Provide and perform, with the assistance of the Engineer, Maturity Method Testing as specified in ASTM C-1074 using Maturity Meter apparatus specified therein.

Maturity Method Testing may be used to estimate the in-place strength of that days production of concrete slabs. Temperature sensors will be embedded at locations designated by the Engineer.

When this method is used, a strength-maturity relationship chart, as outlined in ASTM C-1074, will be prepared and tested at the concrete producer's design mix trial batch laboratory, or at other approved laboratory facilities designated by the Engineer. Compressive strength tests, as specified in ASTM C-1074, will be generated to produce a five point curve with points before and after the target and with prior approval by the Engineer.

The Engineer may require compressive strength testing as outlined in 353-5. Fabricate six test cylinders for protection strength and Maturity Meter correlation testing. The compressive strength cylinder and maturity meter correlation testing will be performed for the first production day and at the discretion of the Engineer for each remaining placement week, or until terminated by the Engineer.

353-11 Method of Measurement.

The quantity to be paid for will be the volume, in cubic yards, of concrete placed and accepted. The quantity will be calculated on the basis of field-measured horizontal dimensions and pavement design thickness. No additional compensation will be allowed for additional concrete required to bring the proposed concrete slab up to finished grade.

353-12 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section and shall include demonstration slab construction, all joint construction, including tie bars and dowels, furnishing of test specimens, and all necessary incidentals.

Payment will be made under:

Item No. 353- 70-	Concrete Pavement Slab Replacement - per cubic yard.

SECTION 355
VALUE ADDED PORTLAND
CEMENT CONCRETE PAVEMENT

355-1 Description.

Construct Value Added Portland Cement Concrete Pavement (Concrete Pavement), subject to a five year warranty period. This Section applies to only new pavements, including added lanes.

Assume responsibility for the quality control, production, placement, consolidation, testing and inspection of all concrete mixtures. Assume responsibility for all mix designs and furnish a copy of each mix design to the Engineer at least 14 days prior to any paving work.

Perform all the associated work specified in this Section for a period of five years after final acceptance of the Contract in accordance with 5-11, including continued responsibility as to any deficiencies discovered by the Department and as to which notice was provided within such maintenance warranty period until all such pre-existing deficiencies are resolved.

The work specified in this Section will not be paid for directly, but will be considered as incidental to other concrete pay items.

355-2 Materials and Construction Requirements.

Meet the requirements of the following:

Portland Cement Concrete.....Section 346
Cement Concrete Pavement .....Section 350
Grinding Concrete Pavement .....Section 352

355-3 Statewide Disputes Review Board.

The Statewide Disputes Review Board in effect for this Contract will resolve any and all disputes that may arise involving administration and enforcement of this Specification. The Contractor and the Department acknowledge that use of the Statewide Disputes Review Board is required, and the determinations of the Statewide Disputes Review Board for disputes arising out of this Specification will be binding on both the Contractor and the Department, with no right of appeal by either party.

Meet the requirements of 8-3.

355-4 Pavement Evaluation and Remedial Action.

355-4.1 General: The Department's Pavement Condition Survey Program and observation by the Engineer will be used as the basis for determining the extent and the magnitude of the pavement distresses occurring on the project. For evaluation purposes, the project will be subdivided into sections of 0.1 mile per lane. The Department may conduct a section by section Pavement Condition Survey of the value added pavement at intermediate times throughout the warranty period. The final survey, if determined by the Engineer to be necessary, will be conducted no later than 45 calendar days before the end of the warranty

period. All surveys conducted by the Department will be at no cost to the Contractor.

The results of the survey, intermediate or final, will be made available to the Contractor within 15 calendar days after completion of the survey.

If the survey findings, intermediate or final, are to be disputed by the Contractor, written notification must be provided to the Engineer within 30 calendar days of the date of receipt of the survey.

During the warranty period, the Contractor may monitor the pavement using nondestructive procedures. Do not conduct any coring, milling or other destructive procedures without prior approval by the Engineer.

355-4.2 Distress Indicators: The Department will use Rideability, Spalling and Cracking, as distress indicators in accordance with the Rigid Pavement Condition Survey Handbook to evaluate the Concrete Pavement.

355-4.3 Threshold Values and Remedial Work: Threshold values and associated remedial work for the Concrete Pavement are specified in Table 355-1.

TABLE 355-1
Condition Survey

DEFICIENCY TYPE	THRESHOLD LEVEL	REMEDIAL ACTION
Rideability	Ride Number < 3.70	Grind all deficient sections in accordance with Section 352.
Spalling in the wheel path	Four areas in any Lane Mile exceeding 1 inch in width and exceeding 6 inches in length OR any single area exceeding 3 inches in width.	Full depth slab replacement for a minimum of 6 feet in length and the full width of the slab in accordance with Section 353.
Spalling outside the wheel path	Four areas in any Lane Mile exceeding 1 1/2 inches in width and 12 inches in length OR any single area exceeding 3 inches in width and 12 inches in length.	Full depth slab replacement for a minimum of 6 feet in length and the full width of the slab in accordance with Section 353.
Cracking	Four Cracks in any Lane Mile with width exceeding 1/8 inch OR any Crack exceeding 3/16 inch.	Full depth slab replacement for a minimum of 6 feet in length and the full width of the slab in accordance with Section 353.
Shattered Slab	Cracking patterns that divide the slab into three or more segments	Full slab replacement in accordance with Section 353.

If a measured distress value indicates remedial action is required per Table 355-1, begin remedial work within 45 calendar days of notification by the Department or a ruling of the Statewide Disputes Review Board. The Statewide Disputes Review Board will determine the allowable duration for the completion of the remedial work, but not to exceed 6 months. However, after each survey, if the Department determines the extent and magnitude of pavement distresses in any areas will not affect the traffic safety, strength of pavement structure or highway esthetics, the Engineer, at his sole option, may defer the remedial work associated with the pavement distresses.

If remedial action is necessary and forensic information is required, it is the responsibility of the Contractor to determine the source of the distress. The Contractor will not be responsible for damages to the pavement as a result of any forensic activities conducted at the discretion of the Engineer.

The Contractor has the first option to perform all remedial work, as determined by the Department. If, in the opinion of the Engineer, the problem poses an immediate danger to the traveling public and the Contractor cannot begin remedial work within 72 hours of written notification, the Engineer has the authority to have the remedial work performed by other forces. The Contractor is responsible for all incurred costs of such work performed by other forces. Remedial work performed by other forces does not alter any of the requirements, responsibilities or obligations of the Contractor.

Complete all remedial work to the satisfaction of the Engineer. Any disputes regarding the adequacy of the remedial work will be resolved by the Statewide Disputes Review Board. Approval of remedial work does not relieve the Contractor from continuing responsibility under the provisions of this Specification.

Notify the Engineer in writing prior to beginning any remedial work. Meet the requirements of the Department's Standard Specifications for Road and Bridge Construction when performing any remedial work. Perform all signing and traffic control in accordance with the current edition of the Department's Design Standards for Design, Construction, Maintenance and Utility Operations on the State Highway System. Provide Maintenance of Traffic during remedial work at no additional cost to the Department. Lane closure restrictions listed in the original contract will apply to remedial work. Written request(s) to obtain permission for lane closure(s) for either forensic investigation or remedial work must be made to the Engineer 48 hours in advance of any lane closures. Do not perform any lane closures until written permission is given by the Engineer.

Perform all remedial work at no cost to the Department. If remedial work necessitates a corrective action to the pavement markings, adjacent lane(s), or roadway shoulders, perform these corrective actions using similar products at no additional cost to the Department.

355-5 Remedial Work.

During the warranty period, perform all necessary remedial work described in 355-4 at no cost to the Department. Should an impasse develop in regard to the required remedial work, the Statewide Disputes Review Board will render a final decision by a majority vote.

The warranty will not apply to deficiencies caused by any one of the following factors, or any other factor found to be beyond the control of the Contractor:

a. Determination that the accumulated ESALs (Number of 18 Kip Equivalent Single Axle Loads in the design lane) have increased by 25% or more over the Accumulated ESALs used by the Department for the design purposes for the warranty period, as determined in accordance with Chapter 8 of the FDOT Project Traffic Forecasting Handbook. In calculating the ESALs, the Average Annual Daily Traffic will be obtained from the Department's traffic classification survey data.

b. Determination that the deficiency was due to failure of the existing underlying layers, for which the Contractor was not responsible.

c. Determination that the deficiency was the responsibility of a third party or its actions, unless the third party was performing work included in the Contract.

355-6 Failure to Perform.

Failure to timely submit any dispute to the Statewide Disputes Review Board, failure to satisfactorily perform any remedial work, or failure to compensate the Department for any remedial work performed by the Department and determined to be the Contractor's responsibility in accordance with this Specification, the Department will suspend, revoke or deny the Contractor's certificate of qualification under the terms of Section 337.16(d)(2), Florida Statutes, for a minimum of 6 months or until the remedial work has been satisfactorily performed (or full and complete payment for remedial work performed by others made to the Department), whichever is longer. Should the Contractor choose to challenge the Department's notification of intent for suspension, revocation or denial of qualification and the Department's action is upheld, the Contractor will have its qualification suspended for an additional minimum of 6 months.

The remedial work is not an obligation of the Contractor's bond required by Section 337.18, Florida Statutes.

SECTION 370
BRIDGE APPROACH EXPANSION JOINTS

370-1 Description.

Construct special expansion joints for concrete pavement near the bridge approach slabs that consist of a section of reinforced concrete subslab supporting the roadway concrete pavement, with a portion of the roadway pavement over the subslab interrupted by a galvanized sheet metal strip, in accordance with the details shown in the Design Standards, Index No. 306 and the Contract Documents.

370-2 Materials.

Bar Reinforcement: Use bar reinforcing steel meeting the requirements of 931-1.1.

Concrete: For the expansion joint subslab, use concrete meeting the requirements of Section 347.

Galvanized Sheet Metal: Use galvanized sheet metal meeting the requirements shown in the plans.

Seal: Use polychloroprene compression seal as shown in Design Standards, Index No. 306.

370-3 Construction Methods.

Construct the expansion joints in accordance with the applicable requirements of Sections 346, 347, 350, 415, Design Standards, Index No. 306 and as directed by the Engineer.

370-4 Method of Measurement.

The quantity to be paid for will be plan quantity, in feet, calculated across the pavement at right angles to the centerline of the roadway pavement, completed and accepted.

370-5 Basis of Payment.

Price and payment will be full compensation for all work and materials specified in this Section or required for the expansion joint, including concrete subslab, sheet metal strip, reinforcing steel, compression seal and all additional excavation required.

Payment will be made under:

Item No. 370- 1-	Bridge Approach Expansion Joint - per foot.

SECTION 400
CONCRETE STRUCTURES

400-1 Description.

Construct concrete structures and other concrete members, with the exception of pavement and incidental concrete construction (which are specified in other Sections).

Refer to Section 450 for prestressed construction requirements additional to the requirements of this Section.

For precast concrete structures meet the requirements of Section 450 for storage, shipping and erection.

Obtain incidental precast products from a plant that is currently on the list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3.

400-2 Materials.

Meet the following requirements:

Concrete	Sections 346 and 347
Penetrant Sealer	Section 413
High Molecular Weight Methacrylate (HMWM)**	Section 413
Reinforcing Steel	Section 415
Water	Section 923
Curing Materials*	Section 925
Epoxy Bonding Compounds**	Sections 926 and 937
Joint Materials**	Section 932
Bearing Pads	Section 932
Non-Shrink Grout**	Section 934
Class 5 Applied Finish Coatings**	Section 975
Galvanizing Compound**	Section 562
Dowel Bar Assembly**	Section 931

*The Engineer will allow clean sand and sawdust for certain curing, when and as specified.

** Use products listed on the Department's Qualified Products List (QPL).

400-3 Depth of Footing.

Consider the elevations of the bottoms of footings, as shown in the plans, as approximate only. The Engineer may change dimensions or elevations of footings as necessary to secure a satisfactory foundation. If the elevation of a footing as shown in the plans is changed to a higher or lower elevation, the Engineer will not consider such change as a material change to the original Contract Documents, a waiver of any condition of the Contract, or an invalidation of any of the provisions of the Contract. If the excavation must be carried deeper than shown in the plans to obtain a satisfactory foundation, the Engineer will revise the plans in accordance with one of the following methods:

(a) The Engineer will keep the top of the footing at the elevation shown in the original plans and will increase the thickness to obtain a satisfactory foundation. The Engineer will follow this method when the change in bottom elevation of the footing is 12 inches or less. When this method is followed, place the reinforcing steel the same as if the footings, as shown in the original plans, were placed on a subfooting of plain concrete; make no alteration in the position of the reinforcing bars relative to the top of the footing.

(b) The Engineer will revise the plans and lower the footing, thereby increasing the height of stem, to obtain a satisfactory foundation. Generally, the Engineer will increase the thickness and width of footing over that shown in the original plans. If this method is followed, use the dimensions, sizes, and location of reinforcing steel shown in the revised plans. The Engineer will follow this method when the change in elevation of the bottom of footing exceeds 12 inches.

The Engineer will determine which of the above methods to use.

400-4 Falsework.

400-4.1 Plans: At the Engineer's request, furnish detailed plans for falsework or centering to the Department. The Contractor is responsible for results obtained by using these plans.

400-4.2 Design and Erection: Design and construct all falsework to provide the necessary rigidity and to support the loads without appreciable settlement or deformation. Use screw jacks or hardwood wedges to take up any settlement in the framework, either before or during the placing of concrete. If any weakness develops and the centering shows undue settlement or distortion, stop the work, remove any masonry affected, and strengthen the falsework before resuming work. Support falsework which cannot be founded on a satisfactory footing on piling. Space, drive, and remove the piling in an approved manner.

400-4.3 Camber: Provide camber to correct for settlement and deflection of falsework. Give bridges permanent camber only when shown in the plans.

400-5 Forms.

400-5.1 General: Provide forms, either of wood or metal, that are as follows: (a) externally secured and braced where feasible; (b) substantial and unyielding; (c) of adequate strength to contain the concrete without bulging between supports and without apparent deviation from the neat lines, contours, and shapes shown in the plans. Design forms to withstand the additional forces of vibration without apparent deviation from the desired shape or position. Assemble forms to be mortar-tight. If using lumber forms, construct them of dressed wood of uniform thickness. Use form liners on wooden forms where Class 3 surface finish is specified. Construct assembled forms to render a concrete surface of smooth, uniform finish. Make provisions to remove forms without injury to concrete surfaces. Remove blocks and bracing with the forms, and do not leave any portion of the forms in the concrete. Use the same form system for a type of work throughout.

400-5.2 Inspection and Approval: Do not place concrete in a form until the form has been inspected and approved. Although the Engineer inspects and approves the forms, the Contractor is responsible for obtaining satisfactory

concrete surfaces, free from warping, bulging, or other objectionable defects. Pay special attention to the ties and bracing. Where the forms appear to be insufficiently braced or unsatisfactorily built, stop and correct defects to the satisfaction of the Engineer.

400-5.3 Non-metallic Form Materials:

400-5.3.1 Lumber: For all surfaces, use lumber that is not less than 3/4 inch in thickness, dressed, and free of knot holes, loose knots, cracks, splits, warps, and other defects. Proportion the spacing of studs, joists, and wales to exclude warps and bulges and to produce true and accurate concrete surfaces. Only use structurally sound lumber.

400-5.3.2 Form Liners: Use form liners of durable, abrasion resistant materials that are unaffected by water. Use liners with a hard surface texture capable of rendering concrete surfaces of a smooth, uniform texture, without grain marks, patterns, or blemishes. Use form liner material of sufficient thickness to eliminate the reflection of irregularities, undesirable patterns, and marks from the forms to the surfaces. Replace liners as necessary to produce a consistent concrete surface texture. Use form liners in large sheets and with true, tight-fitted joints which are logically located. Obtain the Engineer's approval of the layout of sheets. Do not use liners which have been patched. Use liner material of the same stock throughout.

400-5.3.3 Plywood: The Contractor may use plywood of not less than 5/8 inch in thickness manufactured with waterproof glue or protected with an approved impervious coating. Do not use pieces with bulged plies or raveled, untrue edges.

400-5.4 Special Requirements:

400-5.4.1 Re-entrant Angles: Use chamfered forms for exterior concrete corners and filleted forms for interior concrete corners. Use chamfers and fillets that are 3/4 by 3/4 inch and are mill-dressed on all sides to uniform dimensions. The Contractor may use plastic or metal chamfers and fillets provided they perform satisfactorily in producing uniform, smooth concrete corner surfaces without honeycomb.

400-5.4.2 Handrails and Parapets: Construct barriers and parapets in accordance with Section 521.

400-5.4.3 End-bent Caps: Do not place forms for end-bent caps until the embankment has been constructed to within 12 inches of the bottom of the cap. Place a mass of embankment that is sufficient to produce the subsidence, displacement, and settlement which may result from the construction of the total embankment.

400-5.4.4 Footings: Where footing concrete can be placed in dry excavation, the Contractor may omit cribs, cofferdams, and forms, subject to compliance with the following limitations and conditions:

(a) Use this procedure only in locations not exposed to view from traveled roadways.

(b) Obtain required elevations shown in the plans.

(c) Obtain neat line dimensions shown in the plans.

(d) Fill the entire excavation with concrete to the required elevation of the top of the footing.

(e) The Engineer will determine the volume of footing concrete to be paid for from the neat line dimensions shown in the plans.

400-5.5 Form Alignment, Bracing, and Ties: Construct forms in such manner that they may be adequately secured for alignment, shape, and grade. Use bracing systems, ties, and anchorages that are substantial and sufficient to ensure against apparent deviation from shape, alignment, and grade. Do not drive nails into existing concrete. Do not use bracing systems, ties, and anchorages which unnecessarily deface or mark, or have an injurious or undesirable effect on surfaces that will be a part of the finished surface.

If metal ties and anchorages are to remain in the concrete, construct them so as to permit the removal of metal to at least 1 inch beneath the finished surface of concrete. Use accessories for metal ties and anchorages that allow the removal of metal to the prescribed depth while leaving the smallest possible repairable cavity.

When using wire ties, cut or bend them back from the finished surface of the concrete a minimum of 1 inch. Do not use internal ties of wire when forming surfaces that are exposed to view.

400-5.6 Preparation and Cleaning: Meet the following requirements for the condition of forms at the time of beginning concrete casting:

(a) Treat all forms with an approved form-release agent before placing concrete. Do not use material which adheres to or discolors the concrete.

(b) Clean forms of all concrete laitance from previous use and all dirt, sawdust, shavings, loose wire ties and other debris.

(c) Close and secure all inspection and cleanout holes.

400-5.7 Stay-In-Place Metal Forms:

400-5.7.1 General: Utilization of stay-in-place metal forms is permitted in lieu of removable forms to form concrete bridge decks between beams and between the webs of individual box girders when designated in the plans. Stay-in-place metal forms may be of the cellular, non-cellular or non-cellular with top cover sheet type. The flutes of non-cellular stay-in-place metal forms may be filled with polystyrene foam or concrete. When polystyrene foam is used to fill the forms, fill form flutes completely; do not allow any portion of the polystyrene foam to extend beyond the limits of the flutes. Ensure that the polystyrene foam remains in its required position within flutes during the entire concrete placement process. Do not use reinforcing steel supports or other accessories in such a manner as to cause damage to the polystyrene foam. Replace all damaged polystyrene foam to the satisfaction of the Engineer.

Apply polymer sheeting to stay-in-place metal forms in accordance with the requirements in the following table. Apply polymer sheeting to all faces and edges (including sheared edges) of support angles used on bridges with Moderately and Extremely Aggressive Superstructure Environmental Classifications (as shown in the Plans). No polymer sheeting is required for beam attachment straps or clips partially embedded in concrete, and for support angles used on bridges with a Slightly Aggressive Superstructure Environmental Classification. Use polymer sheeting materials and application methods as described herein.

Polymer Sheeting Usage Requirements				
Form Type		Superstructure Environmental Classification (as shown in Plans)		
		Slightly Aggressive	Moderately Aggressive	Extremely Aggressive
Non-cellular form with concrete filled flutes		No polymer sheeting required	Polymer sheeting required on bottom side	Polymer sheeting required on bottom side
Non-cellular form with polystyrene foam filled flutes		Polymer sheeting required on inside	Polymer sheeting required on both sides*	Polymer sheeting required on both sides*
Non-cellular form with Top Cover Sheet	Top Cover Sheet	Polymer sheeting required on bottom side	Polymer sheeting required on bottom side	Polymer sheeting required on bottom side
	Non-cellular form	Polymer sheeting required on top side	Polymer sheeting required on both sides*	Polymer sheeting required on both sides*
Cellular form		No polymer sheeting allowed or required	Not permitted	Not permitted
* Polymer sheeting not required on bottom side of form located within box girders and U-beams.				

Prior to using stay-in-place metal forms, submit detailed plans for approval of the forming system, including method of support and attachment and method of protecting the supporting structural steel components from welding effects. Submit design calculations for the forming system, which have been signed and sealed by the Specialty Engineer. Detail stay-in-place metal forms such that they in no way infringe upon the concrete outline of the slab shown on the plans. Use stay-in-place metal forms that provide and maintain the dimensions and configuration of the original slab in regards to thickness and slope.

Do not weld stay-in-place metal form supports and connections to the structural steel components. Do not connect polymer coated angles or other hardware that support polymer coated metal forms to the beam attachment straps or clips by welding.

Protect structural steel components from damage by using a shield to guard against weld splatter, weld overrun, arc strikes, or other damaging effects of the welding process. Upon completion of welding, rest the metal form support flush on the supporting steel component. Should any weld spatter, weld overrun, arc strike, or other effects of the welding process be evident or occur to the structural steel component, immediately stop in-place welding of the metal form supports for the remainder of the work. In this event, weld all metal form supports off of the structure and erect the forms after prefabrication, or use an

alternate approved method of attaching the form supports. Remove improper weldment, repair the supporting steel component for any improper welding. Perform all required verification and testing at no expense to the Department and to the satisfaction of the Engineer.

Do not use stay-in-place metal forms until the forming system has been approved by the Engineer. The Contractor is responsible for the performance of the stay-in-place forms.

Structures designed, detailed, and dimensioned for the use of removable forms: Where stay-in-place metal forms are permitted, the Contractor is responsible and shall obtain the approval of the Engineer for any changes in design, etc. to accommodate the use of stay-in-place forms. The Engineer will compute pay quantities of the various components of the structure which are paid on a cubic yard basis from the design dimensions shown on the plans with no allowance for changes in deflection or dimensions necessary to accommodate the stay-in-place forms or concrete to fill the form flutes. The Engineer will limit pay quantities of other Contract items that the Contractor increases to accommodate the use of stay-in-place forms to the quantity required for the original plan design.

Submit all changes in design details of bridge structural members that support stay-in-place forms, showing all revisions necessary to enable the supporting components to withstand any additional weight of the forms and the weight of any extra concrete that may be required to fill the forms. Include with the design calculations a comparative analysis of the stresses in the supporting components as detailed on the Contract plans and as modified to support the forms. Use the identical method of analysis in each case, and do not allow the stresses in the modified components to exceed those of the component as detailed in the Contract plans. Include with the design the adjusted cambers for any changes in deflection over those shown on the original plans. Modify the beams to provide additional strength to compensate for the added dead loads imposed by the use of stay-in-place forms. Obtain the additional strength by adding strands to the pre-stressed beams or by adding steel material to increase the section modulus of steel girders. Substantiate the added strength by the comparative calculations. Do not use stay-in-place forms until the forming system and all necessary design revisions of supporting members have been approved by the Engineer.

Structures designed, detailed, and dimensioned for the use of stay-in-place metal forms:

Prior to using stay-in-place metal forms, submit detailed plans for approval of the forming system (including method of support and attachment) together with design calculations. Include an analysis of the actual unit weight of the proposed forming system over the projected plan area of the metal forms. If the weight thus calculated exceeds the weight allowance for stay-in-place metal forms and concrete required to fill the forms shown on the plans, then modify the supporting components to support the excess weight as specified by the Contractor’s Specialty Engineer.

For all structures utilizing structural steel supporting components, paint the vertical sides of the top flange prior to installation of the stay-in-place metal forms in accordance with Section 560.

For non-polymer sheeting form surfaces, use zinc paint coating in accordance with Section 562 to all accessories cut from galvanized sheets, which are not embedded in concrete.

400-5.7.2 Design: Meet the following criteria for the design of stay-in-place bridge deck forms:

1. The maximum self weight of the stay in place metal forms, plus the weight of the concrete or expanded polystyrene required to fill the form flutes (where used), shall not exceed 20 psf.

2. Design the forms on the basis of dead load of form, reinforcement, and plastic concrete plus 50 lb/ft^2 for construction loads. Use a unit working stress in the steel sheet of not more than 0.725 of the specified minimum yield strength of the material furnished, but not to exceed 36,000 psi.

3. Do not allow deflection under the weight of the forms, reinforcement, and plastic concrete to exceed 1/180 of the form span or 1/2 inch, whichever is less, for form spans of 10 feet or less, or 1/240 of the form span or 3/4 inch, whichever is less, for form spans greater than 10 feet. In all cases, do not use a total loading (psf) that is less than 20 plus the product of the deck thickness measured in inches times 12.5.

4. Use a design span of the form equal to the clear span of the form plus 2 inches. Measure the span parallel to the form flutes.

5. Compute physical design properties in accordance with requirements of the AISI Specifications for the Design of Cold Formed Steel Structural Members, latest published edition.

6. For all reinforcement, maintain the design concrete cover required by the plans.

7. Maintain the plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck.

8. Do not consider the permanent bridge deck form as lateral bracing for compression flanges of supporting structural members.

9. Do not use permanent steel bridge deck forms in panels where longitudinal deck construction joints are located between stringers.

10. Secure forms to the supporting members by means other than welding directly to the member.

400-5.7.3 Materials:

400-5.7.3.1 Metal Forms: Fabricate stay-in-place metal forms and supports from steel meeting the requirements of ASTM A 653 having a coating designation G165. Do not use form materials that are less than 0.03 inch uncoated thickness.

400-5.7.3.2 Polymer Sheeting: Use polymer sheeting comprised of at least 85% ethylene acrylic acid copolymer capable of being applied to both G165 and G210 steel sheet as described in ASTM A 742. Ensure that the polymer sheeting has a nominal thickness of 12 mils as manufactured and a minimum thickness of 10 mils after lamination to the steel sheet. Ensure that the polymer sheeting remains free of holes, tears and discontinuities and sufficiently

flexible to withstand the forming process without any detrimental effects to bond, durability or performance. Ensure that the polymer sheeting is UV stabilized and contains antioxidants.

Ensure that the as-manufactured polymer sheeting (prior to application) has an Oxidative Induction Time (OIT) of 60 to 75 minutes at 170°C in air when tested according to ASTM D 3895. Perform additional OIT tests on samples taken from the finished product (polymer sheeting applied to forms) resulting in a minimum OIT according to ASTM D 3895 of 32 minutes at 170°C in air. Ensure that the polymer sheeting adheres to galvanized metal sufficient to prevent undercutting at penetrations made through the polymer sheeting or metal forms to the satisfaction of the Engineer. Ensure that edges subjected to shear cutting are coated by the form manufacturer with two coats of a compatible liquid coating repair material before delivery to the site. Ensure that steel used to produce polymer laminated metal forms is appropriately cleaned and prepared per NCCA (National Coil Coating Association) standard continuous coil coating practices. Ensure that pretreatment for use in conjunction with the manufacturer's polymer sheeting material is approved as compatible by the polymer sheeting manufacturer. Apply pretreatment in accordance with the polymer sheeting manufacturer's procedures. Apply polymer sheeting in accordance with the manufacturer's recommendations and procedures. Ensure that all steel has the polymer sheeting applied prior to fabrication of the stay-in-place forms and accessories.

Ensure that the screws to be used in the fastening of the stay-in-place laminated metal forms have a corrosion resistant cladding that will not have an adverse effect to the system due to the contact of dissimilar metals.

400-5.7.3.3 Certification: Provide a written certification from the manufacturer stating the product meets the requirements of this specification along with the delivery of the coated forms to the jobsite. Ensure that the certification conform**s** to the requirements of Section 6. Ensure that the manufacturer has a quality control program conforming to ISO 9001:2000 standards.

400-5.7.3.4 Polystyrene Foam: Use polystyrene foam comprised of expanded polystyrene manufactured from virgin resin of sufficient density to support the weight of concrete without deformation. Extrude the polystyrene foam to match the geometry of the flutes and provide a snug fit. Use polystyrene foam that has a density of not less than 0.8 lbs/cubic foot. Use polystyrene foam that has water absorption of less than 2.6% when tested according to ASTM C 272. Provide a written certification from the manufacturer stating the product meets the requirements of this Specification along with the delivery of the product.

400-5.7.4 Construction: Install all forms in accordance with approved fabrication and erection plans.

Do not rest form sheets directly on the top of the stringer of floor beam flanges. Fasten sheets securely to form supports, and maintain a minimum bearing length of 1 inch at each end for metal forms. Place form supports in direct contact with the flange of the stringer or floor beam. Make all attachments for coated metal forms by bolts, clips, screws, or other approved means.

400-5.7.4.1 Form Galvanizing Repairs: For any permanent exposed steel where the galvanized coating has been damaged, thoroughly clean, wire brush, and paint it with two coats of galvanizing compound in accordance with Section 562 to the satisfaction of the Engineer. Do not touch up minor heat discoloration in areas of welds.

400-5.7.4.2 Polymer Sheeting Repairs: Inspect and identify areas for damage to the polymer sheeting and repair with liquid polymer coating similar and compatible with respect to durability, adhesion and appearance in accordance with ASTM A 762, as furnished by the stay-in-place form manufacturer. Ensure that the inspection includes checking the polymer sheeting for cuts, tears, cracking, surface pits, peeling, dirt, grease, oil, stains, rust or bare areas. Reject any panels that show coating blistering, peeling or cracking. Repair all polymer sheeting damage according to the following:

a. Surface Preparation: Ensure that all surfaces to be repaired are clean and free of any deleterious substances. Remove all traces of dirt, soil, oil deposits, greases, and other surface contaminates in accordance with the polymer sheeting and coating manufacturer's written specifications prior to touch-up and recoating.

b. Application Procedures: Ensure that the liquid polymer repair coating is applied to a clean dry surface and in accordance with the manufacturer's written specifications. Apply the repair coating using a suitable paintbrush or other means acceptable to the Engineer. Apply a first coat of product to the surface at 2-4 mils in thickness. Let the first coat air dry. Apply a second coat to form a complete layer and increase the thickness, immediately after verifying the first coat is dry to the touch (15-25 minutes depending on the local air drying temperature and atmospheric conditions). Apply the second coat at the same coating thickness as the first at 2-4 mils. Ensure that the total dry film thickness of the two coats is not less than 6 mils. Apply additional coats in this same manner until desired coating thickness is achieved.

400-5.7.5 Placing of Concrete: Vibrate concrete to avoid honeycomb and voids, especially at construction joints, expansion joints, valleys and ends of form sheets. Use approved pouring sequences. Do not use calcium chloride or any other admixture containing chloride salts in the concrete.

400-5.7.6 Inspection: The Engineer will observe the Contractor's method of construction during all phases of the construction of the bridge deck slab, including the installation of the metal form system; location and fastening of the reinforcement; composition of concrete items; mixing procedures, concrete placement, and vibration; and finishing of the bridge deck. Should the Engineer determine that the procedures used during the placement of the concrete warrant inspection of the underside of the deck, remove at least one section of the metal forms in each span for this purpose. Do this as soon after placing the concrete as practicable in order to provide visual evidence that the concrete mix and the procedures are obtaining the desired results. Remove an additional section in any span if the Engineer determines that there has been any change in the concrete mix or in the procedures warranting additional inspection.

If, in the Engineer's judgment, inspection is needed to check for defects in the bottom of the deck or to verify soundness, sound the metal forms

with a hammer as directed by the Engineer after the deck concrete has been in place a minimum of two days. If sounding discloses areas of doubtful soundness to the Engineer, remove the metal forms from such areas for visual inspection after the concrete has attained adequate strength. Remove metal bridge deck forms at no expense to the Department.

At locations where sections of the metal forms have been removed, the Engineer will not require the Contractor to replace the metal forms. Repair the adjacent metal forms and supports to present a neat appearance and to ensure their satisfactory retention and where they are polymer sheeted, coat all exposed surfaces of stay-in-place metal form system elements that are not coated or are damaged with a field applied liquid polymer coating as specified in 400-5.7.4.2. As soon as the form is removed, the Engineer will examine the concrete surfaces for cavities, honeycombing, and other defects. If irregularities are found, and the Engineer determines that these irregularities do not justify rejection of the work, repair the concrete as directed, and provide a General Surface Finish in accordance with 400-15. If the Engineer determines that the concrete where the form is removed is unsatisfactory, remove additional metal forms as necessary to inspect and repair the slab, and modify the method of construction as required to obtain satisfactory concrete in the slab. Remove and replace all unsatisfactory concrete as directed, at no expense to the Department.

If the method of construction and the results of the inspections as outlined above indicate that sound concrete has been obtained throughout the slabs, the amount of sounding and form removal may be reduced when approved by the Engineer.

Corrosion of assembly screws will not be considered a structural or aesthetic problem and is considered acceptable.

Provide the facilities for the safe and convenient conduct of the inspection procedures.

400-5.8 Stay-In-Place Concrete Forms:

400-5.8.1 General: Permanent stay-in-place precast reinforced concrete forms may be used in lieu of removable forms to form concrete bridge deck slabs subject to the conditions contained herein. Precast reinforced concrete stay-in-place forms are not permitted to construct a composite concrete deck. Do not use precast prestressed concrete stay-in-place forms to form any permanent bridge decks.

When detailed plans for structures are dimensioned for the use of removable forms, provide additional slab thickness, elevation changes, changes in design, etc. to accommodate the use of stay-in-place forms, subject to the Engineer's approval. The Engineer will compute pay quantities of the various component members of the structure which are paid on a cubic yard basis from the design dimensions shown on the plans with no allowance for changes in deflection and changes in dimensions necessary to accommodate the stay-in-place forms. The Engineer will limit pay quantities of other Contract items which are increased to accommodate the use of stay-in-place forms to the quantity required for the original plan design.

Prior to using stay-in-place forms, submit for approval detailed plans of the forming system and design calculations. Indicate on the plans the form

panel sizes, placing patterns, type of mastic or felt bearing material and type and method of caulking between panels. Also, submit appropriate changes in design details of structural members supporting stay-in-place forms showing any revisions necessary to enable the supporting components to withstand the additional weight of the forms and perform equally as contemplated in the plans. All calculations and details submitted shall be sealed by the Contractor's Engineer of Record. Modify the beams to provide additional strength to compensate for the added dead loads imposed by the use of stay-in-place forms. Obtain this strength by adding additional strands to prestressed girders or increasing the section modulus for steel girders. Do not use stay-in-place forms until the forming system and any necessary design revisions of supporting structural members have been approved by the Engineer. The Department is not responsible for the performance of the stay-in-place forms by its approval.

400-5.8.2 Materials: Construct permanent concrete forms of precast reinforced concrete with a Class 3 Surface Finish. As a minimum, use the same class of concrete and 28-day minimum compressive strength as being used to construct the bridge deck. Use welded steel wire reinforcement meeting the requirements of Section 931.

400-5.8.3 Design: Use the following criteria for the design of permanent bridge deck forms:

(1) Design the forms on the basis of deadload of form, reinforcement, and plastic concrete plus an unfactored live load of 50 psf for construction loads. Meet the AASHTO design requirements for service loads and ultimate loads as applicable.

(2) Deflection under the weight of the forms, reinforcement, and the plastic concrete shall not exceed 1/180 of the form span or 1/2 inch, whichever is less. In all cases, do not use a loading that is less than 120 psf total.

(3) Use a design span of the form equal to the clear span of the form between supports. Measure the span of concrete forms parallel to the centerline of the form panels.

(4) Compute physical design properties of concrete forms in accordance with current AASHTO design procedures.

(5) Ensure that all steel reinforcement contained in the cast-in-place concrete has the minimum cover shown on the plans or not less than 1 inch, whichever is greater. Measure the minimum cover normal to the plane of the bottom of the cast-in-place concrete. For stay-in-place concrete forms with other than plane surfaces in contact with the cast-in-place concrete, such as regularly spaced geometrical shapes projecting above the plane of the bottom of the cast-in-place concrete, meet the following special requirements:

(a) Space geometrical shapes projecting above the bottom plane of the cast-in-place concrete used to provide support for reinforcement no closer than 3 feet apart and of sufficient height to maintain the required concrete cover on the bottom mat of reinforcing steel.

(b) Construct all other geometrical shapes projecting above the plane of the bottom of the cast-in-place concrete to provide a minimum vertical clearance of 3/4 inch between the closest surface of the projections and the secondary longitudinal reinforcing steel in the deck slab.

(c) Do not allow a minimum horizontal distance from the surface of any transverse reinforcing steel to surfaces of the stay-in-place form of less than 1 1/2 inches.

For all steel reinforcement for the stay-in-place form panels, provide a minimum of 1 inch concrete cover except that, for construction in a salt or other corrosive environment, provide a minimum of 1 1/2 inches concrete cover.

(6) Maintain the plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck. Measure the minimum cover of the bottom mat of steel normal to the top of the precast concrete form panel.

(7) Do not consider the permanent bridge deck form as lateral bracing for compression flanges of supporting structural members.

(8) Do not use permanent concrete bridge deck forms in panels where longitudinal deck construction joints are located between stringers.

(9) Do not allow the maximum weight of the concrete form to exceed 40 lb/ft^2 of form surface.

400-5.8.4 Construction: Install all forms in accordance with approved fabrication and erection plans.

For concrete forms, provide a minimum bearing length of at least 1 1/2 inches but not exceeding 2 1/2 inches. Support concrete forms on the beams or girders by continuous layers of an approved mastic or felt bearing material that will provide a mortar tight uniform bearing. Use a mastic or felt bearing material that has a minimum width of 1 inch and a maximum width of 1 1/2 inches. Seal joints between concrete form panels with caulking, tape, or other approved method.

400-5.8.5 Placing of Concrete: Place the concrete in accordance with the requirements of 400-5.7.5. Immediately prior to placing the slab concrete, saturate concrete stay-in-place form panels with water.

400-5.8.6 Inspection: Inspect the concrete in accordance with the requirements of 400-5.7.6.

After the deck concrete has been in place for a minimum period of two days, inspect the forms for cracks and excessive form deflection, and test for soundness and bonding of the forms by sounding with a hammer as directed by the Engineer. Remove, for visual inspection, form panels found to be cracked that show evidence of leakage and form panels which have a deflection greater than adjacent panels by 1/2 inch or more which show signs of leakage. If sounding discloses areas of doubtful soundness to the Engineer, remove the form panels from such areas for visual inspection after the concrete has attained adequate strength. Remove permanent bridge deck form panels at no expense to the Department.

At locations where sections of the forms have been removed, the Engineer will not require the forms to be replaced. Repair the adjacent forms and supports to present a neat appearance and to ensure their satisfactory retention. As soon as the form is removed, the Engineer will examine the concrete surfaces for cavities, honeycombing, and other defects. If irregularities are found, and the Engineer determines that these irregularities do not justify rejection of the work,

repair the concrete as directed and provide a General Surface Finish in accordance with 400-15. If the concrete where the form is removed is unsatisfactory, as determined by the Engineer, additional forms shall be removed as necessary to inspect and repair the slab, and modify the methods of construction as required to obtain satisfactory concrete in the slab. Remove and replace all unsatisfactory concrete as directed at no expense to the Department.

If the methods of construction and the results of the inspections as outlined above indicate that the Contractor has obtained sound concrete throughout the slabs, the Contractor may moderate the amount of sounding and form removal, when approved.

Provide all facilities for the safe and convenient conduct of the inspection procedures.

400-6 Weep Holes.

Provide weep holes in all abutments, retaining walls, and culverts over 5 feet in height. Provide weep holes that are at least 3 inches in diameter and not more than 10 feet apart, but do not place any weep holes under the area to be occupied by the base or pavement. Place the outlet ends of the weep holes just above the ground line in front of abutments and retaining walls. In culverts, place weep holes approximately 6 inches above the top of the floor slab. Cover the inside ends of all weep holes with wire mesh and at least 2 ft^3 of clean, broken stone or gravel, so placed as to allow free drainage but at the same time prevent the fill from washing out. From approximately 6 inches below the bottom of the inside ends of the weep holes, carry a column of clean, broken stone or gravel at least 1 ft^2 up against the back of the wall to the surface of the original ground.

400-7 Placing Concrete.

400-7.1Weather Restrictions:

400-7.1.1 Concreting in Cold Weather: Do not place concrete when the temperature of the concrete at placement is below 45ºF.

Meet the air temperature requirements for mixing and placing concrete in cold weather as specified in Section 346. During the curing period, if NOAA predicts the ambient temperature to fall below 35ºF for 12 hours or more or to fall below 30ºF for more than 4 hours, enclose the structure in such a way that the concrete and air within the enclosure can be kept above 60ºF for a period of 3 days after placing the concrete or until the concrete reaches a minimum compressive strength of 1,500 psi.

Assume all risks connected with the placing and curing of concrete. Although the Engineer may give permission to place concrete, the Contractor is responsible for satisfactory results. If the placed concrete is determined to be unsatisfactory, remove, dispose of, and replace the concrete at no expense to the Department.

400-7.1.2 Concreting in Hot Weather: Meet the temperature requirements and special measures for mixing and placing concrete in hot weather as specified in Section 346.

When the temperature of the concrete as placed exceeds 75ºF, incorporate in the concrete mix a water-reducing retarder or water reducer if allowed by Section 346.

Spray reinforcing steel and metal forms with cool fresh water just prior to placing the concrete in a method approved by the Engineer.

Assume all risks connected with the placing and curing of concrete. Although the Engineer may give permission to place concrete, the Contractor is responsible for satisfactory results. If the placed concrete is determined to be unsatisfactory, remove, dispose of, and replace the concrete at no expense to the Department.

400-7.1.3 Wind Velocity Restrictions: Do not place concrete for bridge decks if the forecast of average wind velocity at any time during the planned hours of concrete placement exceeds 15 mph. Obtain weather forecasts from the National Weather Service "Hourly Weather Graph" for the city closest to the project site.

400-7.2 Lighting Requirements: Provide adequate lighting for all concrete operations conducted at night. Obtain approval of the lighting system prior to starting the concrete operations.

400-7.3 Inspections before Placing Concrete: Do not place concrete until the depth and character of the foundation and the adequacy of the forms and falsework have been approved by the Engineer. Do not deposit any concrete until all reinforcement is in place and has been inspected and approved by the Engineer.

400-7.4 Exposure to Water: Do not expose concrete other than seal concrete in cofferdams to the action of water before final setting. Do not expose such concrete to the action of salt or brackish water for a period of seven days after placing the concrete. Protect the concrete during this period by keeping salt or brackish water pumped out of cofferdams.

400-7.5 General Requirements for Placing Concrete: Do not place any concrete prior to approval of the Contractors quality control plan in accordance with 105-3. Deposit concrete as nearly as possible in its final position. Do not deposit large quantities at one point and then run or work it along the forms. Take special care to fill each part of the forms, to work coarse aggregate back from the face, and to force concrete under and around reinforcing bars without displacing them.

Use a method and manner of placing concrete that avoids the possibility of segregation or separation of aggregates. If the Engineer determines that the quality of concrete as it reaches its final position is unsatisfactory, remove it and discontinue or adjust the method of placing until the Engineer determines that the quality of the concrete as placed is satisfactory.

Use metal or metal-lined open troughs or chutes with no aluminum parts in contact with the concrete. As an exception, chutes made of aluminum with a protective coating for ready mixed concrete trucks, no longer than 20 feet, may be used. This exception does not apply to any other means of concrete conveyance. Where steep slopes are required, use chutes that are equipped with baffles or are in short lengths that reverse the direction of movement. Where placing operations would involve dropping the concrete freely more than 5 feet,

deposit it through pipes, troughs, or chutes of sheet metal or other approved material. Use troughs, chutes, or pipes with a combined length of more than 30 feet only with the Department's authorization. Keep all troughs, chutes, and pipes clean and free from coatings of hardened concrete by thoroughly flushing them with water after each run or more often if necessary.

Place concrete against supporting material that is moist at the time of concrete placement. If additional water is required, uniformly apply it ahead of the concrete placement as directed by the Engineer. Do not place concrete on supporting material that is frozen. The Contractor may use a moisture barrier in lieu of controlling the foundation grade moisture when approved by the Engineer.

400-7.6 Placing Concrete by Belt Conveyor: Place concrete by means of a belt conveyor system with written Department authorization. Remove conveyor belt systems which produce unsatisfactory results before continuing operations. Take concrete samples for assurance testing at the discharge end of the belt conveyor system. Make available to the Engineer the necessary platform to provide a safe and suitable place for sampling and testing. Remove any concrete placed in an unsatisfactory manner at no expense to the Department before continuing operations.

Use conveyor belt systems that do not exceed a total length of 550 feet, measured from end to end of the total assembly. Arrange the belt assembly so that each section discharges into a vertical hopper arrangement to the next section. To keep segregation to a minimum, situate scrapers over the hopper of each section to remove mortar adhering to the belt and to deposit it into the hopper. Equip the discharge end of the conveyor belt system with a hopper and a chute or suitable deflectors to cause the concrete to drop vertically to the deposit area.

In order to avoid delays due to breakdowns, provide stand-by equipment with an alternate power source prior to the beginning of the placement.

After the beginning of the placement, direct the discharge from the belt conveyor so that the concrete always falls on freshly placed concrete.

400-7.7 Placing Concrete by Pumping: In general, use concrete pumping equipment that is suitable in kind and adequate in capacity for the work proposed. Use a pump discharge line that has a minimum diameter of 4 inches. Use a pump and discharge lines that are constructed so that no aluminum surfaces are in contact with the concrete being pumped. Operate the pump to produce a continuous stream of concrete, without air pockets. When using cement slurry or similar material to lubricate the discharge line when pumping begins, collect such material at the point of discharge. Dispose of the collected slurry in areas provided by the Contractor. Control the pump discharge locations so that the placement locations of the various LOTs of concrete represented by strength test cylinders can be identified in the event the test cylinders indicate deficient strength. When concrete is placed by pumping, take all test samples of concrete at the end of the discharge line, except in accordance with the provisions of Section 346.

400-7.8 Consolidation: Consolidate the concrete by continuous working with a suitable tool in an acceptable manner, or by vibrating as set forth in 400-7.11. When not using vibrators, thoroughly work and compact all thin-

section work with a steel slicing rod. Spade all faces, and flush the mortar to the surface by continuously working with a concrete spading implement.

400-7.9 Obstructions: In cases where, because of obstructions, difficulty is encountered in puddling the concrete adjacent to the forms, bring the mortar content of the mix into contact with the interior surfaces by vibrating the forms. Produce the vibrations by striking the outside surfaces of the forms with wooden mallets or by other satisfactory means. In placing concrete around steel shapes place it only on one side of the shape until it flushes up over the bottom flange of the shape on the opposite side, after which place it on both sides to completion. After the concrete has taken its initial set, exercise care to avoid jarring the forms or placing any strain on the ends of projecting reinforcing bars.

400-7.10 Requirements for Successive Layers: Generally, place concrete in continuous horizontal layers, approximately 12 inches thick. To avoid obtaining a plane of separation between batches, do not allow the time before placing the next successive layer to exceed 20 minutes, unless the Engineer determines that adequate fluidity exists in the underlying layer. Generally, leave each layer of concrete unfinished to secure efficient bonding with the overlying layer. To minimize the visibility of joints on exposed faces, finish the top surface of the concrete immediately adjacent to the forms of the exposed face, smoothing with a plaster mason's trowel. Where required, use inset form work to eliminate featheredges and to obtain concrete layers with a minimum thickness of 6 inches. Conduct the operation of depositing and consolidating the concrete so as to form a dense, impervious mass of uniform texture with smooth faces on exposed surfaces. Remove, dispose of, and replace defective concrete as directed by the Engineer and at no expense to the Department.

400-7.11 Vibration of Concrete:

400-7.11.1 General: Consolidate all concrete except seal, steel pile jackets, and concrete for incidental construction by the use of mechanical vibrators.

400-7.11.2 Vibrators: Provide adequate vibrators on the project that are approved by the Engineer before beginning concrete work. Generally, provide vibrators of the internal type. For thin sections, where the forms are especially designed to resist vibration, the Contractor may use external vibrators. Use a vibrator with a minimum frequency of 4,500 impulses per minute with sufficient intensity and duration to cause complete consolidation of the concrete without causing segregation of the materials. For vibrating thin, heavily reinforced sections, use heads of such size to secure proper vibration of the concrete without disturbance of either the reinforcing steel or the forms.

400-7.11.3 Number of Vibrators Required: Use a sufficient number of vibrators to secure the compaction of each batch before the next batch is delivered, without delaying the delivery. In order to avoid delays due to breakdowns, provide at least one stand-by vibrator, with an appropriate power source.

400-7.11.4 Method of Vibration: Use vibrators to consolidate properly placed concrete. Do not use them to move concrete about in the forms. Insert the vibrators in the surface of concrete at points spaced to ensure uniform vibration of the entire mass of the concrete. Insert the vibrator at points that are no further

apart than the radius over which the vibrator is visibly effective. Allow the vibrator to sink into the concrete by its own weight, and allow it to penetrate into the underlying layer sufficiently so that the two layers are thoroughly consolidated together. After thoroughly consolidating the concrete, withdraw the vibrator slowly to avoid formation of holes.

400-7.11.5 Hand Spading: When necessary in order to secure well-filled forms, free from aggregate pockets, honeycomb, bubbles, etc., spade the concrete by hand, along the surfaces of the forms and in all corners, following the vibration.

400-7.12 Columns: Place concrete in columns in one continuous operation for each lift as shown in the plans.

400-7.13 Slabs and Bridge Decks:

400-7.13.1 Bulkheads, Screed Rails, and Screeding Devices: Strike-off the concrete using an approved metal screed operating on rails or bulkheads. Use devices which do not contain aluminum parts. Prior to placing concrete, provide an approved screed capable of striking-off and screeding the surface of the slab or deck to the required shape. Set all necessary bulkheads and screed rails to the required grade. Use bulkheads, screed rails, and screeding devices that permit vertical profile adjustment to the grade, satisfactory for providing straight transverse slopes, differing transverse slopes broken as shown in the plans and/or transverse slopes with changing grade along the longitudinal length of slab or deck. Locate the screed rails so the entire placement surface can be screeded to grade without using intermediate screed rails, unless approved otherwise by the Engineer.

Use a screed consisting of a truss or heavy beams that will retain it's shape under all working conditions, and a set of rotating drums with a diameter sufficient to carry a 2 inch mortar roll in front of and parallel to the axis of the drums, while making an initial pass. Adjust the drums to prevent mortar buildup forming behind the trailing edges of the drums. For long bridges, as defined in 400-15.2.5.1, provide a device that automatically smoothes the concrete surface to an untextured finish and that is attached to, and is moved by, the rolling drum screed. As an alternate to the drum type screed, a mechanical screed with a metal strike-off may be used. Equip the mechanical screed with mechanical vibrators to provide continuous uniform vibration to the entire length unless otherwise authorized by the Engineer. Small and irregularly shaped areas that cannot be mechanically screeded may be screeded in a manner approved by the Engineer.

400-7.13.2 Screed Demonstration: Subsequent to the placement of all reinforcing steel and prior to placing any slab or deck concrete, demonstrate that the proposed equipment and methods can finish the concrete to the specified grades while maintaining the specified cover over the reinforcement. Provide the demonstration over the entire length and width of the spans to be placed. During the demonstration, load the screed support rails that are cantilevered beyond the fascia girders to simulate the concrete loading that will be placed on the rail support system during actual placement and screeding operations.

400-7.13.3 Screeding Operations: Perform concrete placement and screeding as independently controlled mechanical operations. Ensure that the

passing of the screed and forward movement of the screeding equipment are independent of the movement of concrete placement equipment.

Level the concrete in front of the screed as near to the finished grade as possible to prevent the screed from rising off the rail and forming uneven ridges behind the screed. Pass the screed over the slab or deck as many times as necessary to obtain a satisfactory surface and provide a concrete surface true to grade and crown, and free of irregularities.

Do not add water to the concrete surface to assist in finishing operations unless specifically authorized by the Engineer. If the Engineer permits the addition of water, apply only a fog mist, above the concrete surface, by means of approved power driven spray equipment.

For long bridges, as defined in 400-15.2.5.1, do not manually or mechanically float the concrete surface or apply a texture by broom or any other device to the concrete surface produced by the screeding process. Correct isolated surface irregularities in accordance with 400-15.2.5.3.

400-7.13.4 Placing Operations: Select an approved concrete design mix which ensures complete placement of all slab or deck concrete between construction joints before initial set begins in the plastic concrete. On placements of 50 yd^3 or less, the minimum placement rate is 20 yd^3/h. On placements of greater than 50 yd^3, the minimum placement rate is 30 yd^3/h.

The Engineer will not permit slab or deck placements until an acceptable plan for meeting the minimum placement rate is approved.

400-7.13.5 Concrete Decks on Steel Spans: Where concrete decks are placed on steel spans, release the temporary supports under the bridge before placing any concrete.

400-7.13.6 Concrete Decks on T-Beams: For cast-in-place T-beam construction, cast the slabs and beams in one continuous operation. As an exception, where special shear anchorage or keys are provided for in the plans or approved by the Engineer, the beams and slabs may be constructed in successive placements.

400-7.13.7 Diaphragms: Place concrete diaphragms at least 48 hours before the bridge deck slabs are placed unless otherwise indicated in the plans.

400-7.13.8 Weather Protection: Provide an approved means of protecting unhardened concrete from rain. Position the protection system to shield the concrete from rain and running water. Provide a shield impervious to water over the slab or deck concrete, of sufficient size to protect all areas of slab or deck concrete subject to water damage, and include a means of intercepting and diverting water away from freshly placed concrete. Arrange the equipment so that the weather protection system can be erected over unhardened concrete. When there is a possibility of rain during concrete placement operations, place the weather protection system in stand-by readiness, capable of being deployed in a timely manner. Use the weather protection immediately when rain begins so that slab or deck concrete damage will not occur. Do not place concrete during rain.

Assume responsibility for damage to the slab or deck in the case of failure of the weather protection system.

Describe the weather protection materials and methods in the Contractor's quality control plan.

400-7.14 Concrete Box Culverts: In general, place the base slab or footing of concrete box culverts, and allow them to set before constructing the remainder of the culvert. In this case, make suitable provision for longitudinal keys. Construct bottom slabs, footings, and apron walls as a monolith if practicable. Where transverse construction joints are necessary, place them at right angles to the culvert barrel, and make suitable provision for keys.

In the construction of box culverts having walls 6 feet or less in height, the sidewalls and top slab may be constructed as a monolith or may place the concrete in the walls and allow it to set before placing the top slab concrete.

Where the height of the box culvert walls exceed 6 feet, place the walls, and allow the concrete to set at least 12 hours before placing the top slab concrete. In such cases, form keys in the sidewalls.

When casting the walls and top slabs of box culverts as a monolith, ensure that any necessary construction joints are vertical. Design all construction joints with formed keys. Provide keys that are beveled as shown in the plans or as directed, but do not allow the edge of the beveled material forming the key to be less than 1 1/2 inches from the edge of the concrete.

Construct each wingwall, if possible, as a monolith. Ensure that construction joints, where unavoidable, are horizontal and so located that no joints will be visible in the exposed face of the wing above the ground line.

Precast box culvert sections may be used in lieu of cast-in-place box culvert construction provided the provisions in Section 410 are satisfied.

400-8 Seals.

400-8.1 General: Wherever practicable, dewater all foundation excavations, and deposit the concrete in the dry as defined in 455-15.2. Where conditions are encountered which render it impracticable to dewater the foundation before placing concrete, the Engineer may authorize the construction of a concrete foundation seal of the required size. Then, dewater the foundation, and place the balance of the concrete in the dry.

When required to place seal concrete, the Contractor is responsible for the satisfactory performance of the seal in providing a watertight excavation for placing structural concrete. The Department will provide and pay for the seal concrete as an aid to the construction of the structure. Repair seal concrete as necessary to perform its required function at no expense to the Department.

400-8.2 Method of Placing: Carefully place concrete deposited under water in the space in which it is to remain by means of a tremie, a closed-bottom dump bucket of not less than 1 yd^3 capacity, or other approved method. Do not disturb the concrete after depositing it. Deposit all seal concrete in one continuous placement. Do not place any concrete in running water, and ensure that all form work designed to retain concrete under water is watertight.

400-8.3 Use of Tremie: Use a tremie consisting of a tube having a minimum inside diameter of 10 inches, constructed in sections having water-tight joints. Do not allow any aluminum parts to have contact with the concrete. Ensure that the discharge end is entirely seated at all times, and keep the tremie tube full to the

bottom of the hopper. When dumping a batch into the hopper, keep the tremie slightly raised (but not out of the concrete at the bottom) until the batch discharges to the bottom of the hopper. Stop the flow by lowering the tremie. Support the tremie such as to permit the free movement of the discharge end over the entire top surface of the work and to permit its being lowered rapidly when necessary to choke off or retard the flow. Provide a continuous, uninterrupted flow until completing the work. Exercise special care to maintain still water at the point of deposit.

400-8.4 Time of Beginning Pumping: Do not commence pumping to dewater a sealed cofferdam until the seal has set sufficiently to withstand the hydrostatic pressure, and in no case earlier than 72 hours after placement of the concrete.

400-9 Construction Joints.

400-9.1 Location: Make construction joints only at locations shown in the plans or in the placement schedule, unless otherwise approved in writing. If not detailed in the plans or placement schedule, or in case of emergency, place construction joints as directed.

400-9.2 Provisions for Bond and Transmission of Shear: Use shear key reinforcement where necessary to transmit shear or to bond the two sections together.

400-9.3 Preparations of Surfaces: Before depositing new concrete on or against concrete which has hardened, re-tighten the forms. Roughen the surface of the hardened concrete in a manner that will not leave loosened particles, aggregate, or damaged concrete at the surface. Thoroughly clean the surface of foreign matter and laitance, and saturate it with water.

400-9.4 Placing Concrete: Continuously place concrete from joint to joint. Carefully finish the face edges of all joints which are exposed to view true to line and elevation.

400-9.5 Joints in Sea Water or Brackish Water: For concrete placed in sea water or brackish water, do not place any construction joints between points 2 feet below the mean low water elevation and 6 feet above the mean high water elevation.

400-9.6 Joints in Long Box Culverts: For long concrete box culverts, vertical construction joints may be placed at a spacing not less than 30 feet. When using transverse construction joints, ensure that longitudinal reinforcing steel is continuous through the joint and that the joint is vertical.

400-9.7 Crack Control Grooves in Concrete Bridge Decks: When the plans require crack control grooves in the top surface of decks, either install a tooled “V” groove prior to initial concrete set or saw a groove using an early entry dry cut saw. When using an early entry dry cut saw, operate in accordance with the manufacturer’s recommendations. Commence sawing as soon as the concrete has hardened enough to permit standing on the surface without leaving visible tracks or impressions and before uncontrolled concrete cracks occur.

400-10 Expansion Joints.

400-10.1 General: After meeting the smoothness criteria in 400-15, construct expansion joints to permit absolute freedom of movement. Carefully remove all loose or thin shells of mortar likely to cause a spall with movement at a joint from all expansion joints as soon as possible.

400-10.2 Sealed Joints: Fill expansion joints with a preformed joint filler. Cut the filler to conform to the cross-section of the structure, and furnish it in as few pieces as practicable, using only a single piece in each curb section. Do not use small pieces that would tend to come loose. Prepare joints to be sealed and apply the sealer in accordance with approved manufacturer's directions.

400-10.3 Joint System Installation: Install expansion joints before or after the deck planing required by 400-15.2.5.5 following the manufacturer's instructions. When installed after deck planing, install the edge rail assemblies in the blockouts on a profile tangent between the ends of the deck and/or approach slab to within a +0 and -1/4 inch variation.

When installed before deck planing, install the edge rail assemblies 3/8 inch, ±1/16 inch, below the top surface of the deck or approach slab to compensate for concrete removal during planing.

400-11 Contact and Bearing Surfaces.

400-11.1 Separation of Surfaces: In general, separate all contact surfaces between superstructure and substructure or end walls and between adjacent superstructure sections by a layer of 55 lb roofing felt.

400-11.2 Finishing of Bearing Surfaces: Construct bearings surfaces (areas) to the tolerances as specified herein and in the other parts of the Contract Documents. When using neoprene bearing pads, finish the concrete surface to a uniform 'rough' texture using a burlap drag, fine bristle broom or float. For metal or high load rotational bearings, fill minor depressions, 1/8 inch maximum, caused by finishing, bush hammering, or grinding with a low-viscosity epoxy meeting the requirements of 926-1, Type F-2, applied by the use of a squeegee. Bearing surfaces may be ground to final position with carborundum. Check all bearing surfaces with a metallic straightedge prior to setting bearings or neoprene pads.

400-11.2.1 Deviation from Specified Elevations for Steel Beam Superstructures: Construct to the elevation shown on the plans plus or minus 0.01 feet and do not exceed a 0.01 feet difference between specified elevations of bearing areas of adjacent bearings measured between the centerlines of bearing areas.

400-11.2.2 Deviation from Specified Elevations for Concrete Beam Superstructures: Construct to the elevation shown on the plans plus or minus 0.02 feet.

400-11.2.3 Projecting Irregularities: Projecting irregularities will not exceed 1/16 inch.

400-11.2.4 Variations in Flatness for Neoprene Pads: In any direction, the pad is to be flat to within 1/16 inch. Pads designated to be sloped are not to deviate from the theoretical slope by the same amount.

400-11.2.5 Variations in Flatness for Metal or High Load Rotational Bearings: Construct the bearing area to the tolerance indicated for the measured length along the orthogonal axes.

Bearing area length up to 30 inches long to plus or minus 1/16 inch.

Bearing area length over 30 inches up to 45 inches long to plus or minus 3/32 inch.

Bearing area length over 45 inches long to plus or minus 1/8 inch.

400-11.3 Beam and Deck Slab Units: Do not allow the bearing plate or bearing area plane of precast concrete beam and deck slab units, including prestressed units, to deviate from a true plane by more than 1/8 inch when both bearing areas of a unit are tested on a level plane. Provide a bearing plate or bearing area that also proves to be a true plane when tested in all directions of the plane surface with a steel straightedge. In the event that a 100% true plane is not achieved, the Engineer will accept a surface having not less than 80% of its area in a true plane provided the deviations from such true plane are evenly distributed. Remove minor convex projections by grinding with an abrasive stone. The Engineer will accept minor depressions, provided that they amount to not more than 20% of the bearing area, are evenly distributed over the entire bearing area, and are not deeper than 1/8 inch.

400-11.4 Bearing Pads: Use bearing pads for seating bridge shoes, ends of beams, and slabs of the types specified or required in the plans.

Furnish and install Composite Neoprene Pads as detailed in the plans. Place neoprene pads, where specified or required, directly on masonry surfaces finished in accordance with the requirements of this Article. Ensure that pads, bearing areas of bridge seats, and metal bearing plates are thoroughly cleaned and free from oil, grease, and other foreign materials.

Exercise care in fabrication of related metal parts to avoid producing conditions detrimental to the performance of the pads, such as uneven bearing, excessive bulging, etc.

400-12 Anchor Bolts and Dowels.

Set anchor bolts and dowels as specified in Section 460.

Galvanize all anchor bolts as specified in Section 962.

400-13 Epoxy Bonding Compounds.

Where epoxy bonding compounds for bonding concrete are specified or required, apply the epoxy bonding materials only to clean, dry, structurally sound concrete surfaces. Provide surface preparation, application, and curing of epoxy bonding compound in strict accordance with the manufacturer's recommendations for each particular application. Use an epoxy bonding compound listed on the Department's Qualified Products List.

400-14 Removal of Forms.

Use the table below as the criterion for minimum time or compressive strength required before removal of forms or supports.

When using the time period criterion, include in the time period all days except days in which the temperature falls below 40ºF.

Use the specified 28-day minimum compressive strength value as stated in 346-3.1 for each Class of Concrete utilized.

Location of Concrete Placement	Minimum Time for Form Removal for any Strength Concrete	Minimum (%) of 28-day Compressive Strength for Form Removal
(1) Deck slabs, top slabs of culverts and bottom of caps, forms under sidewalks, and safety curb overhangs extending more than 2 feet		
(a) Class II (Bridge Deck)	7 days*	75*
(b) Class II (Other than Bridge Deck)	7 days	75
(c) Class III	7 days	70
(d) Class IV	7 days	60
(e) Class V	7 days	50
(2) Walls, piers, columns, sides of beams and other vertical surfaces	24 hours**	50**
(3) Front face form of curbs	6 hours	70
* Reference 400-16.4 **Do not place additional load on the section until 70% of the specified 28-day concrete strength is attained. Also, refer to 400-7.4.		

When using the percent of required strength, cast test cylinders for each mix for compressive strength determination or develop a curing concrete strength versus time curve (S/T Curve) which can be used in lieu of multiple test cylinders to determine when percent of required strength has been met.

Prior to curve use; obtain the Engineer's approval of the S/T Curve and its supporting data. An approved testing laboratory may be used to provide this information with approval of the Engineer. Plot S/T Curves using at least three different elapsed times that begin once test cylinders are cast; however, one of the elapsed times must be prior to the Contractor's intended form removal. Each elapsed time plotted must have a corresponding compressive strength computed by averaging the compressive strength of two test cylinders.

Cure such test cylinders as nearly as practical in the same manner as the concrete in the corresponding structural component, and test them in accordance with ASTM C 39 and ASTM C 31. Perform cylinder casting, curing, and testing at no expense to the Department and under the observation of the Engineer. When the S/T Curve indicates a compressive strength equal to or greater than the percentage of specified strength shown in the table above for form removal, the Contractor may remove the forms. When the ambient air temperature falls 15ºF or more below the ambient air temperature that existed during development of a S/T Curve, use a S/T Curve that corresponds to the lower temperature and that is developed in accordance with this section.

Do not remove forms at any time without the consent of the Engineer. Even when the Engineer provides consent to remove the forms, the Contractor is responsible for the work.

400-15 Finishing Concrete.

400-15.1 General Surface Finish (Required for All Surfaces): After placing and consolidating the concrete, strike-off all exposed surfaces to the lines and grades indicated in the plans in a manner that will leave a surface of uniform texture free of undesirable surface irregularities, cavities, and other defects. Cut back metal ties supporting reinforcement, conduit, and other appurtenances a minimum of 1 inch from finished surface. After removing excess mortar and concrete and while the concrete is still in a workable state, carefully tool all construction and expansion joints. Leave joint filler exposed for its full length with clean edges. Ensure that finished work in addition to that specified above is compatible and complementary to the class of surface finish required.

Immediately after removing forms from any exposed concrete surface, remove all fins and irregular projections flush with the surface. Clean, saturate with water, and point all holes, tie cavities, honeycomb, chips and spalls with an approved high-strength, non-metallic, non-shrink grout meeting the requirements of Section 934, mixed and applied in accordance with the manufacturer's recommendations. Exercise care during the roughening process to prevent additional defacement and damage to the formed surface.

In the event unsatisfactory surfaces are obtained, repair these surfaces by methods approved by the Engineer or the affected concrete will be rejected. Repair any surface or remove rejected concrete at no expense to the Department.

400-15.2 Surface Finishes:

400-15.2.1 General: In addition to the general surface work specified for all exposed concrete surfaces, the Engineer may require one of the classes of surface finish listed below. For all such exposed surfaces, begin finish work for the applicable class specified, along with the general finish work, immediately after removal of the forms. In order to further ensure the required quality of the finish, remove forms no later than the minimum time specified for the forms to remain in place. Satisfactorily repair finished concrete surfaces which are subsequently disfigured or discolored at no expense to the Department.

Provide the required class of surface finish for the various items of structural concrete as shown in the plans.

400-15.2.2 Class 1 Surface Finish: As soon as the pointing has sufficiently set, thoroughly saturate the exposed surfaces with water, and rub them with a medium coarse carborundum stone. Continue rubbing until the surface has been ground to a paste and remove all form marks, irregularities, and projections. In this process, do not introduce any additive material other than water. After the rubbing has produced a smooth surface of uniform color, allow the material which has been ground to a paste to reset under proper curing conditions. Subsequently, as a second operation, re-saturate the concrete surfaces with water, and thoroughly rub them with a fine carborundum stone. Continue this rubbing until the surface has a smooth, fine grain texture of uniform color.

The Contractor may substitute a Class 5 applied finish coating in accordance with 400-15.2.6 as an alternate surface finish on all areas where Class 1 surface finish is specified.

400-15.2.3 Class 2 Surface Finish: As soon as pointing has sufficiently set, thoroughly saturate the exposed concrete surfaces with water and rub them

with a medium coarse carborundum stone. Continue rubbing until the surface has been ground to a paste and remove all form marks, irregularities, and projections. In this process, do not introduce any additive material other than water.

After rubbing has produced a smooth surface finish, of uniform color, carefully brush the material which has been ground to a paste to a uniform texture, and allow it to reset under proper curing conditions. Carefully protect these surfaces from disfigurement and discoloration during subsequent construction operations.

400-15.2.4 Class 3 Surface Finish: Where this surface finish is specified, use metal forms or timber forms with a form liner. Where specified or required on the plans, use No. 89 coarse aggregate for concrete.

After concrete has been placed in the forms and compacted, finish all exposed surfaces which are not contained by the forms to produce a surface texture as nearly equal to that produced by the form as practicable. Generally, finish unformed surfaces to a smooth, dense surface with a steel trowel.

Perform all work, including general surface finish work, in a manner that will preserve the same surface texture and color produced by the form. Pointed areas may be rubbed with a dry carborundum stone.

400-15.2.5 Class 4 Deck Finish:

400-15.2.5.1 General: Apply a Class 4 finish on bridge decks and concrete approach slabs. On Short Bridges (bridges and approach slabs having a combined length less than or equal to 100 ft), and on Miscellaneous Bridges (Pedestrian, Trail, and Movable Spans) regardless of length, meet the finish and smoothness requirements of 400-15.2.5.2 and 400-15.2.5.4. On Long Bridges (bridges and approach slabs having a combined length greater than 100 ft) meet the finish and smoothness requirements of 400-15.2.5.3 and 400-15.2.5.5. After meeting the screeding requirements of 400-7.13 and curing requirements of 400-16 and the smoothness requirements, herein, groove the bridge deck and approach slabs.

Regardless of bridge length, finish decks with less than 2 1/2 inches of top cover in accordance with the requirements for Short Bridges.

400-15.2.5.2 Plastic Surface Finish for Short and Miscellaneous Bridges: After screeding is completed, check the surface of the plastic concrete with a 10 foot straightedge, positioning and half-lapping the straightedge parallel to the centerline to cover the entire surface. Immediately correct deficiencies of more than 1/8 inch, measured as an ordinate between the surface and the straightedge.

Finish the concrete surface to a uniform texture using a burlap drag, fine bristle broom or float. Finish the deck to a smooth surface having a sandy texture without blemishes, marks or scratches deeper than 1/16 inch.

400-15.2.5.3 Plastic Surface Finish for Long Bridges: Do not moisten, manually float or apply texture to the concrete surface after the screed, with attached smoothing device, has passed unless correction of isolated surface irregularities is warranted and this should be done as soon as possible after screeding while the concrete is plastic. Correct all flaws such as cavities, blemishes, marks, or scratches that will not be removed by planing.

If the Engineer permits the addition of water when correcting flaws, apply moisture to the concrete surface only if required and only in the immediate vicinity of the isolated irregularity. Apply a quantity of moisture not greater than what is needed to facilitate correction of the irregularity and apply only a fog mist, above the concrete surface, by power driven spray equipment approved by the Engineer.

400-15.2.5.4 Smoothness Requirements for Short Bridges and Miscellaneous Bridges (including approach slabs): Perform a final straightedge check with a 10 foot straightedge, positioning and half-lapping the straightedge parallel to the centerline, approximately 5 feet apart to cover the entire surface. Correct all irregularities greater than 3/16 inch measured as an ordinate to the straightedge, by grinding. Perform grinding by the abrasive method using hand or power tools or by machine, to leave a smooth surface within a 1/8 inch tolerance.

400-15.2.5.5 Smoothness Evaluation and Concrete Surface Planing, Long Bridges (including approach slabs): Prior to planing, provide a smoothness evaluation of the completed bridge deck and concrete approach slab riding surfaces by a computerized Cox California-type profilograph in accordance with the criteria herein and FM 5-558E. Furnish this evaluation through an independent provider approved by the Engineer, using equipment calibrated by the Engineer. The vehicular riding surfaces subject to this evaluation include all bridge deck and concrete approach slab surfaces between gutter lines

Prior to initial profilograph testing, complete work on the bridge deck. Thoroughly clean and clear the bridge deck and approach slab area to be evaluated for smoothness of all obstructions and provide the smoothness evaluation. Ensure that no radio transmissions or other activities that might disrupt the automated profilograph equipment are allowed during the evaluation.

Average the Profile Index Value for the bridge deck, including the concrete approach slabs, for the left and right wheel path of each lane. The maximum allowable Profile Index Value for acceptable smoothness is 10 inches per mile utilizing the 0.2 inch blanking band. Apply this criteria to each 300 feet of each lane. Additionally, correct individual bumps or depressions exceeding a cutoff height of 0.3 inch from a chord of 25 feet (see ASTM E-1274) on the profilograph trace. Ensure that the surface meets a 1/4 inch in 10 feet straightedge check made transversely across the deck and approach slabs if determined necessary by the Engineer. Provide additional profilograph testing as necessary following longitudinal planing and any other actions taken to improve smoothness, until a profile meeting the acceptance criteria is obtained.

Regardless of whether expansion joints are installed before or after deck planing is complete, plane off the concrete deck surface to a minimum depth of 1/4 inch and also meet or exceed the profilograph smoothness criteria. Plane the entire bridge deck and concrete approach slab surfaces longitudinally using a self-propelled planing machine with gang mounted diamond saw cutting blades specifically designed for such work. Use the profilograph generated smoothness data, to establish the optimum planing machine settings. Plane the deck surface close to the gutter line so that there is a smooth transition, without

vertical faces or sudden surface discontinuities, from the fully planed surface to the unplaned surface at the gutter line. Use a machine with a minimum wheel base length of 15 feet, constructed and operated in such manner that it does not cause strain or damage to the deck surface, excessive ravels, aggregate fractures or spalling. The equipment shall be approved by the Engineer. Perform longitudinal planing parallel to the roadway centerline, and provide a consistent, textured surface. Clean the surface of all slurry/debris generated during this work concurrently with operation of the machine.

After the deck has been planed the initial 1/4 inch, reevaluate the pavement smoothness using the profilograph testing described above. Perform cycles of planing and profilograph retesting as necessary until the deck is in compliance with the smoothness criteria but do not exceed the maximum concrete removal depth of 1/2 inch.

400-15.2.5.6 Grooving: After the concrete surface profile, as required by 400-15.2.5, has been accepted by the Engineer, and prior to opening the bridge to traffic, groove the bridge deck and approach slabs perpendicular to the centerline of the structure. Do not groove the deck surface of pedestrian or trail bridges unless otherwise shown in the Contract Documents. Cut grooves into the hardened concrete using a mechanical saw device which will leave grooves nominally 1/8 inch wide and 3/16 inch deep. Space the grooves apart in random spacing center of grooves in the following sequence: 3/4 inch, 1 1/8 inch, 5/8 inch, 1 inch, 5/8 inch, 1 1/8 inch, 3/4 inch in 6 inch repetitions across the width to be grooved in one pass of the mechanical saw device. One 6 inch sequence may be adjusted by 1/4 sequence increments to accommodate various cutting head widths provided the general pattern is carried out. The tolerance for the width of the grooves is +1/16 to –0 inch and the tolerance for the depth of grooves is ±1/16 inch. The tolerance for the spacing of the grooves is ±1/16 inch.

Cut grooves continuously across the deck or approach slab to within 18 inches of gutter lines at barrier rail, curb line and median divider. At skewed metal expansion joints in bridge deck surfaces, adjust groove cutting by using narrow width cutting heads so that all grooves of the bridge deck surface or approach slab surface end within 6 inches, measured normal to centerline of the joint, leaving no ungrooved surface adjacent to each side of the joint greater than 6 inches in width. Ensure that the minimum distance to the first groove, measured normal from the edge of the concrete joint or from the junction between the concrete and the metal leg of the armored joint angle, is 1 inch. Produce grooves that are continuous across construction joints or other joints in the concrete surface less than 1/2 inch wide. Apply the same procedure described above where the gutter lines at barrier rails, curb lines and median dividers are not parallel to the centerline of the bridge to maintain the 18 inches maximum dimension from the grooves to the gutter line. Cut grooves continuously across formed concrete joints.

400-15.2.6 Class 5 Applied Finish Coating:

400-15.2.6.1 General: Place an applied finish coating upon all concrete surfaces where the plans indicate Class 5 Applied Finish Coating. Apply the finish coating after completion of the general surface work specified for all

exposed concrete surfaces. Select an Applied Finish Coating from the Departments Qualified Products List meeting the requirements of Section 975.

400-15.2.6.2 Material: For the coating material, use a commercial product designed specifically for this purpose. Use only coating material that is manufactured by one manufacturer and delivered to the job site in sealed containers bearing the manufacturer's original labels. Submit a copy of the manufacturer's printed instructions to the Engineer.

400-15.2.6.3 Surface Preparation: Prepare the surface prior to the application of an applied finish coating by providing a surface finish in accordance with the requirements of 400-15.1. The Engineer will not require surface voids that are 1/4 inch or less in width and depth to be grouted prior to application of the finish coating. Fill surface void larger than 1/4 inch in width and depth an approved high strength, non metallic, non shrink grout meeting the requirements of Section 934, mixed and applied in accordance with the manufacturer's recommendations. Apply the grout by filling the surface voids using burlap pads, float sponges, or other acceptable methods. As soon as the grout has taken its initial set, brush the surface to remove all loose grout, leaving the surface smooth and free of any voids. Ensure that the surface to be coated is free from efflorescence, flaking coatings, curing compound, dirt, oil, and other substances deleterious to the applied finish coating. Prior to application of the finish coating onto precast or cast-in-place concrete surfaces, test the concrete surface at 30 foot intervals for the presence of curing compound using one or two drops of muriatic acid placed on the concrete surface. If curing compound is present, there will be no reaction between the acid and the concrete. If there is no reaction, remove the compound by pressure washing the concrete surfaces. Prepare the surfaces in accordance with the manufacturer's recommendations, and ensure that they are in a condition consistent with the manufacturer's requirements.

400-15.2.6.4 Application: Apply the finish coating utilizing a method recommended by the manufacturer. When applying the finish coating by spraying, supply heavy-duty spray equipment capable of maintaining a constant pressure necessary for proper application. Mix and cure all coating materials in accordance with the manufacturer's printed instructions. Apply the finished coating at a rate of 50 ±10 ft^2/gal.

400-15.2.6.5 Finished Product: Produce a texture of the completed finish coat that is generally similar to that of rubbed concrete. Ensure that the completed finished coating is tightly bonded to the structure and presents a uniform appearance and texture. If necessary, apply additional coats to produce the desired surface texture and uniformity.

Upon failure to adhere positively to the structure without chipping, flaking, or peeling, or to attain the desired surface appearance, remove coatings entirely from the structure, and reapply the finish coating after surface preparation until achieving the desired finished product. Do not allow the average thickness of the completed finish coating to exceed 1/8 inch.

400-15.2.6.6 Material Tests and Certification: Before any portion of any shipment of finish coating is applied on the project, furnish the Engineer with a certificate from the manufacturer attesting that the commercial product

furnished conforms to the same formula as that previously subjected to the tests specified in Section 975. In addition, submit the following product analysis, obtained from the manufacturer, for each batch of the material used:

(a) Weight per gallon.
(b) Consistency (Krebs Units).
(c) Weight percent pigment.
(d) Weight percent vehicle solids.
(e) Infra-red spectra of vehicle solution.

400-15.2.7 Final Straightedging for Surfaces to Receive Asphalt Concrete Surface: Test the slab surfaces of poured-in-place decks which are to be surfaced with an asphalt concrete wearing course for trueness with a 10 foot straightedge, as specified above. As an exception, correct only irregularities of more than 1/4 inch measured as an ordinate (either above or below the general contour of the surface). The Engineer will not require belting or brooming of slabs that are to be surfaced with an asphalt concrete wearing course. For curing, meet the requirements specified for other deck slabs.

400-15.2.8 Finishing Bridge Sidewalks: Provide bridge sidewalks, that are not finished in accordance with the requirements of Section 522, a Class 4 finish.

400-16 Curing Concrete.

400-16.1 General: Cure cast-in-place and precast (non-prestressed) concrete as required herein for a minimum duration of 72 hours. If forms are loosened or removed before the 72 hour curing period is complete, expand the curing to cover these surfaces by either coating with curing compound or extending the continuous moist cure area.

Until curing has begun, retain concrete surface moisture at all times by maintaining a surface moisture evaporation rate less than 0.1 $lb/ft^2/hr$. Periodically, at the site of concrete placement prior to and during the operation, measure the ambient air temperature, relative humidity and wind velocity with industrial grade weather monitoring instruments to determine the on-site evaporation rate. If the evaporation is, or is likely to become 0.1 $lb/ft^2/hr$ or greater, employ measures to prevent moisture loss such as application of evaporation retarder, application of supplemental moisture by fogging or reduction of the concrete temperature during batching. Compute the evaporation rate by using the nomograph in the ACI manual of Concrete Practice Part 2, Section 308R Guide to Curing Concrete, or by using an evaporation rate calculator approved by the Engineer.

400-16.2 Methods: Except where other curing methods are specified, select from the following options the chosen method(s) for curing all concrete components and indicate the method to be used in the Quality Control Plan.

(a) Continuous Moisture: Place burlap on the surface and keep it continuously saturated for the curing period by means of soaker hoses or automatic sprinklers. Water flow may be metered to cycle repetitively for five minutes on and five minutes off during the 72 hour curing period. Do not apply moisture manually. If side forms are loosened or removed during the curing period, extend the burlap so as to completely shield the sides of the members.

(b) Membrane Curing Compound: Apply a white Type 2 curing compound to all surfaces at a uniform coverage as recommended by the manufacturer but not less than 0.06 gal/yd^2. Allow surfaces covered by the membrane curing compound to remain undisturbed for the curing period. Recoat any cracks, checks or other defects in the membrane seal which are detected during the curing period within one hour. If side forms are loosened during the curing period, maintain surface moisture and remove the forms within one hour and immediately coat the formed surfaces with a membrane curing compound. Bottom surfaces shall be similarly coated after removal of or from the forms.

If curing compound is to be applied by spraying, use a compressor driven sprayer of sufficient size to provide uniform mist. Standby equipment is required in case of mechanical failure and hand held pump-up sprayers may be used only as standby equipment.

(c) Curing Blankets: Curing blankets may be used for curing the top surfaces of members while the member side forms remain in place. Do not use curing blankets which have been torn or punctured. Securely fasten all edges to provide as tight a seal as practical. Should the system fail to maintain a moist condition on the concrete surface, discontinue use of the blankets and continue curing using another method. Keep curing blankets in place for the duration of the curing period.

(d) Accelerated Cure:

(1) General: Accelerated curing of the concrete can be achieved by use of either low pressure steam curing, radiant heat curing or continuous moisture and heat curing. If accelerated curing is completed before the 72 hour curing period has elapsed, continue curing for the remaining part of the 72 hour curing period in accordance with one of the curing methods listed above.

If accelerated curing is used, furnish temperature recording devices that will provide accurate, continuous and permanent records of the time and temperature relationship throughout the entire curing period. Provide one such recording thermometer for each 200 feet of placement length or part thereof. Initially calibrate recording thermometers and recalibrate at least annually.

The preheating period shall equal or exceed the time of initial set as determined by ASTM C 403 and shall not be less than 4 hours. When the ambient air temperature is above 50ºF, allow the member to remain undisturbed in the ambient air for the preheating period. If the ambient air temperature is below 50ºF, apply heat during the preheating period to hold the air surrounding the member at a temperature of 50 to 90ºF.

To prevent moisture loss from exposed surfaces during the preheating period, enclose members as soon as possible after casting or keep the surfaces wet by fog mist or wet blankets. Use enclosures for heat curing that allow free circulation of heat about the member with a minimum moisture loss. The use of tarpaulins or similar flexible covers may be used provided they are kept in good repair and secured in such a manner to prevent the loss of heat and moisture. Use enclosures that cover the entire placement.

During the application or removal of the heat, do not allow the temperature rise or fall within the enclosure to exceed 40ºF/hr. Do not allow the curing temperature throughout the enclosure to exceed 160ºF. Maintain the

curing temperature within a temperature range of 130 to 160ºF until the concrete has reached the required form removal strength for precast and cast-in-place components or the required release strength for prestressed concrete components.

(2) Low-Pressure Steam: The steam used shall be in a saturated condition. Do not allow steam jets to impinge directly on the concrete, test cylinders, or forms. Cover control cylinders to prevent moisture loss and place them in a location where the temperature is representative of the average temperature of the enclosure.

(3) Curing with Radiant Heat: Apply radiant heat by means of pipes circulating steam, hot oil or hot water, or by electric heating elements. Do not allow the heating elements to come in direct contact with the concrete or the forms. Distribute sources of heat in a manner that will prevent localized high temperatures above 160ºF. To prevent moisture loss during curing, keep the exposed surfaces wet by fog mist or wet blankets.

(4) Continuous Moisture and Heat: This method consists of heating the enclosure in combination with the continuous moisture method described above.

In addition to the curing blankets, an auxiliary cover for retention of the heat will be required over the entire placement. Support this cover at a sufficient distance above the placement being cured to allow circulation of the heat.

400-16.3 Silica Fume Concrete: Cure silica fume concrete a minimum of 72 hours using continuous moisture cure. No substitution of alternative methods nor reduction in the time period is allowed. After completion of the 72 hour curing period, apply a membrane curing compound to all concrete surfaces. Apply curing compound according to 400-16.2.

400-16.4 Bridge Decks: Cure bridge decks for a duration of seven days. Apply a membrane curing compound to the deck top surface in accordance with 400-16.2 using a compressor driven sprayer. In general, apply curing compound to a concrete deck when the surface is damp and after all pooled water has evaporated. For Short bridges, begin applying curing compound immediately after the initially placed concrete has been floated, straightedged, textured and a damp surface condition exists and continue applying compound as concrete placement progresses with as little interruption as possible until the entire deck surface has been coated with compound. For Long bridges, begin applying curing compound to the initially placed concrete as soon as a damp surface condition exists and continue applying compound as concrete placement progresses with as little interruption as possible until the entire deck surface has been coated with compound. However, for both Short and Long bridges, the elapsed time between the initial placement of deck concrete and the completed application of curing compound must not exceed 120 minutes. The 120 minute limit may be extended by the Engineer if project specific factors (cool temperatures, high humidity, retarding admixtures, etc.) are prolonging wet surface conditions.

Prior to the first deck placement, submit to the Engineer the method that will be used to periodically measure the rate of application of curing compound in, gallons/sq ft as the deck placement progresses. Prior to the placement of each deck, submit to the Engineer the anticipated quantity of curing compound in

gallons along with the corresponding square feet of deck to be covered to meet the coverage rate in 400-16.2. Compute the actual quantity of curing compound applied at the conclusion of each deck placement and submit the quantity to the Engineer. Apply the curing compound from a work platform.

Place curing blankets on all exposed surfaces which are not formed as soon as possible with minimal effect on the surface texture. Place the curing blankets with sufficient overlapping seams to form an effective moisture seal. Before using curing blankets, mend tears, splits, or other damage that would make them unsuitable. Discard curing blankets that are not repairable. Wet all curing blankets immediately after satisfactorily placing them and maintain them in a saturated condition throughout the seven day curing period. Supply sufficient quantity of potable water at the job site for wetting the blankets.

Where a bridge deck slab is to be subjected to walking, wheeling or other approved construction traffic within the seven day curing period, protect the curing blankets and the slab surface from damage by placing wooden sheeting, plywood or other approved protective material in the travel areas.

When the ends of the curing blankets are rolled back to permit screeding of adjacent bridge deck slabs, keep the exposed surfaces wet throughout the period of exposure.

Removal of bottom and side forms after 72 hours is acceptable upon compliance with 400-14. Apply membrane curing compound to all surfaces stripped of forms within one hour of loosening. Apply curing compound according to 400-16.2.

400-16.5 Construction Joints: Cure construction joint areas using either the continuous moisture or curing blankets method.

400-16.6 Traffic Barriers, Railings, Parapets and End Post: Ensure concrete is cured in accordance with 400-16.2(b). When construction is by the slip form method, coat all concrete surfaces with a curing compound that meets the requirements of 925-2, either within 30 minutes of extrusion or before the loss of water sheen, whichever occurs first. Ensure a curing compound coating period of not less than seven days after application. Prior to each concrete placement, submit to the Engineer the method that will be used to periodically measure the rate of application in gallons/sq ft. Also, prior to each placement, submit to the Engineer the anticipated quantity of curing compound in gallons that will be used to meet the coverage rate specified in 400-16.2 along with the corresponding square footage of barriers, railings, parapets and end posts to be coated with that quantity. Compute the actual quantity of curing compound that is applied during each concrete placement and submit the quantity to the Engineer. Applied Finish Coatings, that are on the Qualified Products List and that are flagged as permitted for use as a curing compound, may be used in lieu of a curing compound; If an Applied Finish Coating is used in lieu of a curing compound, have a backup system that is in full compliance with 400-16.2(b) available at all times to ensure that an effective alternative system will be immediately available if the Applied Finish Coating cannot be applied within 30 minutes of extrusion or before the loss of water sheen.

400-16.7 Removal of Membrane Curing Compounds: Provide the longest possible curing duration; however, remove curing compound on portions of

members to be bonded to other concrete. Compounds may be removed by either sand or water blasting. Water blasting requires the use of potable water and a minimum nozzle pressure of 2,900 psi.

400-17 Protection of Concrete.

400-17.1 Opening to Traffic: Close concrete bridge decks and culverts to traffic for a period of at least 14 days after placing and for such additional times as deemed advisable. In the operation of placing, the Contractor may wheel concrete across previously poured slabs after they have set for 24 hours, provided plank runways are used to keep the loads over the beams.

400-17.2 Storing Materials on Bridge Slabs: Do not store heavy equipment or material, other than light forms or tools, on concrete bridge slabs until 14 days after they have been poured. For all stockpiles, tools, and equipment stored on bridge slabs at any time, obtain prior approval by the Department, and the Engineer will require any such stored materials or equipment to be dispersed in order to avoid overloading any structural part.

400-17.3 Time of Placing Superstructure: In the case of piers or bents with concrete caps, do not place the weight of the superstructure or of beams on the caps until they have reached the age of 10 days.

400-17.4 Alternate Procedure: As an alternate procedure, in lieu of the time delay periods set forth in 400-17.1 and 400-17.3, test beams or cylinders may be cast from representative concrete and cured identically with the concrete in the corresponding structural component. Make the test beams in accordance with ASTM C 31 and test them in accordance with ASTM C 78. When the test results indicate a minimum flexural strength of 550 psi for beams or the minimum 28-day compressive strength shown in the plans, concrete bridge decks and culverts may be opened to traffic or the superstructure and beams may be placed on caps.

400-18 Precast Planks, Slabs, and Girders.

400-18.1 General: Where so shown in the Contract Documents, the Contractor may construct concrete planks, slabs, girders, and other structural elements by precasting. In general, use a method that consists of casting structural elements in a casting yard, curing as specified in 400-16, transporting them to the site of the work, installing them on previously prepared supports and, where so shown in the plans, joining them with poured-in-place slabs or keys. Handle and install precast prestressed members as specified in Section 450.

400-18.2 Casting: Cast precast elements on unyielding beds or pallets. Use special care in casting the bearing surfaces on both the elements and their foundations in order that these surfaces shall coincide when installing the elements. Check bearing surfaces on casting beds with a level and a straightedge prior to the casting. Similarly check corresponding surfaces on the foundations during finishing operations.

400-18.3 Poured-in-Place Keys: Where precast elements are to be joined with poured-in-place keys, carefully align the elements prior to pouring the keys.

400-18.4 Surface Finish: Finish the surface as specified in 400-15, except that where precast slabs and poured-in-place keys form the riding surface, give the entire surface a broomed finish.

400-18.5 Moving, Placing, and Opening to Traffic: Reinforced precast members may be moved from casting beds, placed in the structure, and opened to traffic at the ages shown in the following table:

Handling from casting beds to storage areas	7 days
Placing in structure	14 days
Opening to traffic:	
Precast elements	14 days
Cast-in-place slabs over precast girders	14 days
Cast-in-place keys joining precast slabs	7 days

As an alternate procedure, in lieu of the time delay periods set forth above, test beams may be cast from representative concrete, and cure them identically with the concrete in the corresponding structural component. Test the test beams in accordance with ASTM C 31 and ASTM C 78. When the test results indicate a flexural strength of 550 psi, or more, any of the operations listed above may proceed without completing the corresponding time delay period.

400-18.6 Setting Prestressed Slabs: Before permitting construction equipment on the bridge to erect slab units, submit sketches showing axle loads and spacing and a description of the intended method of setting slab units to the Engineer for approval. Do not use axle loads, spacing, and methods of setting which produce stresses in the slab units greater than the allowable stress.

400-18.7 Protection of Precast Elements: The Contractor is responsible for the safety of precast elements during all stages of construction. The Engineer will reject any precast elements that become cracked, broken, seriously spalled, or structurally impaired. Remove rejected precast elements from the work at no expense to the Department.

400-18.8 Form Material: Form material used to form hollow cores may be left in place. Ensure that the form material is neutral with respect to the generating of products harmful to the physical and structural properties of the concrete. The Contractor is responsible for any detrimental effects resulting from the presence of the form material within the precast element.

400-19 Cleaning and Coating Concrete Surfaces.

Water blast existing concrete surfaces as shown in the plans to be coated. Use water blast equipment producing a minimum working pressure of 2,900 psi with a gauge at or near the nozzle to confirm the working pressure. After cleaning, apply a Class 5 Applied Finish Coating as directed in the plans.

400-20 Approach Slabs.

Construct approach slabs at the bridge ends in accordance with the applicable requirements of Section 350 using Class II (Bridge Deck) concrete. Place the reinforcement as specified in 350-7 and Section 415.

The approach slab may be opened to traffic, vehicular or construction equipment, 14 days after concrete placement or after the prescribed curing period has elapsed and the concrete has attained the required 28 day cylinder strength.

400-21 Disposition of Cracked Concrete.

400-21.1 General: The disposition of cracked concrete is described in this Article and applies to all cast-in-place concrete members, and once installed, to the precast and prestressed concrete members that are produced in accordance with 410, 450, 521, 534, 548 and 641.

400-21.2 Investigation, Documentation and Monitoring: The Engineer will inspect concrete surfaces as soon as surfaces are fully visible after casting, between 7 and 31 days after the component has been burdened with full dead load, and a minimum of 7 days after the bridge has been opened to full unrestricted traffic. The Engineer will measure the width, length and depth of each crack and establish the precise location of the crack termination points relative to permanent reference points on the member. The Engineer will determine if coring of the concrete is necessary when an accurate measurement of crack depth cannot be determined by use of a mechanical probe. The Engineer will monitor and document the growth of individual cracks at an inspection interval determined by the Engineer to determine if cracks are active or dormant after initial inspection. The Engineer will perform all final bridge deck crack measurements once the deck is free of all debris and before transverse grooves are cut and after planing is complete for decks that require planing.

Provide the access, equipment and personnel needed for the Engineer to safely perform this work at no expense to the Department. Core cracks for use by the Engineer in locations and to depths specified by the Engineer at no expense to the Department.

400-21.3 Classification of Cracks: The Engineer will classify cracks as either nonstructural or structural and determine the cause. In general, nonstructural cracks are cracks 1/2 inch or less deep from the surface of the concrete; however, the Engineer may determine that a crack greater than 1/2 inch deep is nonstructural. In general, structural cracks are cracks that extend deeper than 1/2 inch. A crack that is fully or partially underwater at any time during its service life will be classified as a structural crack.

Review and comment on the Engineer's crack classification and determination of cause; however, the Engineer will make the final determination.

400-21.4 Nonstructural Cracking Significance: The Engineer will determine the Cracking Significance. The Cracking Significance will be determined on the basis of total crack surface area as a percentage of total concrete surface area. Cracking significance will be categorized as Isolated, Occasional, Moderate or Severe according to the criteria in Tables 1 and 2. Cracking Significance will be determined on a LOT by LOT basis. A LOT will typically be made up of not more than 100 square feet and not less than 25 square feet of concrete surface area for structures other than bridge decks or typically not more than 400 square feet or not less than 100 square feet for bridge decks. A LOT will not extend beyond a single Elevation Range as shown in Table 1 or 2.

Review and comment on the Engineer's determination of Cracking Significance; however, the Engineer will make the final determination.

400-21.5 Repair Method: Repair or remove and replace cracked concrete as directed by the Engineer. Additional compensation or a time extension will not be approved for repair or removal and replacement of cracked concrete when the Engineer determines the cause to be the responsibility of the Contractor.

400-21.5.1 Nonstructural Cracks: Repair each crack using the method as determined by the Engineer for each LOT in accordance with Table 1 or 2. When further investigation is required to determine repair or rejection, either remove and replace the cracked concrete or provide a structural evaluation signed and sealed by the Contractor's Engineer of Record that includes recommended repair methods and a determination of structural capacity and durability to the Engineer. Upon approval by the Engineer, repair the cracked concrete. Upon approval by the Engineer use epoxy injection in accordance with Section 411 to repair cracks in a member inside a dry cofferdam prior to flooding of the cofferdam. "Reject and Replace" in Table 1 or 2 means there is no acceptable repair method.

400-21.5.2 Structural Cracks: Provide a structural evaluation signed and sealed by the Contractor's Engineer of Record that includes recommended repair methods and a determination of structural capacity and durability to the Engineer. Upon approval by the Engineer, repair the cracked concrete. Complete all repairs to cracks in a member inside a cofferdam prior to flooding the cofferdam.

Table 1
DISPOSITION OF CRACKED CONCRETE OTHER THAN BRIDGE DECKS
[see separate Key of Abbreviations and Footnotes for Tables 1 and 2]

Elev. Range	Crack Width Range (inch) (2) x = crack width	Cracking Significance Range per LOT (1)											
		Isolated Less than 0.005%			Occasional 0.005% to<0.017%			Moderate 0.017% to<0.029%			Severe 0.029% or gtr.		
		Environment Category											
		SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
Elevation: 0 to 6 ft AMHW	x ≤ 0.004	NT	NT	PS (6)	NT	PS (6)	PS (6)	PS (6)	PS (6)				
	0.004< x ≤ 0.008	NT	PS (6)	EI (3)	PS (6)	EI (3)	EI (3)	PS (6)					
	0.008< x ≤ 0.012	NT	PS (6)	EI									
	0.012< x ≤ 0.016	PS (6)	Investigate to Determine Appropriate Repair (4, 5) or Rejection										
	0.016< x ≤ 0.020												
	0.020< x ≤ 0.024								Reject and Replace				
	0.024< x ≤ 0.028												
	x > 0.028												
Elev.: More Than 6 ft to 12 ft AMHW	Crack Width	SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
	x ≤ 0.004	NT	NT	PS (6)	NT	PS (6)	PS (6)	PS (6)	PS (6)	PS (6)	PS (6)		
	0.004< x ≤ 0.008	NT	PS (6)	EI (3)	PS (6)	PS (6)	EI (3)	PS (6)	EI (3)				
	0.008< x ≤ 0.012	NT	PS (6)	EI	EI	EI							
	0.012< x ≤ 0.016	PS (6)	EI	EI	EI								
	0.016< x ≤ 0.020	EI											
	0.020< x ≤ 0.024	Investigate to Determine Appropriate Repair (4, 5) or Rejection											
	0.024< x ≤ 0.028								Reject and Replace				
	x > 0.028												

Elev.: Over Land or More Than 12 ft AMHW	Crack Width	SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
	$x \leq 0.004$	NT	NT	NT	NT	PS (6)	PS (6)	PS (6)	PS (6)	PS (6)	PS (6)		
	$0.004 < x \leq 0.008$	NT	PS (6)	PS (6)	PS (6)	PS (6)	EI (3)	PS (6)	EI (3)	EI (3)	PS (6)		
	$0.008 < x \leq 0.012$	NT	PS (6)	EI	EI	EI	EI	EI	EI				
	$0.012 < x \leq 0.016$	PS (6)	EI	EI	EI	EI	EI						
	$0.016 < x \leq 0.020$	EI	EI	EI	EI								
	$0.020 < x \leq 0.024$	EI	Investigate to Determine Appropriate Repair [4, 5] or Rejection										
	$0.024 < x \leq 0.028$									Reject and Replace			
	$x > 0.028$												

Table 2
DISPOSITION OF CRACKED CONCRETE BRIDGE DECKS
[see separate Key of Abbreviations and Footnotes for Tables 1 and 2]

Elev. Range	Crack Width Range (inch) (2) x = crack width	Cracking Significance Range per LOT (1)											
		Isolated less than 0.005%			Occasional 0.005% to<0.017%			Moderate 0.017% to<0.029%			Severe 0.029% or gtr.		
		Environment Category											
		SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
Elevation: 12 feet or Less AMHW	x ≤ 0.004	NT	NT	NT	NT	NT	NT	NT	NT	NT			
	0.004< x ≤ 0.008	NT	NT	EI/ M	NT	NT	EI/M	EI/ M	EI/M	EI/M			
	0.008< x ≤ 0.012	NT	NT	EI/M	NT	EI/M	EI/M	EI/ M	EI/M				
	0.012< x ≤ 0.016	NT	NT	EI/M	NT	EI/M							
	0.016< x ≤ 0.020	EI/M	EI/M	EI	EI								
	0.020< x ≤ 0.024	EI/M	EI	EI	Investigate to Determine Appropriate Repair (4, 5) or Rejection						Reject and Replace		
	0.024< x ≤ 0.028	EI/M	EI										
	x > 0.028												
Elevation: Over Land or More Than 12 feet AMHW	Crack Width	SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
	x ≤ 0.004	NT	NT	NT	NT	NT	NT	NT	NT	NT			
	0.004< x ≤ 0.008	NT	NT	NT	NT	NT	EI/M	NT	EI/M	EI/M			
	0.008< x ≤ 0.012	NT	NT	EI/M	NT	NT	EI/M	EI/ M	EI/M				
	0.012< x ≤ 0.016	NT	NT	EI/M	NT	EI/M							
	0.016< x ≤ 0.020	NT	EI/M	EI	EI/M								
	0.020< x ≤ 0.024	NT	EI/M	EI	Investigate to Determine Appropriate Repair (4, 5) or Rejection						Reject and Replace		
	0.024< x ≤ 0.028	NT	EI/M										
	x > 0.028												

Key of Abbreviations and Footnotes for Tables 1 and 2		
Type Abbreviation	Abbreviation	Definition
Repair Method	EI	Epoxy Injection
	M	Methacrylate
	NT	No Treatment Required

	PS	Penetrant Sealer
Environment Category	EA	Extremely Aggressive
	MA	Moderately Aggressive
	SA	Slightly Aggressive
Reference Elevation	AMHW	Above Mean High Water

Footnotes

(1) Cracking Significance Range is determined by computing the ratio of Total Cracked Surface Area (TCSA) to Total Surface Area (TSA) per LOT in percent [(TCSA/TSA) x 100] then by identifying the Cracking Significance Range in which that value falls. TCSA is the sum of the surface areas of the individual cracks in the LOT. The surface area of an individual crack is determined by taking width measurements of the crack at 3 representative locations and then computing their average which is then multiplied by the crack length.

(2) Crack Width Range is determined by computing the width of an individual crack as computed in (1) above and then identifying the range in which that individual crack width falls.

(3) When the Engineer determines that a crack in the 0.004 inch to 0.008 inch width range cannot be injected then for Table 1 use penetrant sealer unless the surface is horizontal, in which case, use methacrylate if the manufacturer's recommendations allow it to be used and if it can be applied effectively as determined by the Engineer.

(4) (a) Perform epoxy injection of cracks in accordance with Section 411. Seal cracks with penetrant sealer or methacrylate as per Section 413. (b) Use only methacrylate or penetrant sealer that is compatible, according to manufacturer's recommendations, with previously applied materials such as curing compound or paint or remove such materials prior to application.

(5) When possible, prior to final acceptance of the project, seal cracks only after it has been determined that no additional growth will occur.

(6) Methacrylate shall be used on horizontal surfaces in lieu of penetrant sealer if the manufacturer's recommendations allow it to be used and if it can be applied effectively as determined by the Engineer.

400-22 Method of Measurement.

400-22.1 General: The quantities of concrete to be paid for will be the volume, in cubic yards, of each of the various classes shown in the plans, in place, completed and accepted. The quantity of precast anchor beams to be paid for will be the number in place and accepted. The quantity of bridge deck grooving to be paid for will be the area, in square yards of bridge deck and approach slab, completed and accepted. The quantity of bridge deck grooving and planing to be paid for will be the area, in square yards of bridge deck and approach slab, completed and accepted.

Except for precast anchor beams, for any item of work constructed under this Section and for which measurement for payment is not to be made by the volume of concrete, measurement and payment for such work will be as specified in the Section under which the work is specified in detail.

No separate payment will be made for obtaining the required concrete finish.

400-22.2 Calculation of Volume of Concrete:

400-22.2.1 Dimensions: The quantity will be computed by the plan dimensions of the concrete, within the neat lines shown in the plans, except that no deduction will be made for weep holes, deck drains, or encroachment of inlets and pipes in box culverts, and no chamfers, scorings, fillets, or radii 1 1/2 in^2 or less in cross-sectional area will be taken into account.

400-22.2.2 Pay Quantity: The quantity to be paid for will be the original plan quantity, measured as provided in 400-22.2.1, except that where the plans call for an estimated quantity of miscellaneous concrete for contingent use, the contingent concrete will be measured as the actual quantity in place and accepted.

400-22.2.3 Items not Included in Measurement for Payment: No measurements or other allowances will be made for work or material for forms, falsework, cofferdams, pumping, bracing, expansion-joint material, etc. The volume of all materials embedded in the concrete, such as structural steel, pile heads, etc., except reinforcing steel, will be deducted when computing the volume of concrete to be paid for. For each foot of timber pile embedded, 0.8 ft^3 of concrete will be deducted. The cost of furnishing and placing dowel bars shall be included in the Contract unit price for the concrete.

400-22.2.4 Deck Girders and Beam Spans: In computing the volume of concrete in deck girders and beam spans, the thickness of the slab will be taken as the nominal thickness shown on the drawings and the width will be taken as the horizontal distance measured across the roadway. The volume of haunches over beams will be included in the volume to be paid for.

400-22.2.5 Stay-in-Place Metal Forms: When using stay-in-place metal forms to form the slab of deck girder and beam spans, the volume of concrete will be computed in accordance with the provisions of 400-20.2.4 except that the thickness of the slab over the projected plan area of the stay-in-place metal forms will be taken as the thickness shown on the drawings above the top surface of the forms. The concrete required to fill the form flutes will not be included in the volume of concrete thus computed.

400-22.3 Bridge Deck Grooving: The quantity to be paid for will be plan quantity in square yards, computed, using the area bound by the gutter lines (at barrier rails, curbs and median dividers) and the beginning and end of the bridge or the end of approach slabs, whichever is applicable, constructed, in place and accepted.

400-22.4 Bridge Deck Grooving and Planing: The quantity to be paid for will be plan quantity in square yards, computed, using the area bound by the gutter lines (at barrier rails, curbs and median dividers) and the beginning and end of the bridge or the end of approach slabs, whichever is applicable, constructed, in place and accepted.

400-22.5 Composite Neoprene Pads: The quantity to be paid for will be the original plan quantity, computed using the dimensions of the pads shown in the plans.

400-22.6 Cleaning and Coating Concrete Surfaces: The quantity to be paid for will be the plan quantity in square feet for the areas shown in the plans.

400-23 Basis of Payment.

400-23.1 Concrete:

400-23.1.1 General: Price and payment will be full compensation for each of the various classes of concrete shown in the proposal.

400-23.1.2 Concrete Placed below Plan Depth: Authorized concrete placed in seal or footings 5 feet or less below the elevation of bottom of seal or

footing as shown in the plans will be paid for at the Contract price set forth in the proposal under the pay items for substructure concrete.

Authorized concrete used in seal (or in the substructure where no seal is used) at a depth greater than 5 feet below the bottom of seal or footing as shown in the plans will be paid for as Unforeseeable Work.

Such payment will be full compensation for the cofferdam construction, for excavation, and for all other expenses caused by the lowering of the footings.

400-23.1.3 Seal Concrete Required but Not Shown in Plans: When seal concrete is required as provided in 400-8 and there is no seal concrete shown in the plans, it will be paid for as Unforeseeable Work.

400-23.2 Precast Anchor Beams: Price and payment will be full compensation for the beams, including all reinforcing steel and materials necessary to complete the beams in place and accepted.

No separate prices will be allowed for the various types of anchor beams.

400-23.3 Reinforcing Steel: Reinforcing steel will be measured and paid for as provided in Section 415, except that no separate payment will be made for the fabric reinforcement used in concrete jackets on steel piles or reinforcement contained in barriers, traffic separators or parapets. Where so indicated in the plans, the Department will not separately pay for reinforcing steel used in incidental concrete work, but the cost of such reinforcement shall be included in the Contract unit price for the concrete.

400-23.4 Bridge Deck Grooving: Price and payment will be full compensation for all grinding, grooving, equipment, labor, and material required to complete the work in an acceptable manner.

400-23.5 Bridge Deck Grooving and Planing: Price and payment will be full compensation for all grooving, planing, equipment, labor, and material required to complete the work in an acceptable manner.

400-23.6 Composite Neoprene Pads: Price and payment will be full compensation for all work and materials required to complete installation of the pads.

400-23.7 Cleaning and Coating Concrete Surfaces: Price and payment will be full compensation for all work and materials required. The cost of coating new concrete will not be paid for separately, but will be included in the cost of the item to which it is applied.

400-23.8 General: The above prices and payments will be full compensation for all work specified in this Section, including all forms, falsework, joints, weep holes, drains, pipes, conduits, bearing pads, setting anchor bolts and dowels, surface finish, and cleaning up, as shown in the plans or as directed. Where the plans call for water stops, include the cost of the water stops in the Contract unit price for the concrete.

Unless payment is provided under a separate item in the proposal, the above prices and payments will also include all clearing and grubbing; removal of existing structures; excavation, as provided in Section 125; and expansion joint angles and bolts.

The Department will not change the rate of payment for the various classes of concrete in which steel may be used due to the addition or reduction of reinforcing steel.

The Department will not make an allowance for cofferdams, pumping, bracing, or other materials or equipment not becoming a part of the finished structure. The Department will not pay for concrete placed outside the neat lines as shown in the plans.

When using stay-in-place metal forms to form bridge decks, the forms, concrete required to fill the form flutes, attachments, supports, shoring, accessories, and all miscellaneous items or work required to install the forms shall be included in the Contract unit price of the superstructure concrete.

400-23.9 Payment Items:

Payment will be made under:

Item No. 400- 0-	Class NS Concrete – per cubic yard.
Item No. 400- 1-	Class I Concrete - per cubic yard.
Item No. 400- 2-	Class II Concrete - per cubic yard.
Item No. 400- 3-	Class III Concrete - per cubic yard.
Item No. 400- 4-	Class IV Concrete - per cubic yard.
Item No. 400- 6-	Precast Anchor Beams - each.
Item No. 400- 7-	Bridge Deck Grooving - per square yard.
Item No. 400- 9-	Bridge Deck Grooving and Planing - per square yard.
Item No. 400-143-	Cleaning and Coating Concrete Surfaces - per square foot.
Item No. 400-147-	Composite Neoprene Pads - per cubic foot.

SECTION 410
PRECAST CONCRETE BOX CULVERT

410-1 Description.

Obtain precast box culverts from a plant that is currently on the Department's list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3.

Provide precast four-sided concrete box culverts as an alternative to the structure shown in the Contract Documents. Only monolithic segments, or two-piece segments with three-sided bottom sections and a simple support top slab section, are permitted. Two-piece segments are limited to installations with a minimum of two feet fill height above the top slab.

Construct headwalls, wingwalls and other special features using cast-in-place concrete. Precast wingwalls, cut-off walls or headwalls are not permitted unless otherwise noted in the Contract Documents.

At the beginning of each project, provide a notarized statement to the Engineer from a company designated representative certifying that the plant will

manufacture the products in accordance with the requirements set forth in the Contract Documents and plant's approved Quality Control Plan. The Quality Control Manager's stamp on each product indicates certification that the product was fabricated in conformance with the Contractor's Quality Control Plan, the Contract, and this Section. Ensure that each shipment of precast concrete products to the project site is accompanied with a Quality Control signed or stamped delivery ticket providing the description and the list of the products.

410-2 Materials.

Ensure that the materials used for the construction of precast box culverts have certification statements from each source, showing that they meet the applicable requirements of the following:

Portland Cement Concrete.....Section 346
Reinforcing Steel.....Section 415
Precast Concrete Drainage Products .....Section 449
Wire for Site Cage Machines ..... ASTM A-82, ASTM A-496
..... or ASTM A-615
Coarse Aggregate* .....Section 901
Fine Aggregate* .....Section 902
Curing Materials for Concrete.....Section 925
Materials For Concrete Repair .....Section 930
Non-Shrink Grout.....Section 934
Joint Materials ..... ASTM C-443, ASTM C-877 or ASTM C-990
Geotextile Fabrics .....Section 985

* The gradation requirements of aggregates are not applicable when using dry-cast concrete.

410-3 Materials Acceptance and Testing of Precast Box Culverts. .

410-3.1 General: Meet the requirements of Section 346, except as modified herein:

Prepare, cure, and test the test cylinders in accordance with ASTM C-31 and ASTM C-39 test methods. The use of 4 x 8 inch test cylinders is allowed for the testing of precast concrete box culverts, provided that it meets the requirements of 450-4.1. Follow the alternative method of compaction, in accordance with ASTM C-497, if the consistency of concrete is too stiff for compaction by rodding or internal vibrations. Expose shipping strength test cylinders to the same curing conditions as the precast concrete box sections. Cure the 28-day strength test cylinders in accordance with Section 346.

Perform all concrete quality control testing and inspections in accordance with 346-9.2.

For training and other qualifications meet the requirements of Article 105-5. Test all QC samples for compressive strength in a laboratory meeting the requirements of 6-9.

410-3.2 Quality Assurance Inspection and Testing: The Engineer will perform periodic inspections, sampling, and testing to ensure of the quality and acceptability of the materials, methods, techniques, procedures and processes

being utilized by the manufacturing facility in the fabrication of precast concrete box culverts.

410-3.3 Special Requirements for Dry-Cast Concrete: Dry-cast concrete is defined as a very low slump concrete that requires continuous and intense vibration to compact the concrete, enabling immediate removal of the side forms without detrimental effects to the concrete when used in a dry-cast manufacturing process.

The target slump and air content ranges of 346 - Table 2 and the plastic property tolerances of 346 - Table 6 are not applicable to dry-cast concrete.

Perform absorption tests on specimens from each LOT of dry-cast production in accordance with the test methods in ASTM C-497. The absorption of each specimen must not exceed 9.0 percent of the dry mass for Test Method A procedure or 8.5 percent for Test Method B procedure. All specimens must be free of visible cracks and must represent the full thickness of the product. Test specimens after 28-days of standard curing, or prior to the date of shipping if the precast box sections are to be shipped before to the completion of the 28-day curing period.

Core three specimens for Test Method B in accordance with ASTM C-42 and meet the sampling location and size requirements of ASTM C-497. Prepare or core a minimum of one specimen for Test Method A in accordance with the test cylinder requirements of ASTM C-497. When the initial absorption specimen from a concrete box section fails to conform to this Specification, the absorption test may be made on another specimen from the same box section and the results of the retest may be substituted for the original test results for acceptance of the LOT. The manufacturer may test each box section within a LOT and cull the box sections not meeting absorption requirements marking them as deficient with waterproof paint or other approved means. Deficient box sections must not be shipped to the project site. Reduce the frequency of absorption tests to one test every five LOTs when the results of five consecutive LOTs meet the specified limit.

410-4 Design of Precast Concrete Box Sections.

410-4.1 General: In lieu of a cast-in-place concrete box section or if specified in the Contract Documents, provide precast box culverts in accordance with Design Standards Index No. 291 and the following:

Segment lengths must be between 4 feet and 16 feet. Short-side wall lengths for end segments of skewed culverts, may be less than 4 feet when approved by the Engineer.

Provide tongue and groove joints at the ends of segments. For two-piece box culvert segments, provide keyed joints for the top slab-to-wall connection to prevent lateral displacement at the top of the walls, and double-sided tongue and groove joints in the bottom slab to minimize differential settlement between segments. Alternate methods to prevent differential settlement may be used when included in the Contract Documents or approved by the Engineer. Concrete cover at the joints may be reduced from the nominal cover shown in the Contract Documents, in accordance with the Design Standards, but not less than 1 inch clear to the ends or inside mating surfaces of the joints or 1 1/2 inches clear to the

outside surface of the joint for slightly and moderately aggressive environments, or 2 inches clear to the outside surface for extremely aggressive environments.

Meet one of the following design options:

410-4.1.1 Equivalent to Cast-In-Place Designs: Provide precast box segments identical to the plan details, including reinforcing steel grade, sizes and spacings, concrete cover, concrete class, and slab and wall dimensions. Reinforcing bar sizes and spacings may be reduced provided the equivalent area of reinforcing is provided in each layer. Haunch dimensions may be increased with the approval of the Engineer, but not greater than 8 inches for box culverts with internal spans less than 6 feet, or 12 inches for box culverts with larger internal spans.

410-4.1.2 Standard Precast Designs: Provide precast box segments in accordance with Design Standards Index No. 292 with the same hydraulic opening, fill height and reinforcing steel cover as shown in the plans, for the most critical design loading combination. Perform a bridge load rating in accordance with the Structures Design Guidelines, for any multiple barrel culverts with a total span equal to or greater than 20 feet, when measured between the inside face of end supports, along the centerline of the roadway crossing.

410-4.1.3 Modified or Special Designs: Provide Modified Designs which differ from the standard precast designs in 410-4.1.2 with modifications to the wall and slab thickness, or haunch dimensions. Provide Special Designs for sizes, elements and loads other than those referenced in 410-4.1.2. Redesign box culverts using the same AASHTO design specification, live load, hydraulic opening, fill height, minimum concrete class and concrete cover as shown in the Contract Documents. Special Designs will be required for all two-piece concrete box culvert segments. Provide a minimum member thickness not less than 75% of the thickness of the corresponding member of an equivalent Index No. 292 box culvert, but not less than 7 inches for culverts with 2 inch concrete cover or 8 inches for 3 inch concrete cover. Perform a bridge load rating in accordance with the Structures Design Guidelines, for any redesign with a total span equal to or greater than 20 feet, when measure between the inside face of end supports, along the centerline of the roadway crossing.

410-4.2 Design Submittals: Submit shop drawings for all design options in accordance with 410-12. Submit design calculations, revised plans and load rating when required for approval in accordance with Section 5 for Modified or Special Designs. Ensure that a Specialty Engineer performs the design for Modified Designs of the box culvert and signs and seals the calculations.

Ensure that the Contractor's Engineer of Record performs any bridge load rating and the design for any Special Designs and signs and seals the revised plans, calculations and load rating.

410-5 Other Elements of a Precast Box Culvert System.

Extend reinforcing from precast sections to provide adequate splice lengths or utilize a mechanical rebar splicing system listed on the Department's Qualified Products List (QPL) for securing reinforcing dowels for headwalls, toe walls and wingwalls.

Cast all elements of the headwalls and wingwalls (footing and stem) in-place, unless otherwise noted in the Contract Documents. Cast all cut-off or toe walls for precast box end segments in-place only. Extend the depth of cut-off or toe walls an additional 6 inches with the limits of the bedding material. Bedding material and compaction requirements for wingwalls are the same as required for precast box sections, except that the granular material may be placed to the inside edge of the toe wall, unless otherwise specified in the Contract Documents. Bedding material is not required for cast-in-place wingwall footings.

All requirements of Section 400 and Section 415 apply to the fabrication of these elements. Backfill the locations behind the walls in accordance with the requirements of Section 125.

410-6 Fabrication.

410-6.1 Casting: Cast precast elements in unyielding beds and forms. Ensure bearing surfaces in casting forms are level and straight, and vertical surfaces are plumb prior to casting. Ensure surfaces within the forms against which concrete will be cast, are clean and free from rust and hardened residual concrete. Provide full concrete cover clearance to all form wires and other miscellaneous pieces of metal, except as permitted by Section 415. Bend all tie wires away from the form surface to provide maximum concrete cover. Embedded metal lifting devices may be positioned 1/2 inch below the concrete surface, provided blockouts are backfilled with an epoxy mortar within a distance of 1 1/2 inch of the perimeter of the metal device located within the concrete cover.

410-6.2 Surface Finish: Finish the precast elements in accordance with 400-15.1.

410-6.3 Curing: Perform the curing by any method prescribed in Sections 400 and 450, or by any other Department approved alternate curing method included in the approved Quality Control Plan, or combinations thereof that have provided satisfactory results.

410-6.4 Fabrication Tolerances:

410-6.4.1 Internal Dimensions: Ensure the internal dimensions do not vary more than 1% from the design dimensions, with a maximum of 3/4 inch. Ensure the haunch dimensions do not vary more than 1/4 inch from the design dimensions.

410-6.4.2 Slab and Wall Thickness: Ensure the slab and wall thickness are not be less than that shown in the plans or approved shop drawings by more than 5 percent or 3/16 inch, whichever is greater. A thickness more than that required in the design will not be a cause for rejection although payment will be for plan quantity only.

410-6.4.3 Length of Opposite Surfaces: Ensure the variations in laying lengths of two opposite surfaces of the box section are not more than 1/8 inch/ft of clear span, with a maximum of 5/8 inch for precast boxes with a clear span of up to 7 feet and a maximum of 3/4 inch for boxes with a clear span greater than 7 feet. The exception to this is when beveled ends, for the purpose of laying curves, or skewed ends are specified by the Engineer.

410-6.4.4 Length of Section: Ensure the under run in length of sections is not more than 1/8 inch/ft of length with a maximum of 1/2 inch in any box section.

410-6.4.5 Tongue and Groove Joints or Ends: Ensure the planes formed by the ends of box sections do not vary perpendicular from the joint axis by more than 1/4 inch for internal spans or heights less than 5 feet, or more than 3/8 inch for internal spans or heights of 5 feet or greater.

410-6.4.6 Position of Reinforcement: Meet the requirements of 415-5.10.2 for the maximum variation in the position of slab steel. Meet the requirements of 415-5.8.2 for the maximum variation of wall steel, except that the concrete cover must not be less than 1/4 inch nor more than 1/2 inch from the design dimensions.

410-6.4.7 Area of Reinforcement: Provide the area of reinforcement as indicated in the plans or approved shop drawings as a minimum. If welded wire reinforcement is utilized in lieu of mild steel reinforcement, the provisions of 415-6 apply.

410-6.5 Removal of Forms: Remove forms after the concrete has attained the minimum compressive strength requirements included as part of the Quality Control Plan, but not less than the following:

Vertically cast walls and slabs for four-sided sections	1000 psi
Three-sided box culvert bottom section	2500 psi
Horizontally cast self-supporting slabs or walls	2500 psi

Products manufactured with dry-cast concrete, are exempt from these requirements.

410-6.6 Lifting and Removal From Casting Area: Handle all products, including those manufactured with dry-cast concrete, after the concrete attains sufficient compressive strength as determined by the manufacturer but not less than the following, unless otherwise approved in the Quality Control Plan:

Vertically cast and stored elements (walls and slabs)	1000 psi
Form/pallet supported elements (walls or slabs)	1000 psi
Self-supporting four-sided sections	1000 psi
Self-supporting horizontal slabs or three-sided sections	2500 psi

Limit the flexural tension stresses from handling to a maximum allowable stress of three times the square root of the concrete compressive strength in psi, prior to the concrete attaining the required 28-day strength.

410-7 Handling, Storage, and Shipping.

Handle, store, and ship precast box culverts in a manner that prevents chipping, cracks, fractures, and excessive bending stress. Do not ship precast box culverts before the concrete attains the required 28-day strength.

The manufacturer is permitted to verify the shipping strength test, before 28 days, by testing compressive strength cylinders that are cured under the conditions similar to the product or by testing temperature match cured cylinders.

The manufacturer may use the maturity method, ASTM C-1074, pulse velocity method in accordance with ASTM C-597, or any other approved nondestructive test method to estimate the strength of concrete for determining form removal and handling strengths or before verification of shipping strength by test cylinders.

Curing temperature and cycle must be monitored on a minimum of one box culvert curing cell from each day of production when nondestructive test methods or temperature match cured cylinders are used to determine concrete strengths.

The shipping strength test is the average compressive strength of two test cylinders. Do not ship any products until the Quality Control Manager's stamp is affixed to the product.

410-8 Repairs and Rejection.

Evaluate cracks, spalls and other deficiencies in accordance with 450-12, except that cracks will be classified in accordance with 400-21. Classify fractures and cracks passing through the wall or slab, except for a single end crack that does not exceed the depth of the joint, as structural cracks. Repair nonstructural cracks in accordance with 400-21 (substructure requirements), and all other deficiencies in accordance with 450-13 or the plant's approved repair methods that are included as part of the Quality Control Plan. Ensure that the original performance and durability of the repaired box culverts are maintained.

Use materials for concrete repair that will meet or exceed the strength requirement of the class of concrete used. Materials meeting the requirements of Section 930 may be substituted for non-shrink grout when required by 450-13. Precast box culvert elements are subject to rejection if they fail to conform to any of the Specification requirements after repair or when damaged ends would prevent making a satisfactory joint.

410-9 Marking.

Ensure each section of Precast Box Culvert has permanently and clear marking on an inside face by indentation, waterproof paint, or as specified in the Quality Control Plan, showing the manufacture date, serial number**,** project number, and manufacturer's name or symbol. The top of the box culvert must also be clearly indicated with waterproof paint or as specified in the Quality Control Plan.

410-10 Trench, Foundation, Laying, and Backfill.

410-10.1 General: Meet the requirements of Section 125 and/or Section 121, for trench excavation, foundation construction, laying and backfilling and the following:

Lay all precast box culvert sections on a dry, slightly yielding foundation, to ensure uniform bearing across the full width of the bottom slab. Provide dewatering devices, if applicable, in accordance with 455-29, capable of maintaining a stable and surface-dry trench bottom. Construct any temporary sheet piling used in cofferdams, retaining walls and to incorporate the Contractor's specific means and methods, in accordance with 125-3.

410-10.2 Bedding: Provide bedding that consists of a minimum 6 inch depth of select material, with not more than 15% fines passing the No. 200 U.S. Standard sieve, in accordance with Design Standards Index No. 505 or other granular material approved by the Engineer. Place bedding in maximum 6 inch compacted layers below the culvert to a minimum width of 12 inches outside the exterior walls of the culvert and meet the density requirements of 125-9.2. When coarse aggregate is approved for use as an alternate bedding material, wrap the bottom and sides of the coarse aggregate with a layer of Type D-4 geotextile filter fabric as specified in Design Standards Index No. 199, and substituted the coarse aggregate with select material within 4 feet of the cut-off or toe walls at each end of the precast box culvert. Obtain the Engineer's approval before using flowable fill for bedding material. Provide other special bedding material, when required by the Contract Documents.

Set grade forms 12 inches outside each exterior wall of the box culvert. Uniformly compact this material and then grade off using the forms. Set the grade forms approximately 1/8 to 1/4 inch above the theoretical grade line to allow for soil compression. Adjust this distance to yield the proper grade, but do not use in lieu of the proper compaction of the granular bedding material. Remove the forms after placing the precast box culvert section.

410-10.3 Placement of Precast Box Culvert Sections: Obtain the Engineer's approval of the method of controlling line and grade during culvert installation. Use a method that allows rapid checking of the previously laid sections. Maintain line and grade on sections previously set. The Engineer will consider sections which do not retain the plan line within 0.10 foot or grade within 0.10 foot during laying of subsequent sections, as not having been laid to line and grade. Take up and relay sections not to line and grade without additional compensation.

410-10.4 Placement of Multiple Barrel Culverts: For multiple barrel installations using single-cell precast box sections, provide positive lateral support between the precast box culverts consisting of non-shrink grout, concrete meeting the requirements of Section 347 or non-excavatable flowable fill prior to backfilling. Provide partial height backfill or bracing to maintain alignment, when approved by the Engineer.

410-10.5 Backfilling: Begin backfilling only after the Engineers approval. Seal blockouts and holes provided for lifting or joint restraint by plugging using an epoxy mortar or non-shrink grout in accordance with Sections 926 or 934 and properly cure to ensure a sound and watertight plug, prior to backfilling.

410-11 Joints.

410-11.1 General: Make field joints for precast concrete box culvert sections with either profile rubber gaskets or preformed joint sealants, unless otherwise detailed in the plans or approved shop drawings. Joint performance must meet the requirements of ASTM C-990, and joint openings at the outside face must not exceed 1 1/2 inches in the assembled position at any location along the joint perimeter. Ensure a minimum 50% overlap of the joint tongue and groove around the entire perimeter of the box in the assembled position.

Completely wrap the outside of each joint with geotextile filter fabric. Use fabric meeting the physical requirements of Class D, Type 3 specified on Design Standards, Index No. 199. Provide fabric with a minimum width of 2 feet and a length sufficient to ensure a minimum overlap of 24 inches. The filter fabric must extend a minimum of 12 inches beyond each side of the joint. Secure the fabric tightly against the box culvert sections with metal or plastic strapping. Other methods which will hold the fabric securely against the wall of the culvert until the backfill is placed and compacted, may be used when approved by the Engineer. When specified in the plans, secure the joint by a suitable device capable of holding the sections to line and grade as well as fully home. Remove these devices and repair locations as necessary if intrusive into the concrete after placing and compacting sufficient backfill to secure the sections.

410-11.2 Profile Rubber Gaskets: Install field joints in accordance with the joint manufacturer's instructions and meet the following:

1. Meet the requirements of Article 6 of ASTM C-443,
2. Store all gaskets in a cool place prior to use,
3. Furnish to the Engineer written details regarding configuration of the joint and gasket required to create a soil-tight seal. Do not apply mortar, joint compound or other filler which would restrict the flexibility of the joint.

410-11.3 Preformed Flexible Joint Sealants: Install field joints in accordance with the joint manufacturer's instructions and meet the following:

1. Meet the requirements of ASTM C-990,
2. Furnish to the Engineer a written recommendation of the size (cross-sectional area) of joint sealant which will create a soil-tight seal. Ensure that this amount is the minimum quantity of bitumen sealant used. Do not brush or wipe joint surfaces which are to be in contact with the joint sealant with cement slurry. Fill minor voids with non-shrink grout,
3. Thoroughly clean and dry all joint surfaces which are to be in contact with the sealant material. When recommended by the sealant manufacturer, apply a primer of the type recommended to all joint surfaces which are to be in contact with the sealant material.
4. Apply sealant to form a continuous seal around each joint. The sealant must be protected by a removable wrapper. Do not remove the paper wrapper on the exterior surface of the preformed flexible joint sealant until immediately prior to joining the precast sections. Apply the joint sealant only to dry surfaces. When the atmospheric temperature is below 60°F, either store the joint sealant in an area above 70°F, or artificially warm the joint sealant to 70°F in a manner satisfactory to the Engineer. After assembly ensure that there is full contact and compression of the sealant for the entire perimeter of the joint, as evidenced by the presence of minor bulging along any visible edges of the sealant. Neatly trim any extruded sealant flush with the concrete surface.

410-11.4 Water-tight Joint Treatment: Provide water-tight joints when shown in the Contract Documents. Utilize an external sealing band in accordance with ASTM C-877 in addition to the requirements of 410-11.2 or 410-11.3. Determine the minimum width of sealing bands by substituting the larger of the clear rise or span of the precast concrete box section, for the equivalent pipe diameter in ASTM C-877 Tables 1 and 2. Install external sealing band wrap in

accordance with the manufacturer's instructions prior to wrapping the joint with geotextile filter fabric.

410-12 Shop Drawings.

Submit details of all precast box culvert elements for approval to the Engineer prior to manufacturing in accordance with 5-1.4. These shop drawings must include the proposed layout, lifting devices, and a note describing the casting method for the precast box culverts and details of any modifications to cast-in-place sections or connections thereto. All details must be submitted as a complete package including modifications to cast-in-place sections.

410-13 Method of Measurement.

The quantity to be paid for will be plan quantity for the structure shown in the Contract Documents in accordance with 400-22 and 415-7.

410-14 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including the cost of special bedding material and its placement, additional cut-off or toe wall depth, temporary sheet piling, graded forms, joint materials, filter fabric material, attachment of the filter fabric, dewatering, excavation, channel excavation and lining, backfilling, restraining devices and any other materials or equipment necessary to make a complete and accepted installation.

Payment will be made under pay items for concrete (culverts) and reinforcing steel (roadway).

SECTION 411
EPOXY INJECTION OF CRACKS IN CONCRETE STRUCTURES

411-1 Description.

Inject epoxy into cracks in portland cement concrete.

411-2 Materials.

Meet the requirements of Section 926 and as follows:

Use Type E compound epoxy for injection.

Use Type F-1 compound epoxy for sealing crack surfaces in preparation for injection.

Use epoxy materials on the Qualified Products List.

411-3 Equipment.

For the equipment used to inject the epoxy, meet the recommendations of the epoxy injection material manufacturer and the following requirements:

(1) Use equipment that has the capacity to automatically proportion the material components within the mix ratio tolerances set by the epoxy materials manufacturer.

(2) Use equipment that has the capacity to automatically mix the epoxy component materials within the pump and injection apparatus. The Engineer will not allow batch mixing.

(3) Use equipment that has the capacity to inject the epoxy resin under controlled variable pressures up to 200 psi, with a pressure gauge mounted at or near the nozzle to indicate the actual working pressure.

411-4 Injection Personnel Qualifications.

Employ personnel trained in performing injection work similar to that required for the project to carry out the epoxy injection of cracks in concrete. Provide an on-site supervisor for the epoxy injection work who is qualified by one of the following methods:

(1) Certified by the manufacturer of the epoxy injection material as having the necessary competence to accomplish the epoxy injection work in a satisfactory and safe manner in compliance with these Specifications.

(2) He can furnish documented evidence that he has a minimum of three years experience of on-site supervision of similar epoxy injection work and a list of five contracts in which similar epoxy injection was acceptably completed. Ensure that the listed experience in on-site supervision and completed contracts contains the project name and location, names of contracting parties, the owner's name, brief description of the work, and dates of completion of the epoxy injection work.

Furnish written evidence showing personnel training and the on-site supervisor's qualification to the Department prior to beginning any epoxy injection work.

411-5 Crack Surface Preparation and Cleaning Requirements.

Clean the area surrounding the cracks of all deteriorated concrete, efflorescence and other contaminants detrimental to the adhesion of the surface sealing epoxy compound. Clean the interiors of the cracks with air under sufficient pressure to remove loose materials entrapped within the crack including efflorescence.

411-6 Sealing Cracks for Epoxy Injection.

After cleaning, drill injection port holes using a swivel drill chuck and hollow drill bits, including a vacuum attachment which will remove dust and debris generated during drilling. Determine the spacing of the injection port holes by the size of the crack and the depth of the crack in the concrete substrate. Generally, space the injection ports from 4 to 8 inches apart. Determine the actual spacing of injection ports by field trials. Drill the holes to a minimum depth of 5/8 inch, exercising care in aligning the hole along the plane of the crack so that the hole follows the crack for the full 5/8 inch depth.

Insert the injection ports in the drilled holes approximately 1/2 inch, allowing for a small reservoir below the injection port.

After cleaning the cracks and drilling the injection port holes, seal the crack surface and the injection ports with suitable epoxy.

411-7 Epoxy Injection.

Inject the epoxy in accordance with the epoxy manufacturer's instructions. Determine the actual injection procedures and pressures in field trials, based on crack widths and depth into the substrate and sufficiency of the results.

411-8 Cleaning After Epoxy Injection.

Clean concrete surface areas of excess epoxy materials and injection ports after completing the epoxy injection work. Clean in a manner which will not damage the concrete by scraping, light sand blasting, grinding, use of solvents, or any other appropriate method approved by the Engineer. Clean excess materials so that no epoxy material or injection ports extend beyond the plane surface of the concrete.

411-9 Acceptance.

Drill three cores located in each day's work as directed by the Engineer. Take drilled core samples containing representative crack sizes. The Engineer will accept the epoxy injection work represented by the core samples when the core samples indicate that 90% of the crack void greater than 0.006 inch wide is filled with epoxy resin and the concrete of the core sample is bonded through the crack into a unit.

Re-inject epoxy injection work which does not satisfy the acceptance criteria, and correct it as necessary at no expense to the Department. Install additional injection ports as required to achieve satisfactory reinjection of epoxy resin.

After the epoxy injection work is completed and accepted, fill the core holes with an epoxy mortar consisting of one part by volume epoxy injection resin and four parts by volume clean, dry sand. Supply the sand in moisture proof bags. Do not use previously opened bags of sand for making epoxy mortar. The Contractor may use one part by volume epoxy material for sealing with one part by volume clean, dry sand in lieu of the above.

411-10 Method of Measurement.

411-10.1 Epoxy Material: The quantity to be paid will be the volume, in gallons, authorized, injected, and accepted.

411-10.2 Inject and Seal Crack: The quantity to be paid will be the length, in feet, authorized and accepted, measured along the approximate centerline of the sealed crack.

411-11 Basis of Payment.

411-11.1 Epoxy Material: Price and payment will be full compensation for all work specified in this Section, including furnishing the epoxy material, and miscellaneous related costs, storage, handling, etc.

411-11.2 Inject and Seal Crack: Price and payment will constitute full compensation for furnishing all labor, equipment, incidentals and materials (except epoxy), for cleaning and sealing the crack, and all labor and equipment for injecting the crack.

411-11.3 Payment Items: Payment will be made under:

Item No. 411- 1	Epoxy Material – per gallon.
Item No. 411- 2	Inject and Seal Crack – per foot.

SECTION 413
SEALING CRACKS AND CONCRETE STRUCTURE SURFACES

413-1 Description.

Seal concrete surfaces and cracks in concrete using materials, surface preparation, and application of penetrant sealers and high molecular weight mathacrylates as specified in this Section and in accordance with the manufacturer recommendations. Consult with the FDOT State Materials Office in the event of conflict between the manufacturer's recommendations and this specification. Perform surface preparation and application to all areas as shown in the plans or as directed by the Engineer.

413-2 Penetrant Sealers.

413-2.1 Materials: Use alkylalkoxysilane penetrant sealers, with 40 percent solids and active materials dispersed in water that meet the following:

Table 1: Physical Properties of Penetrant Sealers	
Appearance	White, Milky Liquid
VOC content (EPA method 24)	Less than 350 g/l
Flash Point (ASTM 3278)	Greater than 200° F SETA
Resistance to Chloride ion penetration AASHTO T259 and T260	Less than 0.52 pounds/yd^3(criteria of 1.5) at 1/2 inch level; 0.00 pounds/yd^3 (criteria of 0.75) at 1 inch level
Water absorption test (ASTM C 642)	0.50 percent maximum / 48 hours; 1.5 percent maximum / 50 days
NCHRP 244	
Series II - cube test	
Water weight gain	85 percent reduction minimum
Absorbed chloride	87 percent reduction minimum
Series IV - Southern climate	
Absorbed chloride	95 percent reduction minimum
Scaling resistance test (ASTM C 672)	(non - air - entrained concrete) 0 rating "No Scaling" (100 cycles)

413-2.2 Surface Preparation for Penetrant Sealer:

413-2.2.1 General: Prepare concrete surfaces to receive a penetrant sealer in accordance with these Specifications dependent on whether the surfaces are of recently cast concrete (new construction) or of existing concrete.

413-2.2.2 Surface Preparation for New Construction: Remove substances such as dust, grime, dirt, curing compounds, form oil, debris, etc. by water blasting, light sandblasting, wire brushing, or other methods acceptable to the Engineer, all in accordance with the penetrant sealer manufacturer's recommendations. When using cleaning methods other than water blasting, wash

the cleaned surfaces with water meeting the requirements of Section 923, as a final cleaning operation.

413-2.2.3 Surface Preparation for Existing Concrete: Remove substances such as dust, grime, dirt, stains, mineral deposits, oil, bituminous materials, debris, and all other deleterious material by using water blasting equipment of sufficient operating capacity and pressure, all in accordance with the penetrant sealer manufacturer's recommendations.

413-2.2.4 Cleaning Equipment: Use approved water blasting equipment to clean existing concrete surfaces. Use water blasting equipment which is specifically manufactured to clean concrete surfaces. Use equipment that has a minimum rated nozzle capacity of 6,000 psi using the spray head proposed for use in the work.

413-2.2.5 Water for Blasting: Use water meeting the requirements of Section 923.

413-2.2.6 Concrete Surface Cleaning Operation: During the cleaning operation, exercise sufficient care to minimize the removal of the concrete matrix. Furnish hand tools, power grinders, and other similar equipment to remove materials which cannot be removed by water blasting without abrading the concrete matrix beyond acceptable limits. Wash concrete surfaces cleaned by methods other than water blasting with water blasting equipment as the final cleaning operation.

Limit the duration of water blasting to provide a light abraded surface. Do not allow surface abrasion to exceed 0.016 inch. The Engineer will not require further cleaning of stains still apparent after abrading to a depth of 0.016 inch. Avoid exposure of coarse aggregate by water blasting.

Reclean concrete surfaces which become contaminated before applying the penetrant sealer at no expense to the Department prior to applying the penetrant sealer.

413-2.3 Application of Penetrant Sealer Materials: Apply the penetrant sealer only to surfaces which have been prepared in accordance with these Specifications and approved by the Engineer. For application of the penetrant sealer, meet these Specifications and the penetrant sealer manufacturer's recommendations.

Prior to application of any penetrant sealer, cure concrete for a minimum of 21 days.

Apply penetrant sealer no later than ten days after completion of the surface preparation and prior to any contamination of the prepared surfaces as determined by the Engineer.

413-2.3.1 Application Equipment: Apply the penetrant sealer using any suitable air or airless sprayer with an operating pressure of approximately 20 psi.

413-2.3.2 Application Limitations: Apply the penetrant sealer material only when the ambient air temperature is between 50 and 90ºF. Apply the penetrant sealer only to concrete surfaces which have dried a minimum of 48 hours after water last contacted the concrete surfaces. Do not apply the penetrant sealer when winds are blowing 25 mph or more, during rainfall, or when water spray or mist is present.

413-2.3.3 Application: Apply the penetrant sealer only to concrete surfaces that have been prepared in accordance with the requirements and limitations set forth in these Specifications. Determine the actual coverage rate in square feet per gallon on the basis of field trials. Conduct a field trial to determine coverage rate at the beginning of any penetrant sealer application operation. Conduct additional confirmation field trials at a frequency of once for every 5,000 ft^2 applied, each production day of application, or when the character of the work changes, whichever is sooner. For each field trial, determine the optimum coverage rate for 500 ft^2 of surface area. Maintain the penetrant sealer application rate between 155 and 225 ft^2 covered per gallon of penetrant sealer used. Apply the penetrant sealer in a uniform manner without puddling and skips. Redistribute any penetrant sealer which is applied and subsequently puddles in low areas over the concrete surfaces by use of a squeegee.

Generally, begin the application of the penetrant at the lowest elevation and proceed upward toward higher elevations.

Maintain operating pressures in the sprayers used for application of the penetrant sealer material sufficiently low so that atomization or misting of the material does not occur.

413-2.4 Control of Materials:

413-2.4.1 Packaging and Identification: Deliver the penetrant sealer to the project in unopened, sealed containers with the manufacturer's label identifying the product and with numbered seals intact. Ensure that each container is clearly marked by the manufacturer with the following information:

a. Manufacturer's name and address.
b. Product name.
c. Date of manufacture.
d. Expiration date.
e. LOT identification number.
f. Container serial number.

413-2.4.2 Manufacturer's Certification: Provide the Engineer a certification conforming to the requirements of Section 6 from the manufacturer, confirming that the penetrant sealer meets the requirements of this Section. Do not incorporate these materials into the project until the Engineer has accepted and approved the certification for the material. Submit such certification for each LOT of material delivered to the project. In each certification, identify the serial or LOT numbers of the containers certified.

413-2.4.3 Materials Sampling for Tests: The Engineer may require samples from each LOT or container of materials delivered to the project or from containers at the point of use. When samples are required, furnish samples in accordance with the Engineer's instructions.

413-2.4.4 Storage of Materials: Store materials delivered to the job site in original unopened containers within an appropriate storage facility. Use a storage facility that provides protection from the elements, and safe and secure storage of the materials.

413-2.4.5 Unused Material in Opened Containers: Do not return unused material in opened containers to storage for later use. Either apply such

material to appropriate areas on concrete surfaces or remove and dispose of it at offsite locations provided by the Contractor.

413-2.5 Acceptance: The Engineer will accept penetrant sealer application when it is determined that the Contractor has properly cleaned all surface areas to be sealed and has applied the penetrant sealer within the required rates of application.

413-3 High Molecular Weight Methacrylate (HMWM).

413-3.1 General: Perform the surface preparation and application of a high molecular weight methacrylate to seal cracks on horizontal and slightly sloped concrete surfaces as approved by the Engineer. Applications on bridge decks and other riding surfaces will require the addition of sand over the treated areas to increase the friction (skid) number measured as described by ASTM E-274.

The rate of application (gl/ft^2 of concrete) and the application method and equipment must be approved by the Department's State Materials Office (SMO) prior to commencement of work based on the size, depth and the internal condition of cracks. Submit a written sealer application plan based on the above described crack characteristics for approval by the SMO. In addition, provide a minimum of 14 days advanced notice so that personnel from the State Materials Office may be present at the beginning of work to evaluate the cracks and provide final approval of the application rate. Make arrangements with the material manufacturer to provide on-site technical assistance for the initial application and certify that the mixing ratio, application methods, and sand broadcasting are correct and in accordance with their recommendations.

Maintain a daily log of used resin material to be verified by the Engineer. Include the drum or container identification number in the log as well as the date and location of use. Retain the containers at the jobsite until the Engineer verifies its use and authorizes removal from the site.

413-3.2 Materials: The methacrylate system must be a three component system consisting of: a) methacrylate monomer, b) cumene hydroperoxide (CHP) initiator, and c) cobalt promoter. Use a HMWM monomer that is approved by the Department and included on the Department's Qualified Products List. Use initiator and promoter approved by the monomer manufacturer. Manufacturers seeking evaluation of their products must submit an application conforming to the requirements of Section 6 along with the following documentation:

1. Manufacturer's material installation instructions showing the product can be installed in accordance with this Section.

2. Independent laboratory test data and results showing the product has been tested in accordance with the requirements of this Section and meets the requirements.

413-3.2.1 Properties: Use a methacrylate material that meets the following physical and performance requirements:

Table 2: Physical Properties of Methacrylate Resin	
Viscosity (Brookfield RVT)	14-20 cps at 50 rpm
Density (ASTM D1481)	8.5 - 9.0 lb/gl at 77o F
Flash Point (ASTM D93)	> 200 oF (Pensky Martens CC)

Odor	Low
Bulk Cure Speed	3 Hours @ 73o F (max.)
Surface Cure	8 Hours @ 73° F (max.)
Gel Time (ASTM 2471)	60 minutes (max.)
Tack Free Time	5 Hours (max.) (at 72 °F and 50% Relative Humidity
Compressive Strength (AASHTO T106)	6,500 psi (min)
Tensile Strength (ASTM C307)	1,300 psi (min)
Shear Bond Adhesion (ASTM C882)	600 psi (min)
Wax Content	0

The monomer shall have a shelf life of no less than 12 months and shall be no more than 8 months old at the time of application. Provide each container shipped to the job site with the following information on a manufacturer's label: manufacturer's name, product name, lot or batch number, date of production, and drum serial number. Identify the catalysts by their generic classification and provide the date of manufacture.

413-3.2.2 Sand: Use uniformly graded 6-20 (or similar), clean, bagged, blast sand for spreading over the applied polymer on bridge decks and other riding surfaces. Certify that the sand has a maximum moisture content that does not exceed 0.25% and that the maximum amount of dust or other material that may pass through a No. 200 sieve (–200 content) is not greater than 0.75%.

Store the sand at a location that will preserve the above described conditions and characteristics of the sand until applied.

413-3.3 Surface Preparation:

413-3.3.1 Cleaning: On the day of application, thoroughly power sweep the area to be treated to remove all dust, dirt or debris present. On bridge decks and other riding surfaces, use a tractor mounted (or similar) power broom with non-metallic bristles suitable for the intended purpose.

Use a power vacuum after sweeping when sealing cracks on grooved bridge decks. Re-clean the deck as necessary just prior to the application as debris may be blown back onto the work area by adjacent traffic or other means.

If present, remove oils and oil based substances from the concrete surface using an approved solvent.

413-3.3.2 Containment: Provide adequate containment to prevent the sealer material from flowing beyond the designated area of application. Plug any drain holes or openings within the work area. Prevent airborne material from dispersing onto open traffic lanes or outside the work area.

413-3.4 Application:

413-3-4.1 Equipment: Apply the material according to the manufacturer's specifications using mobile equipment capable of distributing material on large areas of decks and riding surfaces. Apply the material by hand using adequate containers for isolated or localized applications.

413-3.4.2 Mixing: Mix the methylmethacrylate material following the manufacturer's specified mixing proportions for the catalysts. Perform the initial mixing by equally dividing the resin to be used into two separate containers. In

all instances, mix the initiator (CHP) at the HMWM manufacturer's specified volume with 50% of the monomer resin in one container and the cumene promoter at the HMWM manufacturer's specified volume with the other 50% in the second container. After properly blending, combine the two resins and mix as per manufacturer's instructions. For spray bar application, mix the activator/resin blend and the promoter/resin blend through a static mixer in the feed line located ahead of the material distribution bars where polymerization would start. Calibrate the valves to the static mixer to ensure a one to one mixing ratio of the two blends.

413-3.4.3 Polymer Application (Mobile Distribution): Apply the material only under weather conditions recommended by the manufacturer and when no rainfall has occurred during the previous 48 hours and no rain is expected for the next 6 hours following completion of the application. Unless otherwise approved by the Engineer, distribute the monomer uniformly over the work area using a pressure nozzle or spray head distribution bar system. Provide feed to the distribution bar(s) using positive displacement pumps moving equal amounts of the two monomer blends from two calibrated drums.

Calibrate the equipment to mix the two monomer blends to the recommended ratio (by volume) within ±5%. The discharge volume shall be calibrated to the moving speed to provide a discharge rate capability ranging from 50 to 200 square feet per gallon at a pressure ranging from 15 to 60 psi.

The typical application rate of the material is approximately 100 square feet per gallon. Prior to application of the monomer, the State Materials Office will determine the final production application rate based on the internal characteristics of the cracks as determined from Contractor supplied cores that the Engineer approves as being representative of the overall cracking conditions.

413-3.4.4 Polymer Application (Localized Distribution): Distribute the material by hand over the work area using pails or other suitable containers adequate for the size of the area. This only applies to localized small areas or areas where the use of mobile distribution equipment would be considered impractical as approved by the Engineer.

Apply the material only under weather conditions recommended by the manufacturer and on areas that have been maintained dry for a minimum of 48 hours. Ensure that the area remains dry for the next 6 hours following completion of the application.

413-3.4.5 Sealing of Cracks: Regardless of the method used to apply the material over the concrete surface, work the material back and forth over the cracks to maximize the amount of material to be absorbed by the cracks. Move the material over the cracks using brooms, squeegees or paint brushes as appropriate, based on the size of the area. Commence this operation immediately after distributing the material on the concrete surface. Continue this operation until no additional material is flowing inside the cracks or the material begins to exhibit signs of polymerization.

Do not distribute material over areas larger than what the available personnel can effectively work over the cracks within the limits of the pot life.

413-3.4.6 Sand Distribution: Apply sand over the monomer treated area within a timely period following the application of the polymer based on the manufacturer's recommendations for the existing conditions. Use equipment that will produce a uniform distribution of the sand over the treated area. If wheel mounted, use a sand spreader that has pneumatic tires compatible with the treatment material such that no tire footprints are left on the deck surface.

Use an initial application rate of 0.6 (±0.05) pounds of sand per square yard of treated area, and adjust the rate as necessary to produce a skid number (SN) of no less than 25 at 24 hours and 30at 7 days. Coordinate with the Engineer to conduct a preliminary on-site skid test to determine the actual sand application rate prior to the beginning of production application. If friction numbers below those specified are obtained, completely remove all loose sand from the surface and re-apply the polymer at a rate of 150 square feet per gallon and spread additional sand as necessary to achieve the specified skid numbers. Remove the surface material by grinding or other approved method if satisfactory friction values are not achieved. Friction tests will be conducted by the State Materials Office.

413-3.5 Opening Riding Surfaces to Traffic: Protect the sand covered area from vehicular traffic until the polymer has fully cured. After curing, power vacuum to remove excess sand from the riding surface, before opening to traffic.

413-3.6 Cure Test: Test curing on the treated area using a cotton strand or cotton ball. Consider the material fully cured and ready for traffic when polymer does not adhere to the cotton ball when pressed against the treated surface and then pulled away. Obtain approval from the Engineer prior to reopening area to traffic.

413-4 Method of Measurement.

Prestressed, precast items designated in the plans to be sealed with penetrant sealer, will not be measured for separate payment. The Contractor shall include the cost of cleaning, sealing, and applying Penetrant Sealer with the cost of the prestressed, precast items. For cast-in-place surfaces to be sealed with penetrant sealer, the quantities to be paid for will be (1) the volume, in gallons, of Penetrant Sealer as determined by use of the field measured area satisfactorily sealed divided by the approved application rate based on field trials, and (2) the area, in square feet, of Cleaning and Sealing Concrete Surfaces as determined by field measurement, completed and accepted.

Quantities of high molecular weight methacrylate to be paid will be based on the volume in gallons of monomer resin material (not including the promoter and initiator) actually used to seal the cracked surfaces at the approved application rate, and the dimensions of the treated areas in square feet.

The area of application will be computed based on the Plan dimensions of concrete surface sealed with methacrylate. For localized application, the Engineer will determine the method of measurement that most accurately reflects the area of application in square feet.

413-5 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including cleaning, furnishing and applying the material required to satisfactorily clean and seal cracks and designated surface areas, testing, and miscellaneous related costs including storage, handling, etc.

No additional compensation will be made for material, reapplication or removal due to Contractor error, or to correct deficient friction (skid) values.

Payment will be made under:

Item No. 413-149-	Penetrant Sealer - per gallon
Item No. 413-151-	Methacrylate Monomer - per gallon
Item No. 413-154-	Cleaning and Sealing Concrete Surfaces - square foot

SECTION 415
REINFORCING STEEL

415-1 Description.

Furnish and place in concrete masonry reinforcing steel of the quality, type, size, and quantity designated.

415-2 Materials.

Meet the following requirements:

Bar Reinforcement 931-1.1
Fabric Reinforcement 931-1.2

415-3 Protection of Material.

Store steel reinforcement above the surface of the ground, upon platforms, skids, or other supports, and protect it as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placing steel reinforcement in the work, ensure that the steel reinforcement is free from loose rust, scale, dirt, paint, oil, and other foreign material.

415-4 Bending, Splicing, and Cutting.

Fabricate reinforcing bars as prescribed in the CRSI Manual of Standard Practice. Bend the reinforcement cold to the shapes indicated in the plans. Perform bending in the shop before shipment, and not in the field unless shown otherwise in the Contract Documents.

Do not hot bend or straighten, weld, or thermal cut reinforcing steel unless otherwise specified in the Contract Documents.

415-5 Placing and Fastening.

415-5.1 Bar Spacing - General: Except as otherwise specified herein, ensure that each bar is within 1 inch of the plan position.

415-5.2 Concrete Blocks for Spacing: Use precast concrete blocks to space and support the reinforcing steel. Use concrete blocks with a strength equal to or

greater than the concrete in which they are to be placed and have wires cast into them for fastening to the steel. Moist-cure the blocks for at least three days.

Provide a letter stating the class of concrete used to fabricate the concrete blocks, and identifying the batch and load of concrete from which the concrete blocks were cast.

415-5.3 Wire for Tying: For tying reinforcing steel, use soft pliable wire, that readily bends and twists without breaking and that provides a tie of sufficient strength to hold the reinforcing steel in its proper position.

415-5.4 Splices: Where splices are authorized, rigidly clamp the bars or tie them in a manner meeting the Engineer's approval. Use the splice length as shown on the plans. The Contractor may submit additional splices the Specialty Engineer recommends for approval prior to use.

Do not use welded splices except as specifically authorized by the Engineer and, when authorized, meet the requirements of AWS D 1.4 "Structural Welding Code - Reinforcing Steel".

Use mechanical couplers or splice devices which develop at least 125% of the specified yield strength of the bar being spliced and are listed on the Departments Qualified Products List.

415-5.5 Footings:

415-5.5.1 Supports: In general, support the footing mat steel with concrete blocks having dimensions not greater than 4 by 4 inches by plan clearance. Fasten concrete blocks to the steel using the cast-in wires. The Engineer may approve other proposed means of support.

415-5.5.2 Tolerances: Place footing mat steel within 1/2 inch vertically from the plan bottom clearance and within 1 inch from the plan side clearance.

415-5.5.3 Tying: Tie footing mat steel with a double-strand single tie at all intersections on the periphery and at alternate intersections within the mat.

415-5.6 Dowel Bars for Columns and Walls:

415-5.6.1 Supports and Positioning: Position dowel bars projecting into columns and walls so as to allow splicing of the column bars or vertical wall bars to the dowels and to tie the dowel bars in their plan position. Support the dowel bars by a rigid template constructed across the top of the footing, and attach them to the template in such manner that placing the concrete does not disturb their position. Set the supports prior to the pouring of the concrete in the footings, and do not push dowel bars into the wet concrete after placing the footing concrete.

415-5.6.2 Tolerances: Place the dowels within 1/2 inch of their plan position and with a side clearance tolerance not exceeding 1/4 inch.

415-5.7 Verticals and Hoops for Columns:

415-5.7.1 Spacing-off from Side Forms: Space-off column steel from the side forms by concrete blocks of dimensions not exceeding 2 by 2 inches by clearance dimension. Securely fasten each block to the reinforcing.

415-5.7.2 Tolerances and Clearance:

(a) Column Verticals: Place column verticals within 1/2 inch of their plan position. Ensure that the side form clearance is within 1/4 inch of the specified clearance.

(b) Column Hoops: Place every hoop within 1 inch of the plan position for the specific hoop, with no accumulation of such tolerance caused by

the spacing between any two hoops. Ensure that side form clearance for any hoop is within 1/2 inch of its specified clearance.

415-5.7.3 Tying: Tie the column hoops to the column verticals at each intersection, by a cross tie or "figure 8" tie.

415-5.8 Wall Steel (Not Including Dowel Bars):

415-5.8.1 Supports: Space-off wall steel from the side forms by concrete blocks of dimensions not greater than 2 by 2 inches by clearance dimensions. Fix the spacing between wall mats by means satisfactory to the Engineer.

415-5.8.2 Tolerance: Except where it is necessary in order to clear a fixture, place each bar within 1 inch of its specified position. In any case, ensure that the number of bars in any affected unit is as specified, and place the remainder of the bars (not thus affected) within the specified 1 inch tolerance.

415-5.8.3 Tying: Tie wall steel with a cross tie or "figure 8" tie. On the periphery, tie the steel at each intersection. Within the mat, tie the steel at every third intersection, except that where the wall is of such size that it is necessary that workmen use the reinforcing as a ladder, the Engineer may require tying at every other intersection, or at every intersection, as he deems necessary.

415-5.9 Beams and Caps:

415-5.9.1 Supports: Maintain bottom clearances by approved heavy beam bolsters. Support additional layers of main longitudinal steel from the lower layers by heavy upper-beam bolsters, placed directly over low supports.

Begin the spacing of beam bolsters at not more than 2 feet from the end of the beams or caps and space the additionally required bolsters at not more than 4 feet.

Use concrete blocks, having dimensions not greater than 2 by 2 inches by specified clearance, fastened to the steel by the cast-in wires, for spacing the upper main longitudinal steel below the top bars. Maintain the side clearance by concrete blocks, having dimensions not greater than 2 by 2 inches by required clearance, fastened to the reinforcing steel by the cast-in wires.

415-5.9.2 Tolerances: Place the main longitudinal steel so as to provide a bottom and top clearance within 1/4 inch of the plan vertical dimensions for all layers. Space the steel from side forms within 1/2 inch of the specified spacing.

Space and tie the stirrups within 1 inch of the plan position for each individual stirrup, and do not allow the tolerance to accumulate.

415-5.9.3 Tying: Tie all intersecting bars with a double-strand single tie.

415-5.10 Deck Slabs:

415-5.10.1 Supports:

(a) Bottom Mats: In general, support the bottom mats of steel by one row of slab bolsters placed 6 inches from the edge of the slab and by two rows down each panel between beams. Do not allow the spacing between rows to exceed 4 feet, measured center to center.

As an exception, when deemed satisfactory by the Engineer, the Contractor may use concrete blocks in lieu of slab bolsters. Use blocks 2 by 2 inches by clearance dimensions. Space concrete blocks 4 feet on center as a maximum. If at any time, however, the Engineer judges that the concrete blocks do not provide the proper support, he may require using slab bolsters.

(b) Top Mats: Support the top mats of steel by either continuous high chairs or individual high chairs. Support continuous high chairs along both sides of each beam and approximately 6 inches back from the edge of the beam. Place the outside row of high chairs 6 inches from the edge of the slab. If using individual high chairs, space them transversely, as specified for the continuous high chair, and do not allow the longitudinal spacing to be greater than 4 feet.

As an alternate to the above, on prestress beam construction, the Contractor may support the top mat of steel on the shear connectors bent to the proper elevation with one line of high chairs centered between the beams.

(c) Truss Bars: Support truss bars at each end of the top bends by continuous high chairs or by individual high chairs spaced longitudinally at not more than 4 feet.

415-5.10.2 Tolerances: Ensure that top and bottom clearances are within 1/4 inch from those shown on the plans.

Ensure that end and bottom clearances are within 1/4 inch from those shown on the plans.

Ensure that end and edge clearances are within 1/4 inch of the clearance specified.

Place curb bars within 1/4 inch in any direction of the plan position.

415-5.10.3 Tying: Tie all steel in each layer with a double-strand single tie at every intersection on the periphery and at every third intersection in the interior area. If encountering difficulty in maintaining the reinforcing steel in position during the placing of concrete, tie additional intersections as necessary to hold the reinforcing steel secure.

415-5.11 Box Culverts:

415-5.11.1 Supports:

(a) Bottom Slabs: In the bottom slabs of box culverts, provide supports for single-mat steel and for bottom-mat steel, including placement and spacing, as specified for footing mat steel in 415-5.5. In addition, where the plans call for more than one mat of steel in the bottom slab of the culvert, support the top mat away from the bottom mat, either by upper beam bolsters or by other means satisfactory to the Engineer.

(b) Walls: Place, space and support the steel in walls of box culverts in accordance with the requirements of 415-5.8.

(c) Top Slabs: In the top slabs of box culverts, support the bottom mats of steel by a row of slab bolsters 12 inches from the inside face of the walls and with additional rows of bolsters at spacings not exceeding 4 feet, center to center. As an exception, unless the Engineer deems the use of the slab bolsters as necessary to obtain proper support, the Contractor may use concrete blocks as the supporting device. Use blocks of dimensions not greater than 2 by 2 inches by the required clearance, with spacings not exceeding 4 feet in any direction. Fasten blocks to the reinforcing steel by the cast-in wires.

(d) Truss Bars: Support truss bars as specified in 415-5.10.1 (c).

415-5.11.2 Tolerances: Use tolerances in placing the steel in box culvert slabs as specified for deck slabs in 415-5.10.2. Use tolerances for placing steel in walls as specified in 415-5.8.2.

415-5.11.3 Tying: Tie steel in box culverts as specified for deck slabs in 415-5.10.3.

415-5.12 Cleaning: Before placing any concrete, clean all mortar from the reinforcement.

415-5.13 Chairs and Bolsters:

415-5.13.1 General: Provide reinforcing steel bar supports manufactured in accordance with all requirements of the CRSI Manual of Standard Practice. Use chairs and bolsters of adequate strength to withstand a 300 pound concentrated load without permanent deformation or breakage, with the deformation under a 300 pound load being less than 5% of the support height.

Ensure that no more than 5% of the reinforcing steel bar supports exhibit unsatisfactory performance, breakage, or permanent deformation during rebar tying and/or concrete placement operations. If a bar support does not achieve this level of performance, reduce the average spacing between bar supports by 15%, or remove that product from use on the job.

Ensure that bar supports, both chair and bolster, do not move during concrete placing operations. To prevent movement, tie supports to the reinforcing steel.

When using bar supports on corrugated metal stay-in-place forms, use supports specifically designed for the form being used.

For structural elements located in extremely aggressive environments, do not use metal chairs and bolsters in contact with forms or floor surfaces to support reinforcing steel.

415-5.13.2 Metal Chairs and Bolsters: For metal bar supports in contact with steel stay-in-place forms and metal bar supports in contact with boundary surfaces of concrete to be cast, provide supports constructed with molded plastic legs or plastic protected steel legs. Do not allow any portion of the bar support other than the molded plastic leg or plastic protected portion of the steel leg to be closer than 1/2 inch from the boundary surface of concrete to be cast.

Certify that all metal bar supports meet the following requirements:

(1) That they are manufactured from cold drawn steel wire in accordance with the wire sizes and geometrical dimensions shown in the CRSI Manual of Standard Practice, Chapter 3, Table II.

(2) That the plastic used for protection of the steel legs has a thickness of 3/32 inch or greater at points of contact with the form work.

Provide plastic protection by a dipping operation, by adding premolded plastic tips to the legs of the support or by molding plastic to the top wire of the support. Ensure that the plastic material used for protection of steel legs does not chip, crack, deform, or peel under ordinary job conditions. Provide molded plastic legs that have sufficient strength to carry the weight of the supported reinforcing steel in its required position without deformation and relaxation under job conditions.

415-5.13.3 Plastic Chairs and Bolsters: Use chairs and bolsters comprised of either reinforced or non-reinforced virgin or recycled plastic, able to meet the concentrated load requirements of 415-5.13.1 within a working

temperature range of 20 to 150°F, and have a maximum water absorption rate of 0.5%, as per ASTM D 570.

Protect plastic rebar chairs from exposure to sunlight until placed in the form. Mold plastic rebar supports in a configuration which does not restrict concrete flow and consolidation around and under the rebar support. Do not use continuous legs or rails on concrete surfaces.

Due to the wide range of applications and heights, ensure that the manufacturer additionally certifies all plastic chair and/or bolster systems for 2 inch, 3 inch, 4 inch and 4 1/2 inch heights.

Provide each individual bar support with an identification number unique to the particular model permanently marked on the surface as included in the Qualified Products List.

415-5.13.4 Qualified Products List: Use plastic chair and bolster products listed on the Department's Qualified Products List. Manufacturers seeking evaluation of products for inclusion on the Qualified Products List must submit an application in accordance with 6-1 and include certified test reports from an independent laboratory showing that the plastic chair and bolster products meet all the requirements specified herein. Plastic chair and bolster products made of recycled plastic products must meet the additional requirements of Section 972.

415-6 Welded Deformed Steel Wire Fabric Reinforcement.

415-6.1 General: The Contractor may substitute welded deformed steel wire fabric reinforcement for deformed bar reinforcement when approved on shop drawings. Propose substitutions of welded deformed steel wire fabric in a manner that provides a cross-sectional area per foot of welded deformed steel wire fabric equal to that provided on the plans for deformed bar reinforcement. Orient the deformed wires of welded deformed steel wire fabric reinforcement in the same position as bar reinforcement detailed in the plans. The Contractor may use smooth or deformed cross wires of welded deformed steel wire reinforcement. Use a cross wire size that is a minimum of 35% or more of the area of the deformed wire.

Provide welded steel wire fabric reinforcement as shown in the plans.

415-6.2 Design: When welded deformed steel wire fabric reinforcement is substituted for deformed bar reinforcement, ensure that the development length, splices, shear reinforcement, and distribution meet the requirements of the AASHTO LRFD Bridge Design Specifications.

415-7 Method of Measurement.

415-7.1 General: The quantity to be paid for will be the computed weight, in pounds, of reinforcing steel entering into the completed structure or item of work and accepted. The quantity will not include the reinforcing steel in any item of work for which the basis of payment includes the steel reinforcement. No separate payment will be made for reinforcing steel in pipe endwalls. No deduction will be made from reinforcing steel quantities for encroachment of inlets and pipes in box culverts. The lengths to be used in the calculation will be

the detailed lengths of bars as shown in the plans. The quantity to be paid for will be the original plan quantity, determined as provided above.

415-7.2 Unit Weights of Bars: The unit weights used will be CRSI Standard Reinforcing Steel Bar Weights.

415-7.3 Fabric Reinforcement: Where fabric reinforcement is to be paid for by weight, the quantity to be paid for will be the product of the area, in square feet, of the fabric actually incorporated in the structure and accepted, by the manufacturer's standard weight per square foot.

When welded deformed steel wire fabric reinforcement is substituted for deformed bar reinforcement, the quantity to be paid for will be the quantity which would be paid for if bar reinforcement as detailed in the plans were utilized, based on plan quantity.

415-8 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including all welding, all clips, spacers, ties, mechanical couplers, etc., and wire or other material used for fastening the reinforcement in place.

In case short bars are permitted for use when full length bars might reasonably be required, the weight paid for will be only that which would be obtained if full length bars were used, with no allowance for lap.

Payment will be made under:

Item No. 415- 1- Reinforcing Steel - per pound.

SECTION 416
INSTALLING ADHESIVE-BONDED ANCHORS AND DOWELS FOR STRUCTURAL APPLICATIONS

416-1 Description.

Prepare and install adhesive bonded anchors and dowels in hardened concrete as indicated in the Contract plans, as directed by the Engineer, and in accordance with the manufacturer's instructions and this Section.

Anchors and dowels in this Section are intended for use in structural applications where designated on the Contract plans.

416-2 Materials.

Use adhesive bonding material systems which meet the requirements of Section 937, and are included on the Qualified Products List. For applications involving installation of traffic railing barrier reinforcement and anchor bolts to existing bridge decks and approach slabs, use only Type HSHV adhesives.

416-2.1 Storage of Materials: Store materials delivered to the job-site in the original unopened containers within an appropriate facility capable of maintaining storage conditions consistent with the manufacturer's recommendations.

416-3 Equipment.

Ensure that the equipment used to install adhesive-bonded anchors and dowels is in conformance with the recommendations of the manufacturer.

416-4 Preparing of Concrete Members.

Ensure that concrete members receiving adhesive-bonded anchors or dowels are structurally sound and free of cracks in the vicinity of the anchor or dowel to be installed. Unless other equipment is recommended by the adhesive manufacturer, drill holes to the diameter required by the manufacturer, but as a minimum, not less than 105% of the diameter including deformations, nor more than 150% of the nominal diameter of the steel bar anchor or dowel, using a rotary hammer drill and bit.

Use a metal detector specifically designed for locating steel in concrete to avoid conflicts with existing steel reinforcement whenever placement tolerances and edge clearances permit. Perform core drilling to clear existing steel reinforcement only when approved by the Engineer. Dry the drilled holes completely prior to cleaning and installing the anchors or dowels.

Clean and prepare drilled holes in accordance with the manufacturer's recommendations, but as a minimum, use oil-free compressed air to remove loose particles from drilling, brush inside surface to free loose particles trapped in pores, then use compressed air again to remove the remaining loose particles. Use a non-metallic bristle brush and avoid over-brushing to prevent polishing the inside surface of the drilled hole.

416-5 Installing of Anchors or Dowels.

Remove all debris, oils, and any other deleterious material from the anchors and dowels to avoid contamination of the adhesive bonding material. Install anchors or dowels in accordance with the details shown on the plans and the manufacturer's instructions, with particular attention to requirements and/or limitations due to anchor position, dampness, ambient temperature, and curing.

Use adequate quantities of the adhesive bonding material to fill the drilled hole to within 1/4 inch of the concrete surface measured after placement of the steel bar or anchor. For horizontal and inclined installations, provide temporary supports to maintain the anchors or dowels in the center of the drilled holes until the adhesive bonding material has cured.

416-6 Testing of Anchors or Dowels.

Field test installed anchors and dowels for traffic railing barrier applications using Type HSHV adhesives. The Engineer may also require testing of installed anchors and dowels for other applications.

416-6.1 Field Testing: Provide an Independent Testing Agency to perform field testing of the installed anchors and dowels under the direction of a Professional Engineer registered in the State of Florida. Submit test reports for each LOT signed and sealed by the Professional Engineer. Perform restrained static tension tests to prevent damage to the surrounding concrete. A restrained test is defined as a test conducted in accordance with ASTM E-488 except that the test equipment support clearance requirements of ASTM E-488 do not apply.

The reaction base shall be approximately equal to the drilled hole diameter for the anchor to preclude concrete or masonry failure, but allow bond failure. Displacement measurement for field testing is not required. Test individual anchors and dowels by proof loading in tension to 85% of the Specified Bond Strength in Section 937, based on the nominal anchor or dowel diameter and embedment depth, but not more than 90% of the yield strength of the anchor or dowel, unless otherwise shown in the Contract Documents.

Divide the anchors and dowels into LOTs for testing and acceptance. Each LOT must contain a maximum of 100 anchors or dowels, of the same diameter, embedment length and Adhesive Bonding Material System. Randomly select four of the anchors and dowels in each LOT for testing, except if there are three or less in the LOT, in which case, test all anchors, unless otherwise directed by the Engineer. If three consecutive LOTs have no failing tests, sample the next three LOTs at a 2% rate and if these LOTs have no failing tests, sample at a rate of 1% for the remaining LOTs unless there is a failure; however, regardless of LOT size, sample at least one dowel per LOT. For every failed field test, perform two additional field tests on adjacent untested anchors or dowels within the LOT. Continue additional field tests until no more test failures occur, or all anchors and dowels within the LOT are tested. For the next LOT after a failed LOT, the sampling rate must be 4% but not less than one dowel per LOT and conform to the sampling rate procedure above including rate reductions as appropriate.

416-6.2 Removal & Replacement of Failed Test Specimens: Remove all anchors and dowels that fail the field test, without damage to the surrounding concrete. Redrill holes to remove adhesive bonding material residue and clean in accordance with 416-4. Reinstall new anchors and dowels in accordance with 416-5. Do not reuse the failed anchors and dowels unless approved by the Engineer. Assign reinstalled anchors into new LOTs only containing reinstalled anchors or dowels of the same diameter, embedment length and adhesive bonding material system, and field test in accordance with 416-6.1.

416-7 Acceptance.

The Engineer will base acceptance of adhesive-bonded anchors and dowels on determining that the material requirements of Section 937, the installation and testing requirements of this Section, and the placement requirements of the plans have been met.

416-8 Basis of Payment.

The work specified in this Section will not be paid for directly, but will be considered as incidental work.

SECTION 425
INLETS, MANHOLES, AND JUNCTION BOXES

425-1 Description.

Construct inlets, manholes, and junction boxes from reinforced concrete as shown in the Design Standards and the plans. Brick masonry may be used if the structure is circular and constructed in place. Furnish and install the necessary

metal frames and gratings.. Construct yard drains from concrete meeting the requirements of Section 347. Adjust structures shown in the plans to be adjusted or requiring adjustment for the satisfactory completion of the work.

425-2 Composition and Proportioning.

425-2.1 Concrete: For inlets, manholes, and junction boxes, use Class II or IV concrete, as designated in the plans and Design Standards and as specified in Section 346. For yard drains use concrete as specified in Section 347.

425-2.2 Mortar: For brick masonry, make the mortar by mixing one part portland cement to three parts sand. Miami Oolitic rock screenings may be substituted for the sand, provided the screenings meet the requirements of 902-5.2.3 except for gradation requirements. Use materials passing the No. 8 sieve that are uniformly graded from coarse to fine.

Masonry cement may be used in lieu of the above-specified mortar provided it is delivered in packages properly identified by brand name of manufacturer, net weight of package, and whether it is Type 1 or Type 2, and further provided that it has not been in storage for a period greater than six months.

425-3 Materials.

425-3.1 General: Meet the following requirements:

Sand (for mortar)	902-3.2
Portland Cement	Section 921
Water	Section 923
Reinforcing Steel	931-1.1 and 415-3
Brick and Concrete Masonry Units	Section 949
Castings for Frames and Gratings	Section 962

425-3.2 Gratings: Use gratings and frames fabricated from structural steel or cast iron as designated in the appropriate Design Standard. When “Alt. G” grates are specified in the plans, provide structural steel grates that are galvanized in accordance with the requirements of ASTM A-123.

425-4 Forms.

Design and construct wood or metal forms so that they may be removed without damaging the concrete. Build forms true to line and grade and brace them in a substantial and unyielding manner. Obtain the Engineer’s approval before filling them with concrete.

425-5 Precast Inlets, Manholes, and Junction Boxes.

Precast inlets, manholes and junction boxes, designed and fabricated in accordance with the plans, the Design Standards and Section 449, may be substituted for cast-in-place units.

425-6 Construction Methods.

425-6.1 Excavation: Excavate as specified in Section 125.

Where unsuitable material for foundations is encountered, excavate the unsuitable material and backfill with suitable material prior to constructing or setting inlets, manholes and junction boxes.

As an option to the above and with the Engineer's approval, the Contractor may carry the walls down to a depth required for a satisfactory foundation, backfill to 8 inches below the flowline with clean sand and cast a non-reinforced 8 inch floor.

425-6.2 Placing and Curing Concrete: Place the concrete in the forms, to the depth shown in the plans, and thoroughly vibrate it. After the concrete has hardened sufficiently, cover it with suitable material and keep it moist for a period of three days. Finish the traffic surface in accordance with 522-7.2, or with a simulated broom finish approved by the Engineer.

425-6.3 Setting Manhole Castings: After curing the concrete as specified above, set the frame of the casting in a full mortar bed composed of one part portland cement to two parts of fine aggregate.

425-6.4 Reinforcing Steel: Follow the construction methods for the steel reinforcement as specified in Section 415.

425-6.5 Laying Brick: Saturate all brick with water before laying. Bond the brick thoroughly into the mortar using the shovejoint method to lay the brick. Arrange headers and stretchers so as to bond the mass thoroughly. Finish the joints properly as the work progresses and ensure that they are not less than 1/4 inch or more than 3/4 inch in thickness. Do not use spalls or bats except for shaping around irregular openings or when unavoidable at corners.

425-6.6 Backfilling: Backfill as specified in Section 125, meeting the specific requirements for backfilling and compaction around inlets, manholes, and junction boxes detailed in 125-8.1 and 125-8.2. However, for outfall lines beyond the sidewalk or future sidewalk area, where no vehicular traffic will pass over the pipe, inlets, manholes, and junction boxes, compact backfill as required in 125-9.2.2.

425-6.7 Adjusting Existing Structures: Cut down or extend existing manholes, catch basins, inlets, valve boxes, etc., within the limits of the proposed work, to meet the finished grade of the proposed pavement, or if outside of the proposed pavement area, to the finished grade designated on the plans for such structures. Use materials and construction methods which meet the requirements specified above to cut down or extend the existing structures.

The Contractor may extend manholes needing to be raised using adjustable extension rings of the type which do not require the removal of the existing manhole frame. Use an extension device that provides positive locking action and permits adjustment in height as well as diameter and meets the approval of the Engineer.

425-7 Method of Measurement.

The quantities to be paid for will be (1) the number of inlets, manholes, junction boxes, and yard drains, completed and accepted; and (2) the number of structures of these types (including also valve boxes) satisfactorily adjusted.

425-8 Basis of Payment.

425-8.1 New Structures: Price and payment will be full compensation for furnishing all materials and completing all work described herein or shown in the plans, including all clearing and grubbing outside the limits of clearing and

grubbing as shown in the plans, all excavation except the volume included in the measurement designated to be paid for under the items for the grading work on the project, all backfilling around the structures, the disposal of surplus material, and the furnishing and placing of all gratings, frames, covers, and any other necessary fittings.

425-8.2 Adjusted Structures: When an item of payment for adjusting manholes, valve boxes, or inlets is provided in the proposal, price and payment will be full compensation for the number of such structures designated to be paid for under such separate items, and which are satisfactorily adjusted, at the Contract unit prices each for Adjusting Inlets, Adjusting Manholes, and Adjusting Valve Boxes.

For any of such types of these structures required to be adjusted but for which no separate item of payment is shown in the proposal for the specific type, payment will be made under the item of Adjusting Miscellaneous Structures.

425-8.3 Payment Items: Payment will be made under:

Item No.	425- 1-	Inlets - each.
Item No.	425- 2-	Manholes - each.
Item No.	425- 3-	Junction Boxes - each.
Item No.	425- 4-	Adjusting Inlets - each.
Item No.	425- 5-	Adjusting Manholes - each.
Item No.	425- 6-	Adjusting Valve Boxes - each.
Item No.	425- 8-	Adjusting Miscellaneous Structures - each.
Item No.	425- 10-	Yard Drains - each.

SECTION 430
PIPE CULVERTS

430-1 Description.

Furnish and install drainage pipe and end sections at the locations called for in the plans. Furnish and construct joints and connections to existing pipes, catch basins, inlets, manholes, walls, etc., as may be required to complete the work.

Construct structural plate pipe culverts or underdrains in accordance with Sections 435 and 440.

Obtain pipe culverts from a Producer currently on the Department's list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3.

When the producer's Quality Control Program is suspended, accept responsibility of either obtaining drainage products from another producer with an accepted Quality Control Program or await re-approval of the producer's Quality Control Program. The Engineer will not allow changes in Contract Time or completion dates as a result of the producer's Quality Control Program suspension. Accept responsibility for all delay costs or other costs associated with the producer's Quality Control Program suspension.

430-2 Materials.

430-2.1 Pipe: Meet the following requirements:

Concrete Pipe	Section 449
Round Rubber Gaskets	Section 942
Corrugated Steel Pipe and Pipe Arch	Section 943
Corrugated Aluminum Pipe and Pipe Arch	Section 945
Corrugated Polyethylene Pipe	Section 948
Polyvinyl Chloride (PVC) Pipe	Section 948

430-2.2 Joint Materials: Use joint materials specified in 430-7 through 430-10 according to type of pipe and conditions of usage.

430-2.3 Mortar: Use mortar composed of one part portland cement and two parts of clean, sharp sand, to which mixture the Contractor may add hydrated lime in an amount not to exceed 15% of the cement content. Use mortar within 30 minutes after its preparation.

430-3 Type of Pipe to Be Used.

430-3.1 General: When the plans designate a type (or types) of pipe, use only the type (or choose from the types) designated. As an exception, when the plans designate reinforced concrete pipe as Class S, Class I, Class II, Class III and Class IV, the Contractor may use non-reinforced concrete pipe up to and including 36 inch in diameter.

430-3.2 Side Drain: If the plans do not designate a type (or types) of pipe, the Contractor may use either a minimum Class I concrete pipe, corrugated steel pipe, corrugated aluminum pipe, corrugated polyethylene pipe or PVC pipe. If one of the metal types is chosen, use the minimum gage specified in Section 943 for steel pipe or Section 945 for aluminum pipe.

Non-reinforced concrete pipe may also be substituted for concrete pipe in side drains, subject to the provisions of 430-3.1.

430-4 Laying Pipe.

430-4.1 General: Lay all pipe, true to the lines and grades given, with hubs upgrade and tongue end fully entered into the hub. When pipe with quadrant reinforcement or circular pipe with elliptical reinforcement is used, install the pipe in a position such that the manufacturer's marks designating "top" and "bottom" of the pipe are not more than five degrees from the vertical plane through the longitudinal axis of the pipe. Do not allow departure from and return to plan alignment and grade to exceed 1/16 inch per foot of nominal pipe length, with a total of not more than 1 inch departure from theoretical line and grade. Take up and relay any pipe that is not in true alignment or which shows any settlement after laying at no additional expense to the Department.

Do not use concrete pipe with lift holes except round pipe which has a inside diameter in excess of 54 inches or any elliptical pipe.

Repair lift holes, if present, by use of a hand-placed, stiff, non-shrink, 1-to-1 mortar of cement and fine sand, after first washing out the hole with water. Completely fill the void created by the lift hole with mortar. Cover the repaired area with a 24 by 24 inches piece of filter fabric secured to the pipe. Use a Type

D-3 filter fabric meeting the requirements shown on Design Standards, Index 199.

Secure the filter fabric to the pipe using a method that holds the fabric in place until the backfill is placed and compacted. Use a grout mixtures, mastics, or strapping devices to secure the fabric to the pipe.

When installing pipes in structures, construct inlet and outlet pipes of the same size and kind as the connecting pipe shown in the plans. Extend the pipes through the walls for a distance beyond the outside surface sufficient for the intended connections, and construct the concrete around them neatly to prevent leakage along their outer surface as shown on the Design Standards, Index 201. Keep the inlet and outlet pipes flush with the inside of the wall. Resilient connectors as specified in 942-3 may be used in lieu of a masonry seal.

Furnish and install a filter fabric jacket around all pipe joints and the joint between the pipe and the structure in accordance with Design Standards, Index Nos. 201 and 280. Use fabric meeting the physical requirements of Type D-3 specified on the Design Standards, Index 199. The fabric shall extend a minimum of 12 inches beyond each side of the joint or both edges of the coupling band, if a coupling band is used. The fabric shall have a minimum width of 24 inches, and a length sufficient to provide a minimum overlap of 24 inches. Secure the filter fabric jacket against the outside of the pipe by metal or plastic strapping or by other methods approved by the Engineer.

Meet the following minimum joint standards:

Pipe Application	Minimum Standard
Storm and Cross Drains	Water-tight
Gutter Drain	Water-tight
Side Drains	Soil-tight

When rubber gaskets are to be installed in the pipe joint, the gasket shall be the sole element relied on to maintain a tight joint. Soil tight joints must be watertight to 2 psi. Water-tight joints must be water-tight to 5 psi unless a higher pressure rating is required in the plans.

430-4.2 Trench Excavation: Excavate the trench for storm and cross drains, and side drains as specified in Section 125.

430-4.3 Foundation: Provide a suitable foundation, where the foundation material is of inadequate supporting value, as determined by the Engineer. Remove the unsuitable material and replace it with suitable material, as specified in 125-8. Where in the Engineer's opinion, the removal and replacement of unsuitable material is not practicable, he may direct alternates in the design of the pipe line, as required to provide adequate support. Minor changes in the grade or alignment will not be considered as an adequate basis for extra compensation.

Do not lay pipe on blocks or timbers, or on other unyielding material, except where the use of such devices is called for in the plans.

430-4.4 Backfilling: Backfill around the pipe as specified in 125-8 unless specific backfilling procedures are described in the Contract Documents.

430-4.5 Plugging Pipe: When existing pipe culverts are to be permanently placed out of service, fill them with flowable fill that is non-excavatable, contains a minimum 350 lbs/cy of cementitious material and meets the requirements of Section 121 and/or plug them with masonry plugs as shown in the plans. Install masonry plugs that are a minimum of 8 inches in thickness, in accordance with Design Standards, Index 280.

When proposed or existing pipe culverts are to be temporarily placed out of service, plug them with prefabricated plugs as shown in the plans. Install prefabricated plugs in accordance with the manufacturer's recommendations. Do not fill, or construct masonry plugs in, any pipe culverts intended for current or future service.

430-4.6 End Treatment: Place an end treatment at each storm and cross drain, and side drain as shown in the plans. Refer to the Design Standards for types of end treatment details.

As an exception to the above, when concrete mitered end sections are permitted, the Contractor may use reinforced concrete U-endwalls, if shop drawings are submitted to the Engineer for approval prior to use.

Provide end treatments for corrugated polyethylene pipe and PVC pipe as specified in Section 948, or as detailed in the plans.

430-4.7 Metal Pipe Protection: Apply a bituminous coating to the surface area of the pipe within and 12 inches beyond the concrete or mortar seal prior to sealing, to protect corrugated steel or aluminum pipe embedded in a concrete structure, such as an inlet, manhole, junction box, endwall, or concrete jacket.

Ensure that the surface preparation, application methods (dry film thickness and conditions during application), and equipment used are in accordance with the coating manufacturers' published specifications.

Obtain the Engineer's approval of the coating products used.

430-4.8 Final Pipe Inspection: Based on contract pavement type, upon completion of placement of concrete pavement or the placement of structural asphalt, but prior to placement of asphalt friction course, dewater installed pipe and provide the Engineer with a video recording schedule allowing for pipe videoing and reports to be completed and submitted to the Department and reviewed prior to continuation of pavement.

For pipe 48 inches or less in diameter, provide the Engineer a video DVD and report using low barrel distortion video equipment with laser profile technology, non-contact video micrometer and associated software that provides:

1. Actual recorded length and width measurements of all cracks within the pipe.
2. Actual recorded separation measurement of all pipe joints.
3. Pipe ovality report.
4. Deflection measurements and graphical diameter analysis report in terms of x and y axis.
5. Flat analysis report.
6. Representative diameter of pipe.
7. Pipe deformation measurements, leaks, debris, or other damage or defects.

8. Deviation in pipe line and grade, joint gaps, and joint misalignment.

Laser profiling and measurement technology must be certified by the company performing the work to be in compliance with the calibration criteria posted at: www.dot.state.fl.us/construction/contractorissues/laser.htm . Reports may be submitted in electronic media if approved by the Engineer.

For video recorded, laser profiled pipe that indicates deflection that appears to be in excess of that allowed by Specification, the Engineer may require further testing of the pipe. If directed by the Engineer, test pipe using a mandrel. The mandrel shall be pulled by hand and be approved by the Engineer prior to use. If use of a mandrel is selected as the means of further testing, the mandrel's diameter, length, and other requirements shall conform to 430-4.8.2. Remove, replace, and retest pipe failing to meet the specific deflection requirements for the type of pipe installed, at no cost to the Department. Should the deflection test prove that the pipe met specifications, the Department will bear the cost of the deflection testing.

The Engineer may waive this requirement for side drains and cross drains which are short enough to inspect from each end of the pipe.

430-4.8.1 Video Report: Provide a high quality DVD in a MPEG2 format video with a standard resolution of 720 x 480. Use a camera with lighting suitable to allow a clear picture of the entire periphery of the pipe. Center the camera in the pipe both vertically and horizontally and be able to pan and tilt to a 90 degree angle with the axis of the pipe and rotating 360 degrees. Use equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition.

The video image shall be clear, focused, and relatively free from roll, static, or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe. The video will include identification before each section of pipe filmed. The identification will include the project number, the structure number corresponding to the structure number on the set of plans for the project, size of pipe, the date and time, and indicate which pipe is being filmed if multiple pipes are connected to the structure. Notes should be taken during the video recording process. Provide the Engineer with copies of these notes along with the video.

Move the camera through the pipe at a speed not greater than 30 feet per minute. Mark the video with the distance down the pipe. The distance shall have an accuracy of one foot per 100 feet. Film the entire circumference at each joint. Stop the camera and pan when necessary to document defects.

430-4.8.2 Mandrels: Use mandrels which are rigid, nonadjustable, odd-numbered legged (minimum 9 legs) having a length not less than its nominal diameter. The diameter at any point shall not be less than the allowed percent deflection of the certified actual mean diameter of the pipe being tested. The mandrel shall be fabricated of metal, fitted with pulling rings at each end, stamped or engraved on some segment other than a runner with the nominal pipe size and mandrel outside diameter.

430-5 Removing Existing Pipe.

If the plans indicate that existing pipe is to remain the property of the Department, collect and stack along the right-of-way all existing pipe or pipe arch so indicated in the plans to be removed, or that does not conform to the lines and grades of the proposed work and that is not to be re-laid, as directed by the Engineer. Take care to prevent damage to salvageable pipe during removal and stacking operations.

430-6 Placing Pipe Under Railroad.

430-6.1 General: Construct pipe culverts under railroad tracks in accordance with the requirements of the railroad company.

Perform all the shoring under the tracks, and sheeting and bracing of the trench, required by the railroad company or deemed necessary by the Engineer in order to ensure safe and uninterrupted movement of the railroad equipment, at no expense to the Department.

430-6.2 Requirements of the Railroad Company: Install pipe using methods required by the railroad company and shown in the Contract Documents.

When the general method of installation required by the railroad company is indicated in the plans, do not alter such method, or any other specific details of the installation which might be indicated in the plans, without receiving approval or direction from the railroad, followed by written approval from the Engineer.

430-6.3 Notification to Railroad Company: Notify the railroad company and the Engineer at least ten days prior to the date on which pipe is to be placed under the railroad tracks.

430-6.4 Placing Pipe by Jacking: Obtain the Engineer's and the railroad company's approval of the details of the jacking method to be used, when placing pipe through the railroad embankment, before the work is started.

430-6.5 Use of Tunnel Liner: When the railroad company requires that a tunnel liner be used for placing the pipe in lieu of the jacking method, the Department will pay for the tunnel liner material separately in cases where the Contract Documents do not require the use of a tunnel liner. For these cases the Department will reimburse the Contractor for the actual cost of the liner, delivered at the site. The Department will base such cost on a liner having the minimum gage acceptable to the railroad.

430-7 Specific Requirements for Concrete Pipe.

430-7.1 Sealing Joints: Seal the pipe joints with round rubber or profile gaskets meeting the requirements of Section 449. Ensure that the gasket and the surface of the pipe joint, including the gasket recess, are clean and free from grit, dirt and other foreign matter, at the time the joints are made. In order to facilitate closure of the joint, application of a vegetable soap lubricant immediately before closing of the joint will be permitted. Prelubricated gaskets may be used in lieu of a vegetable soap lubricant when the lubricating material is certified to be inert with respect to the rubber material.

430-7.2 Laying Requirements for Concrete Pipe with Rubber Gasket Joints: Do not allow the gap between sections of pipe to exceed 5/8 inch for pipe diameters of 12 inches through 18 inches, 7/8 inch for pipe diameters of 24 through 66 inches, and 1 inch for pipe diameters 72 inches and larger. Where minor imperfections in the manufacture of the pipe create an apparent gap in excess of the tabulated gap, the Engineer will accept the joint provided that the imperfection does not exceed 1/3 the circumference of the pipe, and the rubber gasket is 1/4 inch or more past the pipe joint entrance taper. Where concrete pipes are outside of these tolerances, replace them at no expense to the Department. Do not apply mortar, joint compound, or other filler to the gap which would restrict the flexibility of the joint.

430-7.3 Field Joints for Elliptical Concrete Pipe: Use either a preformed plastic gasket material or an approved rubber gasket to make a field joint.

430-7.3.1 Plastic Gasket: Meet the following requirements when field joints are made from preformed plastic gasket material:

430-7.3.1.1 General: Install field joints in accordance with the manufacturer's instructions and the following:

430-7.3.1.2 Material: Meet the requirements of 942-2.

430-7.3.1.3 Joint Design: Ensure that the pipe manufacturer furnishes the Engineer with details regarding configuration of the joint and the amount of gasket material required to affect a satisfactory seal. Do not brush or wipe joint surfaces which are to be in contact with the gasket material with a cement slurry. Fill minor voids with cement slurry.

430-7.3.1.4 Primer: Apply a primer of the type recommended by the manufacturer of the gasket material to all joint surfaces which are to be in contact with the gasket material, prior to application of the gasket material. Thoroughly clean and dry the surface to be primed.

430-7.3.1.5 Application of Gasket: Apply gasket material to form a continuous gasket around the entire circumference of the leading edge of the tongue and the groove joint, in accordance with the detail shown on the Design Standards, Index No. 280. Do not remove the paper wrapper on the exterior surface of the gasket material until immediately prior to joining of sections. Apply plastic gasket material only to surfaces which are dry. When the atmospheric temperature is below 60ºF, either store plastic joint seal gaskets in an area above 70ºF, or artificially warm the gaskets to 70ºF in a manner satisfactory to the Engineer.

430-7.3.1.6 Installation of Pipe: Remove and reposition or replace any displaced or contaminated gasket as directed by the Engineer. Install the pipe in a dry trench. Carefully shape the bottom of the trench to minimize the need for realignment of sections of pipe after they are placed in the trench. Hold to a minimum any realignment of a joint after the gaskets come into contact. Prior to joining the pipes, fill the entire joint with gasket material and ensure that when the pipes are joined there is evidence of squeeze-out of gasket material for the entire internal and external circumference of the joint. Trim excess material on the interior of the pipe to provide a smooth interior surface. If a joint is defective, remove the leading section of pipe and reseal the joint.

430-7.3.2 Rubber Gasket: Meet the following requirements when field joints are made with profile rubber gaskets:

430-7.3.2.1 General: Install field joints in accordance with the manufacturer's instructions and the following:

430-7.3.2.2 Material: Meet the requirements of 942-4.

430-7.3.2.3 Joint Design: Ensure that the pipe manufacturer furnishes the Engineer with details regarding configuration of the joint and gasket required to effect a satisfactory seal. Do not apply mortar, joint compound, or other filler which would restrict the flexibility of the gasket joint.

430-7.4 Requirements for Concrete Radius Pipe:

430-7.4.1 Design: Construct concrete radius pipe in segments not longer than 4 feet (along the pipe centerline), except where another length is called for in the Contract Documents. Join each segment using round rubber gaskets. Ensure that the pipe manufacturer submits details of the proposed joint, segment length and shape for approval by the Engineer, prior to manufacture.

430-7.4.2 Pre-Assembly: Ensure that the manufacturer pre-assembles the entire radius section in his yard, in the presence of the Engineer, to ensure a proper fit for all parts. At the option of the manufacturer, the Contractor may assemble the pipe without gaskets. Consecutively number the joints on both the interior and exterior surfaces of each joint, and make match marks showing proper position of joints. Install the pipe at the project site in the same order as pre-assembly.

430-8 Specific Requirements for Corrugated Metal Pipe.

430-8.1 Field Joints:

430-8.1.1 General: Make a field joint with locking bands, as specified in Article 9 of AASHTO M 36 and AASHTO M 196M for aluminum pipe. For aluminum pipe, fabricate bands from the same alloy as the culvert sheeting.

When existing pipe to be extended is helically fabricated, make a field joint between the existing pipe and the new pipe using one of the following methods:

(1) Cut the new pipe to remove one of the re-rolled annular end sections required in Sections 943 or 945, or fabricate the pipe so that the re-rolled annular section is fabricated only on one end. Use either a spiral (helical) band with a gasket or a flat band with gaskets as required by 430-8.1.2 (2) to join the pipe sections.

(2) The Contractor may construct a concrete jacket as shown on the Design Standards, Index No. 280, provided that the minimum cover required by the Design Standards, Index No. 205 can be obtained.

430-8.1.2 Side Drain, Storm and Cross Drain, and Gutter Drains: Where corrugated metal pipe is used as side drain, storm and cross drain, or gutter drain, use a rubber or neoprene gasket of a design shown to provide a joint as specified in 430-4.

Use a gasket of one of the following dimensions:

(1) For annular joints with 1/2 inch depth corrugation: either a single gasket a minimum of 7 inches by 3/8 inch or two gaskets a minimum of 3 1/2 inches by 3/8 inch; and for annular joints with 1 inch depth corrugations:

either a single gasket a minimum of 7 inches by 7/8 inch or two gaskets a minimum of 3 1/2 inches by 7/8 inch.

(2) For helical joints with 1/2 inch depth corrugation: either a single gasket a minimum of 5 inches by 1 inch or two gaskets a minimum of 3 1/2 inches by 1 inch; and for helical joints with 1 inch depth corrugations: either a single gasket a minimum of 5 inches by 1 1/2 inches or two gaskets a minimum of 3 1/2 inches by 1 1/2 inches.

(3) Such other gasket designs as may be approved by the Engineer.

If, in lieu of a single gasket spanning the joint, two gaskets are used, place these individual gaskets approximately 2 inches from each pipe end at the joint. When two gaskets are used, seal the overlapping area on the coupling band between the gaskets consistent with the joint performance specified. The Contractor may tuck a strip of preformed gasket material over the bottom lip of the band for this purpose. Use coupling bands that provide a minimum circumferential overlap of 3 inches. As the end connections on the coupling band are tightened, ensure that there is no local bending of the band or the connection. Use precurved coupling bands on pipe diameters of 24 inches or less.

Use flat gaskets meeting the requirements of ASTM D-1056, designation 2C2 or 2B3. In placing flat gaskets on pipe prior to placing the coupling band, do not stretch the gasket more than 15% of its original circumference. Use circular gaskets meeting the requirements of ASTM C-361. Do not stretch the circular gasket more than 20% of its original circumference in placing the gasket on pipe. Use preformed plastic gasket material meeting the composition requirements of 942-2.2.

Apply an approved vegetable soap lubricant, as specified for concrete pipe in 430-7.1.1.

430-8.1.3 Alternate Joint: In lieu of the above-specified combination of locking bands and flat gaskets, the Contractor may make field joints for these pipe installations by the following combinations:

(a) Use the metal bands as specified in Article 9 of AASHTO M 36M that are at least 10 1/2 inches wide and consist of a flat central section with a corrugated section near each end, designed to match the annular corrugation in the pipe with which they are to be used. Connect the bands in a manner approved by the Engineer, with a suitable fastening device such as the use of two galvanized 1/2 inch diameter bolts through a galvanized bar and galvanized strap, suitably welded to the band. Use a strap that is the same gage as the band.

Where helically corrugated pipe is to be jointed by this alternate combination, ensure that at least the last two corrugations of each pipe section are annular, and designed such that the band will engage each pipe end with the next-to-outside annular corrugation.

(b) For these bands, use a rubber gasket with a circular cross-section of the "O-ring" type conforming to ASTM C-361. Use gaskets having the following cross-sectional diameter for the given size of pipe:

Pipe Size	Gasket Diameter
12 inches through 36 inches (with 1/2 inch depth corrugations)	13/16 inch
42 inches through 96 inches (with 1/2 inch depth corrugations)	7/8 inch
36 inches through 120 inches (with 1 inch depth corrugations)	1 3/8 inches

Use preformed gasket material to seal the overlapping area on the coupling band between gaskets.

(c) Use channel band couplers in helical pipe with ends which have been reformed and flanged specifically to receive these bands. Use channel band couplers that are of a two piece design, are fabricated from galvanized steel stock conforming to AASHTO M 36, have 2 by 2 by 3/16 inch angles fastened to the band ends to allow for proper tightening, and meet the following:

Band Thickness	Pipe Wall Thickness
0.079 inch	0.109 inch or lighter
0.109 inch	0.138 inch or heavier
3/4 inch wide	0.109 inch or lighter
1 inch wide	0.138 inch or heavier

Furnish two 1/2 inch diameter connection bolts with each band, that conform to ASTM A-307, Grade A and are electroplated in accordance with ASTM B-633.

Use a gasket with the joint that is a hydrocarbon blend of butyl rubber meeting the chemical composition and physical properties of 942-2.2. Use a 3/8 by 3/4 inch gasket for pipe fabricated from 0.109 inch or lighter material and a 3/8 by 1 inch gasket for pipe fabricated from 0.138 inch and heavier material.

The Contractor may use a flange band coupler without the gasket for all applications other than side drain, storm and cross drain, and gutter drain.

Do not use the flange band coupler to join dissimilar types of pipe.

The Contractor may join reformed flanged helical pipe to existing annular or reformed pipe having annular ends. On non-gasketed installations, use either an annular band or an alternate joint described in 430-8.1.3. On gasketed installations, use an annular band, minimum of five corrugations in width, in conjunction with two O-ring gaskets as specified in 430-8.1.3. Use mastic material to seal the area of band overlap.

The minimum joint performance standards specified in 430-4.1 apply.

430-8.2 Laying and Shape Requirements for Corrugated Metal Pipe: Install pipe using either a trench or open ditch procedure.

Check pipe shape regularly during backfilling to verify acceptability of the construction method used. Pipe deflected 5% or more of the certified actual mean diameter of the pipe at final inspection shall be replaced at no cost to the

Department. Deflection measurements are taken at the point of smallest diameter on the corrugations.

430-9 Specific Requirements for Corrugated Polyethylene Pipe and Polyvinyl Chloride (PVC) Pipe.

430-9.1 Field Joints: Use gasketed joints to seal side drain, and storm and cross drain. Use gaskets meeting the requirements of Section 449. Ensure that the pipe manufacturer provides a joint design approved by the Engineer before use.

430-9.2 Installation Requirements Including Trenching, Foundation and Backfilling Operations: Check structure shape regularly during backfilling to verify acceptability of the construction method used.

Pipe deflected 5% or more of the certified actual mean diameter of the pipe at final inspection shall be replaced at no cost to the Department.

430-10 Desilting Pipe or Concrete Box Culvert.

Desilt pipe culvert and concrete box culvert as designated in the plans.

430-11 Method of Measurement.

430-11.1 New Pipe: The quantities of storm and cross drain pipe, storm drain trench, side drain pipe and gutter drain pipe to be paid for will be plan quantity, in place and accepted. The plan quantity will be determined from the inside wall of the structure as shown on the plans, along the centerline of the pipe.

430-11.2 Mitered End Section: The quantity to be paid for will be the number completed and accepted.

430-12 Basis of Payment.

430-12.1 General: Prices and payments will be full compensation for all work specified in this Section, including all excavation except the volume included in the items for the grading work on the project, and except for other items specified for separate payment in Section 125; all backfilling material and compaction; disposal of surplus material; and all clearing and grubbing outside of the required limits of clearing and grubbing as shown in the plans.

430-12.2 Removing Existing Pipe: When existing pipe is removed and replaced with new pipe approximately at the same location, the cost of excavating and removing the old pipe and of its disposal will be included in the Contract unit price for clearing and grubbing.

430-12.3 Site Restoration: The cost of restoring the site, as specified in 125-11, that is disturbed, solely for the purpose of constructing pipe culvert, will be included in the Contract unit price for the pipe culvert, unless designated specifically to be paid for under other items.

430-12.4 Plugging Pipes: The cost of temporarily plugging a pipe culvert, either proposed or existing, will be incidental to the contract unit price for new pipe culvert.

The cost of filling and/or plugging an existing pipe culvert that is to be permanently placed out of service will be paid for at the contract unit price for filling and plugging pipe, per cubic yard. Price and payment will be full

compensation for flowable fill, masonry, concrete, mortar, and all labor and materials necessary to complete the work.

When the project includes no quantities for new pipe culverts, and temporary plugs are required for existing pipe culverts, the cost will be considered as extra work, in accordance with 4-3.5.

430-12.5 Desilting Pipe: Desilting Pipe will be paid for at the contract unit price per foot for each pipe desilted. Price and payment will be full compensation for furnishing all equipment, tools and labor, disposal of silt and debris, and all incidentals necessary for satisfactorily performing the work.

430-12.6 Desilting Concrete Box Culverts: Price and payment will be full compensation for all work required.

430-12.7 Flared End Sections: Price and payment will be full compensation for all work and materials required.

430-12.8 Mitered End Sections: Price and payment will be full compensation for all pipe, grates when required, fasteners, reinforcing, connectors, anchors, concrete, sealants, jackets and coupling bands, and all work required.

430-12.9 Railroad Requirements: Where pipe culvert is constructed under railroad tracks, the Contract unit price for the pipe culvert will include the costs of any jacking operations and the operation of placing the pipe by use of a tunnel liner, (except as specified for unanticipated tunnel liner, in 430-6.5, where reimbursement is to be made for such unanticipated liner), and all other work necessary to meet the requirements of the railroad company, excluding the costs of watchman or flagman services provided by the railroad company, except as provided below.

The Department will reimburse the Contractor for the actual costs of any trestle bridge work which is performed by the railroad's forces, as billed to him by the railroad, less the value of any salvage materials derived there from, whether such salvage materials are retained by the railroad company or by the Contractor. When the work of shoring and bracing is to be performed by the railroad, such fact will be stipulated in the Contract Documents and the Contractor will be required to pay to the railroad the amount of such costs, which amount will be reimbursed to him by the Department. The Contract unit price for the pipe culvert shall include the costs of all other work of shoring and bracing.

430-12.10 Payment Items: Payment will be made under:

Item No.	430- 17-	Pipe Culvert Optional Material - per foot.
Item No.	430- 94-	Desilting Pipe – per foot.
Item No.	430- 96-	Polyvinyl Chloride Pipe - per foot.
Item No.	430- 98-	Mitered End Section - each.
Item No.	430-200-	Flared End Sections - each.
Item No.	430-610-	U-Endwall - each.
Item No.	430-830-	Filling and Plugging Pipe – cubic yard.
Item No.	430-950-	Desilting Concrete Box Culvert – per cubic yard.

SECTION 431
PIPE LINER

431-1 Description.

Rehabilitate drainage pipe by installing a pipe liner in accordance with the requirements of this Section. The plans will indicate the location of the pipe to be rehabilitated, the material composition and the alternate liner types that may be used to rehabilitate the pipe, and the method of liner installation.

431-2 Materials.

Meet the requirements of Section 948.

431-3 Pre-installation Requirements.

Prior to installing the pipe liner, inspect the host pipe and ensure that it is clean, dry and stable. Inspect the host pipe by means of closed circuit television. The closed circuit television inspection may be augmented by a visual inspection in which persons enter a host pipe to inspect it, at no additional cost to the Department. Obtain written approval from the Engineer prior to allowing persons to enter a host pipe. Furnish all equipment necessary to inspect, remove silt and other debris, and dewater the host pipe to the satisfaction of the Engineer. Seal cracks and joints using an approved chemical grout of either acrylamide base gel, acrylic base gel, urethane base gel, or urethane base foam. Place flowable fill as directed by the Engineer to maintain the stability of the host pipe.

431-4 Installation Methods.

431-4.1 General: Install the liner using one of, or a combination of, the following methods: sliplining, inverting, pulling/pushing, spiral winding, paneling, coating, or bursting. Seal or grout the annular space between the interior of the host pipe and the exterior of the liner according to the liner manufacturer's written instructions.

431-4.2 Sliplining: Use either polyethylene, high density polyethylene, polyvinyl chloride, fiberglass, steel or aluminum pipe liner. Install the liner by joining discrete lengths, panels or segments of the pipe liner in a manhole or other access point and inserting the liner into the host pipe.

431-4.2.1 Polyethylene: Install polyethylene pipe liner in accordance with ASTM F-585. The manufacturer's written instructions may be substituted for ASTM F-585 with written permission from the Engineer.

431-4.2.2 High density polyethylene: Install high density polyethylene pipe liner in accordance with ASTM F-585. The manufacturer's written instructions may be substituted for ASTM F-585 with written permission from the Engineer.

431-4.2.3 Polyvinyl chloride: Install polyvinyl chloride pipe liner in accordance with ASTM F-1698.

431-4.2.4 Fiberglass, steel or aluminum: Install fiberglass, steel or aluminum pipe liner in accordance with the manufacturer's written instructions.

431-4.3 Inverting: Install a resin impregnated felt tube pipe liner into the host pipe, and cure in place, in accordance with ASTM F-1216.

431-4.4 Pulling/Pushing: Install the liner in accordance with the manufacturer's written instructions. Protect the pipe liner end using a device that uniformly distributes the applied load around the perimeter of the liner. Continuously monitor the applied load, and do not stretch the liner by more than 1% of its original length. For liner lengths of 100 feet or less, the end protection device may be omitted, with written permission from the Engineer. Do not seal the liner ends or begin grouting prior to 24 hours after liner installation.

431-4.5 Spiral Winding: Install the pipe liner in accordance with ASTM F-1698 or ASTM F-1741.

431-4.6 Paneling: Install the pipe liner in accordance with the manufacturer's written instructions. Limit paneling to host pipes having 90 inch or greater internal diameters. Do not place panels where a liner joint will lie along or near the crown of the host pipe.

431-4.7 Coating: Use materials and install the pipe liner in accordance with the manufacturer's written instructions.

431-4.8 Bursting: Install the pipe liner in accordance with the manufacturer's written instructions. Limit bursting to vitrified clay or concrete crossdrain or sidedrain pipe having no lateral connections or risers. Further limit bursting to locations where no part of the host pipe passes within 5 feet of any buried utility or pavement base material.

431-5 Acceptance.

Inspect the complete rehabilitation by means of closed circuit television. Obtain written approval from the Engineer prior to allowing persons to enter a host pipe. Provide the Engineer with videos of all preliminary and final inspections.

431-6 Method of Measurement.

The quantity of pipe liner to be paid for will be the length, per foot, of pipe liner installed and accepted, measured along the centerline of the pipe, from end to end.

The quantity of flowable fill to be paid for will be in accordance with Section 121.

The quantity of desilting pipe to be paid for will be in accordance with Section 430.

431-7 Basis of Payment.

Price and payment for pipe liner will be full compensation for furnishing and installing the pipe liner in accordance with the requirements of this Section, including all materials, labor and incidentals required for sealing cracks and joints in the existing pipe, and sealing and grouting the annular space between the liner and interior of the host pipe.

Price and payment for pipe liner will also be full compensation for all equipment, materials and labor required for inspections, and for furnishing videos of the inspections to the Engineer.

Price and payment for flowable fill will be in accordance with Section 121.

Price and payment for desilting pipe will be in accordance with Section 430.

Payment will be made under:

Item No. 431- 1-	Pipe Liner - per foot.
Item No. 431- 2-	Pipe Inspection - per foot.

SECTION 435
STRUCTURAL PLATE PIPE AND PIPE ARCH CULVERTS

435-1 Description.

Construct structural plate pipe and pipe arch culverts.

435-2 Materials.

Meet the requirements of Section 944 for steel and Section 945 for aluminum.

When the plans call for bituminous coated pipe or pipe arch, meet the coating requirements of 944-4.

When other types of coating material are shown in the plans, use a coating that consists of at least two coats of the specified material, applied at the job site. Apply the coating by brush or by spray.

435-3 Trench, Foundation, Laying, and Backfill.

Perform this work as specified in Section 430, and as follows.

Provide a foundation for the bottom plates that is of uniform density and carefully shaped to fit the lower plate of the pipe or pipe arch. Thoroughly tamp the backfill material against the remaining plates.

435-4 Assembly.

Assemble the plates to form the pipe or pipe arch structure in accordance with the diagram furnished by the manufacturer. Connect the plates by bolting tightly in all bolt holes provided.

435-5 Method of Measurement.

The quantities to be paid for will be the plan quantity, in feet, of pipe or pipe arch, installed in place, completed and accepted. The quantity will be measured along the centerline of the structure from end to end of metal for full section structures, from average end to end at top and bottom for beveled-end structures.

435-6 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including all materials, backfilling, and disposal of surplus material and all excavation except the volume included in the items for grading work and for other items specified for payment in Section 125.

Payment will be made under:

Item No. 435-	Structural Plate Pipe Culvert - per foot.

SECTION 436
TRENCH DRAIN

436-1 Description.

Construct Trench Drain, with one of the materials listed below, for the purpose of collecting and removing surface run-off from paved areas. Furnish and install trench drain in accordance with the Design Standards, at the locations shown in the plans or as directed by the Engineer.

436-2 Materials.

Provide preformed channels or pipe with sufficient strength to withstand construction handling and placement of concrete backfill without deforming or deviating from line and grade. Furnish the Engineer with certification from the manufacturer that the Trench Drain System meets the requirements of this Section.

436-2.1 Channels/Pipe: Meet the following requirements:

Steel Pipe	Section 943
Aluminum Pipe	Section 945
Polyethylene	Section 948 and ASTM D3350
Polymer Concrete	ASTM D6783
Fiberglass	ASTM D3517

436-2.2 Concrete Backfill: Use concrete that meets the requirements of Section 347.

436-2.3 Grates: Provide steel grates and supporting frames that meet the requirements of Section 962. Ductile iron frames and grates must meet the requirements of ASTM A536. Ensure that ductile iron grates and frames are compatible and from the same manufacturer. Frames must be anchored into the concrete backfill with studs bolts or lugs. Grates must have at least 30% open area and fasten securely to frames to avoid rattling, Grates must be removable for the entire channel length and have vandal resistant locking devices. Ensure that frames have a minimum of 4 inch long studs, bolts or lugs at all four corners.

436-2.4 Clean-Out covers for Type 1 Drains: Install steel or ductile iron covers that meet the requirements of Section 962.

436-2.5 Outlet Pipe: Connect outlet pipe to the trench drain with standard manufactured connectors. Unless a particular type is called for in the plans, use any of the following types of pipe:

Concrete	Section 449
Steel	Section 943
Aluminum	Section 945
Polyvinyl Chloride	948-1.7
Polyethylene	948.2.3

436-3 Installation.

Submit to the Engineer the proposed method of installation, noting any deviation from the manufacturer's recommendations. Place concrete backfill in the trench against undisturbed material at the sides and bottom of the trench in a manner that will prevent floating or shifting of the trench drain, and will prevent

voids in, or segregation of the concrete. Tamp and spade to prevent honeycombing. Form the top surface to the lines shown in the plans. Remove any foreign material that falls into the trench prior to or during placement of concrete.

436-4 Method of Measurement.

The quantity to be paid for will be plan quantity, in place and accepted. The plan quantity will be measured from the inside wall of the structure as shown on the plans, along the centerline of the pipe/channel.

436-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including all materials, tools, equipment, concrete backfilling, outlet pipe, connections to new or existing structures and all incidentals necessary to complete the work.

Payment will be made under:

Item No. 436- 1- Trench Drain - per foot.

SECTION 440
UNDERDRAINS

440-1 Description.

Construct underdrains, underdrain cleanout structures, underdrain inspection boxes and underdrain outlet pipes. Use any one of the types of pipe listed in 440-2, unless a particular type is specifically required. Use only perforated pipe, and do not use open joints.

440-2 Materials.

Meet the following requirements:

Concrete Pipe	Section 449
Filter Aggregate	902-4
Corrugated Steel Pipe	Section 943
Corrugated Aluminum Pipe	945-1
Polyvinyl-Chloride	948-1
Corrugated Polyethylene Pipe	948-2
Filter Fabric Sock	948-3
Geotextile Fabrics	Section 985

Use bitumized-fiber pipe only when called for in the Contract Documents.

440-3 Excavating Trench.

Excavate the trench carefully, to the depth required to permit the pipe to be laid to the grade required, and to the dimensions shown in the plans.

440-4 Laying Pipe.

440-4.1 General: Bed the pipe firmly on the bottom of the trench, with the perforations down and joints securely made.

440-4.2 Corrugated Steel Pipe - Protection of Coating: Handle corrugated steel pipe in such a way that the zinc coating will not be bruised or broken. Do not use pipe showing bruises or breakage of the zinc coating.

440-4.3 Protection of Drain Inlet: Protect the influent end of the pipe in a manner which will prevent any soil from entering the drain.

440-4.4 Lateral Connections: Make lateral connections with prefabricated wyes, tees, elbows, etc., as required.

440-4.5 Underdrain Inspection Box: Construct underdrain inspection boxes in accordance with the Design Standards, Index No. 245 and the plans.

440-4.6 Underdrain Cleanout Structures: Construct underdrain cleanout structures of in-line wye fittings and stub for access where called for in the plans.

440-5 Placing Filter Material and Backfilling.

440-5.1 Placing Material: After laying the pipe and obtaining the Engineer's approval, backfill the trench with filter material to the lines shown on the plans.

440-5.2 Compaction of Filter Material and Protection of Pipe: Place and compact the filter material around the pipe and for the full width of the trench, in layers not exceeding 6 inches in thickness. Take special care to avoid displacement or damage to the pipe.

440-5.3 Backfill Above Filter Material: For all types of pipe, backfill the portion of the trench above the filter material with suitable pervious material. Place and compact the material in layers not exceeding 4 inches in thickness.

440-6 Type V Underdrain Construction.

To prevent clogging of Type V Underdrain from construction sediments, initially excavate the associated stormwater facilities to rough grade. After the contributing drainage area is stabilized, construct the underdrains and excavate the stormwater facilities to achieve the final elevation.

440-7 Method of Measurement.

The quantities to be paid for will be the length, in feet, of underdrain, which includes underdrain cleanout structures, measured in place, along the centerline and gradient of the underdrain, completed and accepted. The quantities to be paid for will be the length, in feet, of outlet pipe measured in place, along the centerline and gradient of the outlet pipe, completed and accepted. The quantity of underdrain inspection boxes to be paid for will be the number completed and accepted.

440-8 Basis of Payment.

Price and payment will be full compensation for all the work, including all materials and all excavation except the volume included in the items for the grading work.

Payment will be made under:

Item No. 440- 1-	Underdrains - per foot.
Item No. 440- 70-	Underdrain Inspection Box - each.
Item No. 440- 73-	Underdrain Outlet Pipe - per foot.

SECTION 443
FRENCH DRAINS

443-1 Description.

Construct French Drains, utilizing one of the authorized types of pipe, with coarse aggregate, or ballast rock when specified, and filter fabric.

443-2 Materials.

443-2.1 Pipe: Unless a particular type is specified in the plans, pipe furnished may be any of the following types:

(1) Concrete Pipe (Bell & Spigot): Slotted or perforated concrete pipe may be used. Meet the requirements of Section 449 for concrete pipe. Use the class of pipe specified on the Design Standards, Index No. 205. Do not use gaskets. Fully insert the spigot in the bell, and bring home. Conform to Design Standards, Index No. 285 for slotted pipe. Use perforated pipe having perforations equally located 360 degrees around the pipe. Use pipe having not less than 30 round perforations, 3/8 inch each, per square foot of inside pipe surface. Extend perforations to within 6 inches of the bell or spigot area. The Engineer will permit other perforations not less than 5/16 inch nor more than 3/8 inch in the least dimension if they provide an opening area not less than 3.31 in^2/ft^2 of pipe surface.

(2) Corrugated Aluminum Alloy Culvert Perforated Pipe: Meet the requirements of Section 945. Use perforated pipe having perforations equally located 360 degrees around the pipe. Locate perforations either on the inside crests or on the neutral axis of all corrugations except that perforations are not required within 4 inches of each end of each length of pipe or in a corrugation where seams are located.

Provide pipe having not less than 30 round perforations, 3/8 inch each, per square foot of pipe surface. The Engineer will permit other perforations not less than 5/16 inch nor more than 3/8 inch in the least dimension if they provide an opening area not less than 3.31 in^2/ft^2 of pipe surface.

(3) Corrugated Steel Perforated Pipe: Meet the requirements of Section 943. Space the perforations and meet the requirements as specified in (2) above.

(4) Bituminous Coated Corrugated Steel Perforated Pipe: Meet the requirements of Section 943. Space the perforations and meet the requirements as specified in (2) above. Place the perforations prior to the bituminous coating. The Engineer will accept the minimum opening of not less than 3.31 in^2/ft^2 of pipe if 50% of the opening area is maintained after coating.

(5) Corrugated Polyethylene Pipe: Meet the requirements of 948-2.3. Space the perforations and meet the requirements as specified in (2) above.

(6) Polyvinyl Chloride (PVC) Pipe: Meet the requirements of 948-1.7. Space the perforations and meet the requirements as specified in (2) above.

443-2.2 Coarse Aggregate: Meet the requirements of 901-1.4 for No. 4 stone.

443-2.3 Select Fill: Use select fill, unless otherwise called for, consisting of well-graded limerock or limerock and sand fill. Sand, or fill having a high proportion of sand, will not be accepted as select fill. Prior to placing select fill, obtain the Engineer's approval.

443-3 Excavating Trench.

Excavate the trench in accordance with Section 125 unless specific trench excavation procedures are described in the plans.

Carefully excavate the trench to such depths as required to permit the filter fabric, coarse aggregate and the pipe to be placed in accordance with the details shown on the plans.

443-4 Laying Pipe.

Lay all pipe conforming with the lines and grades specified in the plans and in accordance with these Specifications. Unless otherwise specified in the plans, set the pipe with a 36 inch minimum cover and a maximum cover of 66 inches.

443-5 Placing Coarse Aggregate and Backfilling.

After the pipe placement has been approved, carefully place the coarse aggregate or ballast rock, without disturbing the pipe, around and over the pipe to a depth shown on the plans. Then fold the filter fabric over the coarse aggregate or ballast rock as shown on the plans, and fill the portion of the trench above the coarse aggregate with select fill material placed in layers not to exceed 6 inch compacted thickness. After placing the pipe, carefully place the coarse aggregate, without disturbing the pipe, around the pipe to a depth shown in the plans. Fold the filter fabric over the coarse aggregate. Backfill and compact as described below.

443-5.1 French Drains Under Pavement: Fill the area above the coarse aggregate with select fill material meeting the requirements of this Section. Place and compact the select fill according to the requirements for pipe as specified in Section 125. The Department will allow use of additional coarse aggregate over the top of the pipe instead of select fill material. In this case, the top of the coarse aggregate shall not be higher than the bottom of the base, unless shown in the plans. The Department will not pay additional costs associated with substituting coarse aggregate for select fill.

443-5.2 French Drains not Under Pavement: Fill and compact the area above the coarse aggregate according to the requirements for pipe in Section 125, unless specific procedures are described in the plans as specified in Section 125.

443-6 Method of Measurement.

The quantity of French Drains to be paid for under this Section will be the length in feet, measured in place, completed and accepted or paid for separately under the several related pay items as specified on Design Standards, Index No. 285 for French Drains with a significantly different cross-section.

443-7 Basis of Payment.

The quantities determined as provided above will be paid for at either (1) the Contract unit price per foot for French Drains or (2) separately under the several

related pay items as defined in 443-6. Such prices and payments will be full compensation for all the work specified in this Section and will include all materials and all excavation, and will also include sheeting or shoring, if required, the disposal of surplus material, pavement restoration, backfilling and tamping, but will not include payment for items paid for elsewhere in the specifications.

Payment shall be made under:

Item No. 430- 72-	Slotted or Perforated Pipe Culvert - per foot.
Item No. 443- 70-	French Drains - per foot.
Item No. 443- 71-	Ballast Rock - per cubic yard.
Item No. 514- 71-	Plastic Filter Fabric - per square yard.

SECTION 446
EDGEDRAIN (DRAINCRETE)

446-1 Description.

Construct Edgedrain (Draincrete), and Edgedrain Outlet Pipe as shown in the plans and Design Standards, Index No. 287. Use any one of the types of pipe listed in 446-2, unless a particular type is specifically required within the Contract Documents. Use only perforated pipe, and do not use open joints.

446-2 Materials.

Meet the following requirements:

Portland Cement Concrete*	Section 347
Coarse Aggregate	Section 901
Portland Cement	Section 921
Water	Section 923
Polyvinyl-Chloride Pipe	Section 948
Polyethylene Pipe	Section 948
Filter Fabric	Section 985

*For Draincrete, the concrete requirements of Section 347 are modified as follows:

Use Type I or II portland cement (no fly ash or other pozzolans permitted).

Composition:

Grade of coarse aggregate (stone)	#57, #67 or #89
Maximum Water/Cement ratio	0.38
Minimum cement factor	385 lb/yd^3 of Draincrete
Maximum Slump Range	Not Applicable
Fine Aggregate	None
Admixtures	None

Do not use materials which contain hardened lumps, crusts, or frozen matter, or are contaminated with dissimilar material.

446-3 Control of Quality.

446-3.1 Concrete Design Mix: Submit the proposed design mix prior to production, on the "Concrete Mix Design" form, for the Engineer's approval. Use only draincrete design mixes having prior approval of the Engineer. Do not change the design mix component materials except as per 446-3.2.

The Department will verify the proposed mix design and may witness the trial batching. Meet the unit weight requirements as determined in accordance with FM 5-530, and the drain rate in accordance with FM 5-570. Also, provide one of the following with the design mix submittal:

(1) Evidence from three sets of production data, either from Department acceptance tests or independently verifiable commercial mixes, that draincrete produced in accordance with the proposed design mix meets the requirements of this Section.

(2) Test data from a single trial batch of 0.10 yd^3 minimum is required, which demonstrates that the draincrete produced using the proposed mix, designated ingredients, and designated water-cement ratio meets the requirements of this Section.

446-4 Construction.

446-4.1 Excavating Trench: Meet the requirements of Section 440.

446-4.2 Laying Pipe: Meet the requirements of Section 440.

446-4.3 Placement of Draincrete: Obtain the Engineer's approval before placing the draincrete. Deliver the draincrete to the site of placement in a freshly mixed unhardened state. Deposit draincrete in the form or trench by a method approved by the Engineer, to ensure uniform distribution. Do not use vibrators. Avoid displacement or damage to the pipe or filter fabric.

446-5 Sampling and Testing.

446-5.1 General: The Engineer will take random samples of the draincrete at the point of placement to determine the drain rate in accordance with FM 5-570 to determine the drain rate. A minimum of two test cylinders will be made for each LOT. A LOT represents one day's production of each mix design.

446-5.2 Acceptance of Hardened Draincrete: Meet the minimum drain rate of 6 oz/second. Draincrete not meeting the drain rate requirement will be rejected.

Remove, and replace all rejected draincrete at no cost to the Department.

446-6 Method of Measurement.

The quantity of Edgedrain (Draincrete) to be paid for will be the length, in feet, measured in place, along the centerline and gradient of the Edgedrain (Draincrete), completed and accepted. The quantity of Edgedrain Outlet Pipe to be paid for will be the length, in feet, measured in place along the centerline and gradient of the outlet pipe, completed and accepted.

446-7 Basis of Payment.

Price and payment will be full compensation for all work, including all materials, excavation, equipment, labor and incidentals necessary to complete the work.

Payment will be made under:

Item No. 446- 1-	Edgedrain (Draincrete) - per foot.
Item No. 446- 71-	Edgedrain Outlet Pipe - per foot.

SECTION 449
PRECAST CONCRETE DRAINAGE PRODUCTS

449-1 Description.

Precast concrete drainage products hereinafter called products, may include but are not limited to, round concrete pipe, elliptical concrete pipe, underdrains, manholes, endwalls, inlets, junction boxes, three-sided precast concrete culverts, and precast concrete box culverts.

Ensure that all precast drainage products are designed and manufactured in accordance with the requirements of the Contract Documents.

Obtain precast concrete pipes, box culverts, and drainage structures from a plant that is currently on the Department's list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3.

At the beginning of each project, provide a notarized statement to the Engineer from a company designated representative certifying that the plant will manufacture the products in accordance with the requirements set forth in the Contract Documents and plant's Quality Control Plan. The Quality Control Manager's stamp on each product indicates certification that the product was fabricated in conformance with the Contractor's Quality Control Plan, the Contract, and this Section. Ensure that each shipment of precast concrete products to the project site is accompanied with a Quality Control signed or stamped delivery ticket providing the description and the list of the products.

Accept responsibility of either obtaining products from a plant with an approved Quality Control Program, or await re-approval of the plant, when the plant's Quality Control Program is suspended by the Department.

The Engineer will not allow changes in Contract Time or completion dates as a result of the plant's loss of qualification. Accept responsibility for all delay costs or other costs associated with the loss of the plant's qualification.

449-2 Materials.

Ensure that the materials used for the construction of the precast drainage products have a certification statement from the source, showing that they meet the applicable requirements of the Specifications with the following modifications:

Reinforcing Bar	Section 415
Coarse Aggregate*	Section 901
Fine Aggregate*	Section 902
Portland Cement and blended cement	Section 921
Water	Section 923
Admixtures	Section 924
Pozzolans and slag	Section 929

Gasket Material ..... Section 942
Blended Hydraulic Cements..... AASHTO M 240
Welded Wire Fabric ..... ASTM A 185 or ASTM A 497
Wire for Site Cage Machines
.....ASTM A 82, ASTM A 496 or ASTM A 615

*For concrete pipes the gradation requirements of concrete aggregates as set forth in Sections 901 and 902 are not applicable.

449-3 Construction Requirements.

Unless otherwise stipulated within the Contract Documents, meet the following requirements for concrete mix, product design, fabrication, transportation, and installation:

Three-Sided Precast Culverts ..... Section 407
Precast Concrete Box Culvert ..... Section 410
Pipe Culverts and Storm Sewers ..... Section 430
French Drains ..... Section 443
Inlets, Manholes, and Junction Boxes ..... Section 425 and ASTM C 478
Underdrains ..... Section 440 and ASTM C 444
Steel Reinforced Round Concrete Pipe ..... ASTM C 76
Reinforced Elliptical Concrete Pipe ..... ASTM C 507
Non-reinforced Concrete Pipe..... ASTM C 985

Meet the special requirements for the applicable pipes as described in 449-4 and 449-5.

449-4 Concrete Pipe.

449-4.1 Special Requirements for Steel Reinforced Concrete Pipe: Use pipe meeting the requirements of ASTM C 76 with the modifications as described in 449-4.2. Use Special Designed pipe meeting the requirements of ASTM C 655. Use Class S pipe meeting the requirements of ASTM C 655 and the 0.01 inch crack and ultimate D - loads given on the Design Standards, Index No. 205. Ensure all pipes are properly marked.

449-4.2 Modifications to ASTM C 76 and ASTM C 507: The following supersedes the provisions of ASTM C 76 and ASTM C 507:

(a) Ensure all materials used in concrete are certified from the source and conform to the requirements of 449-2.

(b) Ensure all Joint Reinforcement requirements are in accordance with the Design Standards.

(c) When membrane curing compounds are used, ensure that the requirements of 925-2 are met and the membrane curing compounds are applied in accordance with 400-16 immediately after the pipe has been removed from the form.

(d) Ensure the manufacturer has a suitable apparatus for testing each product in accordance with ASTM C 497 and performs all tests outlined in ASTM C 497 when requested by the Engineer.

(e) Ensure that the variation of laying lengths of two opposite sides of pipe is not more than 1.04% of the diameter, with a maximum of 1/2 inch in any length of pipe, except where beveled-end pipe for laying on curves is specified.

(f) Ensure that the type of wall markings is included on all precast pipes.

(g) Ensure all repairs are made in accordance with Section 449-5.4.

449-4.3 Special Requirements for Non-Reinforced Concrete Pipe: Ensure the requirements of ASTM C 985 and the ultimate D - loads given on the Design Standards, Index 205 are met with the following exception: Modify material requirements set forth in ASTM C 985 with the material requirements set forth in 449-2. Ensure all pipes are properly marked.

449-4.4 Special Requirements for Reinforced Elliptical Concrete Pipe: : Use elliptical concrete pipes conforming to the requirements of ASTM C 507, except for the exceptions and modifications as specified in 449-4.2. Ensure the requirements of Table I of ASTM C 507 for standard elliptical pipe, the requirements of Class HE-III and Class HE-IV of Table I of ASTM C 507 for Standard elliptical pipe and special elliptical pipe, respectively are met and the joint design requirements set forth in Article 7 of ASTM C 443 are met.

449-4.5 Concrete Underdrain Pipe: Use perforated concrete pipe for underdrains meeting the requirements of ASTM C 444, with the following modifications:

(a) Strength of Finished Pipe: Underdrain pipe will not be required to be reinforced, and will not be tested for strength of the finished pipe. Approval of the strength of the finished pipe will be based on visual inspection and check.

(b) Perforations: The perforations must be molded into the pipe at the time of fabrication, and any undue chips, fractures, incurred thereby, either in the interior of the pipe or on the periphery, which are sufficient to significantly impair the strength or efficiency, will be cause for rejection of the pipe.

Ensure the perforations are circular, and of the diameter called for below, with a tolerance of ±1/16 inch. Furnish all pipe included in any single order, or for any single installation operation, such diameter is reasonably uniform.

Schedule of Perforations For Concrete Underdrain Pipe

Internal Diameter of Pipe	Diameter of Perforations *(Design)	No. of Rows	**Approximate distance between Rows	**Spacing within Rows
6 inches	3/8 inch	4	4 inches	5-6 inches
6 inches	1/4 inch	4	4 inches	4-5 inches
8 inches	3/8 inch	4	5 inches	5-6 inches
8 inches	1/4 inch	4	5 inches	4-5 inches

*1/16 inch fabrication tolerance, over and under.
**Perforations to be staggered in alternate rows. The spacing between rows must be uniform.

449-4.6 Rejection of Concrete Pipe: Specific causes for rejection of concrete pipe, in addition to any failure to meet the general requirements specified in the Contract Documents, are as follows:

(a) Failure to meet the requirements listed in ASTM C 76 for permissible variations in dimensions with the modifications outlined in 449-4.1 and 449-4.2.

(b) Occurrence of defects listed in ASTM C 76.

449-5 Requirements For Pipe Joints When Rubber Gaskets Are To Be Used.

449-5.1 Design of Joint: Use pipe joint of the bell-and-spigot type or the double spigot and sleeve type, meeting the requirements called for in the Design Standards. Ensure the joint is so proportioned that the spigot, or spigots, will readily enter the bell or sleeve of the pipe.

Ensure the joint ring forms for forming the joint surface are made of either heavy steel, cast iron, or aluminum, and accurately machined to the dimensions of the joint. They must be a true circular form within a tolerance of 1/32 inch. Dimensional checks of joint ring form will indicate for each size pipe a length of spigot, or tongue, not more than 1/8 inch shorter than the bell, or groove, depth. The pipe will be so manufactured that joint surfaces are concentric with the inside of the pipe within a tolerance of 3/32 inch. The shape and dimensions of the joint must be such as to provide compliance with the following requirements:

(a) The joint must be so dimensioned that when the gasket is placed on the spigot it will not be stretched more than 20% of its original length, or the maximum stretch length that is recommended by the manufacturer, whichever is lower.

(b) The space provided for the gasket must be a groove in the spigot end of the pipe and such space, when the joint is made, it cannot be more than 110% of the volume of the gasket.

(c) The joint must be designed so that when the outer surface of the spigot and the inner surface of the bell come into contact at some point on the periphery, the diametric deformation in the gasket at the point of contact cannot be greater than 50% of the normal gasket diameter, and the diametric deformation in the gasket at a point opposite the contact point cannot be less than 20% of the normal gasket diameter.

(d) When the pipes are joined, there must be parallel surfaces on both the bell and the spigot, extending from the outside edge of the gasket toward the bell face for a distance of not less than 3/4 inch. These parallel surfaces cannot be farther apart than 1/8 inch, when the spigot is centered in the bell. The tapers on these surfaces cannot exceed three degrees.

(e) The inside surface of the bell at the end of the bell must be flared to facilitate joining the pipe sections without damaging or displacing the gasket.

449-5.2 When Rubber Gaskets are Used: Ensure that the pipe joints have been tested at the plant hydrostatically and shown to meet the requirements of Section 6.2 of the Materials Manual, which is available at the following URL: www.dot.state.fl.us/specificationsestimates/materialsmanual/section62.pdf .

449-5.3 When Profile Rubber Gaskets are Used: Ensure the joint design meets the requirements set forth in Article 7 of ASTM C 443.

449-5.4 Tolerances in Imperfections, and Permissible Repairs for Joint of Concrete Gasketed Pipe: Ensure that all surfaces of near-contact of the jointed pipes are free from air holes, chipped or spalled concrete, laitance, and other such defects.

Pipes showing minor manufacturing imperfections or handling injuries to the bell or spigot may be acceptable if such defects are acceptably repaired as prescribed below.

Individual air holes (trapped air), or spalled areas with a length of up to one-half the pipe radius, or 12 inches whichever is less, may be repaired by careful use of a hand-placed, stiff, pre-shrunk, 1-to-1 mortar of cement and fine sand, and with no additional preparation other than a thorough washing with water of the defect. Curing will be done either by moisture curing under wet burlap or by application of an approved membrane curing compound. Such repaired pipe which is sound, properly finished and cured, and which otherwise conforms to specification requirements will be acceptable.

Exposed reinforcing and minor spalling in the spigot groove may be accepted if repaired in the following manner: The spalled areas will be chipped back to solid concrete. Exposed reinforcing will be cleaned of all laitance and scale. The entire area is to be coated with an approved epoxy at a thickness of 5 to 10 mils. The coating must be smooth and conform to the shape of the groove. The epoxy must be a Type F-1 as specified in Section 926.

SECTION 450
PRECAST PRESTRESSED CONCRETE CONSTRUCTION

450-1 Description.

Fabricate, store, transport and erect precast/prestressed concrete members prestressed by the pretensioning method. Pretensioned precast prestressed concrete products are products prestressed by the pretensioning method. In this method, steel components are stressed and anchored; the concrete for the product is then cast and cured, and finally the stress in the steel components is released from the anchorages to the concrete through bond, after the concrete has attained its specified release strength.

A precast prestressed concrete plant, hereinafter called plant, is an independent operating facility capable of performing all the operations necessary to fabricate precast/prestressed concrete products.

Obtain precast/prestressed products from a plant that is currently on the Department's list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3.

When the plant's Quality Control Program is suspended, accept responsibility of either obtaining precast/prestressed products from a precast/prestressed concrete plant with an accepted Quality Control Program, or await re-approval of the concrete plant's Quality Control Program. The Engineer will not allow changes in Contract Time or completion dates as a result of the concrete plant's Quality Control Program suspension. Accept responsibility for all delay costs or other costs associated with the plant's Quality Control Program suspension.

450-2 Quality Control Program.

450-2.1 General: Develop a Quality Control Program as specified in 105-3.

Meet the requirements of the accepted Quality Control Program, Contract Documents, and Precast/Prestressed Concrete Institute (PCI) Manual for Quality Control for plants and production of structural precast concrete products. The requirements of the Contract Documents will govern, when there is a discrepancy between the PCI Manual and the Contract Documents.

Accept responsibility for performing daily Quality Control inspections of all phases of work ensuring all materials and workmanship incorporated into the product meet the requirements of the Contract Documents. Also, maintain a daily activity report detailing the results of the daily Quality Control Program activities. Ensure these daily reports and minutes of the weekly meetings with the Engineer and the plant's production personnel are maintained at the plant. During the weekly meetings, discuss the results of the Quality Control inspections.

Inspect the product for conformance with the product dimension tolerances shown in Appendix B of PCI Manual MNL-116 (Manual for Quality Control for Plants and Production of Structural Precast Concrete Products), except as modified herein. Apply the tolerances with respect to the theoretical positions and dimensions shown in the plans. Apply the same tolerances for U-Beams as those specified for I-girders, excluding sweep tolerance, when inspecting the product for conformance with dimension tolerances. Limit sweep to 1/2 inch for U-Beams and Inverted T-Beams. The maximum allowable sweep for AASHTO Beams, Florida-I Beams and Florida Bulb T-Beams is 1/8 inch per 10 ft length, but not to exceed 1.5 inch. The maximum allowable sweep for piling is 1/8 inch per 10 ft, but not to exceed 1.0 inch. The tolerances represent the total allowable tolerance that will be accepted in the finished product. Do not apply tolerances shown for the overall dimensions of a member to violate the tolerances shown for positions of reinforcing and prestressing steel. Apply the tolerances during and after the fabrication of prestressed products. Do not reduce the concrete cover for reinforcing steel, prestressing steel or any other metallic objects specified in the plans more than 1/4 inch. Do not reduce the concrete cover for reinforcing steel, prestressing steel or any other metallic objects when the cover specified in the plans is minimum cover.

Ensure the tolerance on all miscellaneous shaping including, but not limited to, chamfers, miters, bevels, keys, tapers, radii, holes, inserts, block outs, are within ±1/8 inch of the control dimension of the shape.

Ensure the Quality Control inspector is present during concrete placements and performs inspection during all fabrication of precast prestressed concrete products, including the inspection of the operations before, during and after the placement of concrete.

450-2.2 Plant: Ensure each plant has an onsite Quality Control Manager meeting the requirements of Section 105.

450-2.3 Product Certification: Ensure the Quality Control inspector makes a final inspection of all completed products at the plant before shipment to verify that all Contract Documents requirements are met. Upon verification that all Contract Document requirements have been met and all necessary repairs have been satisfactorily completed, the product will be stamped with approved QCM stamp identified in the Quality Control Plan.

Attach to each monthly request for payment, certification that the listed precast prestressed products have been produced under the Quality Control Plan and meet the Contract Document requirements. Ensure the certification is signed by a legally responsible person of the plant and is provided on the plant's letterhead.

450-2.4 Documentation: Ensure that a system of records is maintained in each plant which will provide all information regarding the certification and/or testing of prestressing steel, reinforcing steel, concrete materials and/or concrete, curing materials, embedded items, tensioning, concrete proportioning, pre-placement, placement, post-placement inspections, curing, and disposition of products. Include in the record keeping the deficiencies found as a result of the inspection and testing. Keep certified test reports for all materials incorporated into the production of precast prestressed concrete products.

Ensure that the printout or manual record of the tensioning operations is maintained and reflects the identification of the bed, type of fabricated products, the complete Financial Project Identification Number, jack identification number, date prestressing strands were stressed, temperature at the time of stressing, and signature of the qualified tensioning machine operator.

Ensure the proposed method and format for documenting required information is included in the Quality Control Plan.

Maintain records until all the precast prestressed products for a project have been fabricated then submit all the records to the Engineer. Ensure records are available at all times for the Engineer's inspection.

450-2.5 Quality Assurance Inspection and Testing: The Engineer will perform periodic inspections, sampling, and testing to ensure of the quality and acceptability of the materials, methods, techniques, procedures and processes being utilized by the Contractor in the fabrication of precast prestressed concrete products.

450-3 Materials.

450-3.1 General: Meet the following requirements:

Concrete	Section 346
Steel Strands*	Section 933
Steel Bars	Section 933
Steel Accessories	Section 933
Reinforcing Steel and Metal Fabric**	Sections 415 and 931
Embedded Duct Enclosures	Section 462
Membrane Curing compounds***	Section 925
Epoxy Resin Compounds	Section 926
Burlap	Section 925
Curing Blanket	400-16
Penetrant sealer***	Section 413

* Do not use strands from more than one source in any individual prestressed element, with the exception of the partially tensioned strands (dormant strands).

** The steel spirals for reinforcing in concrete piling may be manufactured from stock meeting the requirements of any grade of reinforcing steel, as shown in ASTM A 615 for steel bars, or ASTM A 82 for steel wire.

*** Use membrane curing compounds and sealers that are compatible with coating or other materials that are applied to concrete surface.

Use inserts in accordance with the recommendations of the manufacturers and within their certified capacities and application qualifications. Do not use aluminum inserts.

Use draped strand devices of sufficient rigidity having adequate support to retain the position of the strand unchanged under the induced load. Do not allow the devices to induce friction to the tendons such that the required jacking force and elongation cannot be attained.

450-3.2 Strand Chucks and Splice Chucks: For pretensioning, use strand chucks that are capable of anchoring the strands without slippage after seating and ensure against strand failure within the grips at loads less than 95% of ultimate strength.

Provide manufacturer's certification that splice chucks used to transmit the prestressing force from one prestressing tendon to another are capable to hold at least 95% of the ultimate tensile strength of the prestressing strand.

Do not use wedges that become worn, cracked, deformed, or that allow dead end seating in excess of 3/8 inch. Use components from the same manufacturer to make up chucks and to provide proper wedge fit.

Use chucks as complete units. Clean, inspect, and lubricate the chucks between each use. Use wedges and housing that are compatible and made for the specific type and size of prestressing strand that are being used, avoid improper fit and improper seating of wedges on the strands.

The Engineer will allow one splice per strand subject to the following:

(1) Splices are located outside the concrete products (except for precast piling where up to two splices are permitted to be used in each pile, so long as they are not located in the same vertical cross section, perpendicular to longitudinal axis of the pile).

(2) Strands which are being spliced have the "lay" or "twist" in the same direction.

450-4 Material Acceptance and Testing.

450-4.1 Concrete: Perform the QC sampling and testing of concrete in accordance with the requirements of Section 346.

450-4.2 Reinforcing Steel, Welded Wire Fabric and Prestressing Steel for Pretensioning:

450-4.2.1 General: Identify all reinforcing steel, welded wire fabric and prestressing steel for pretensioning by LOTs. A LOT of reinforcing steel or welded wire is a shipment of material from the same manufacture and heat. A LOT of prestressing steel is a shipment of material of the same size, production grade and heat from the same manufacture.

Acceptance of reinforcing steel, welded wire fabric and prestressing steel for pretensioning is based on manufacturer's certification and the Department's verification tests. The sampling for verification testing will be

performed by the Department at each precast plant, on at least two LOTs per year, additional samples may be taken at the manufacturing source of reinforcing steel, welded wire fabric and prestressing strands.

When products contain the material that has failed to meet the requirements of 450-3, reject the unused material of the failed LOT. The Engineer may require the evaluation of the products, which contain the failed material, in accordance with 450-14.

450-4.2.2 Reinforcing Steel and Welded Wire Fabric: Obtain and maintain for each LOT a certified mill analysis, physical property test report and the manufacturer's assigned LOT number(s) with the heat of the material represented. Verify that the report represents the steel received and that the steel meets the Contract Documents requirements. Reject all unidentified reinforcing steel or welded wire fabric received at the plant or job site.

Provide the manufacturer's certified mill analysis and three 7 ft long, randomly selected samples from the designated LOT of reinforcing steel and three randomly selected samples from the designated LOT of welded wire fabric when requested by Engineer. Ensure each sample of welded wire fabric covers an area of 4 intersections of transverse and longitudinal bars. Ensure the transverse wires of each piece of welded wire fabric extend approximately 6 inches to both sides.

450-4.2.3 Prestressing Steel for Pretensioning: Obtain and maintain for each LOT of material received, the manufacturer's assigned LOT number(s), certified test values for specified material properties together with a representative load-elongation curve and the modulus of elasticity value based upon strand nominal area. Provide and support by records maintained by the strand manufacturer, production tolerances applied in selection of the reported strand modulus. Verify that documents provided represent the shipment received and meets the Contract Documents requirements.

Reject all unidentified prestressing steel received at the plant or job site.

Provide the manufacturer's certified mill analysis and three 5 foot long randomly selected samples from the designated LOT of material when requested by the Engineer.

450-4.2.4 Strand Chucks and Splice Chucks: Obtain and maintain certified test results certifying that the material meets the requirements of 450-3.

450-4.2.5 Steel Accessories: Use only steel accessories meeting the requirements of 450-3.

450-4.2.6 Ducts: Obtain and maintain certified test results certifying that the material meets the requirements of 450-3.

450-5 Shop Drawings.

Submit shop drawings when the Contract Documents do not contain all the detailed information necessary to fabricate and/or erect the pretensioned prestressed concrete product. Ensure the submitted shop drawings meet the requirements of 5-1 and any additional Contract Document requirements.

Shop drawings are not required to depict supplemental reinforcing steel used to facilitate fabrication of products.

In lieu of shop drawings, furnish one copy of the following to the Engineer:

1. A copy of the Framing Plan with product designations for all superstructure components.

2. Strand detensioning schedule.

3. Tensioning and elongation calculations.

4. Details of supplemental steel that remains as part of the finished product.

5. Submit full plan details and Specifications, when proposing to use materials and/or methods that differ from the requirements of the Contract Documents. Ensure the alternate materials and methods meet the following requirements:

a. The provisions of the Contract Documents.

b. The AASHTO LRFD Bridge Design Specifications, edition with interims as referenced in plans.

c. The recommendations of the material manufacturer.

d. Any materials change proposed by the Contractor and approved by the Engineer.

e. Net compressive stress in the concrete due to prestressing acting alone, after all losses, is not less than that provided by the stranding shown in the plans.

f. Ultimate strength of the structure with the proposed changes is not less than the ultimate strength of the original design.

g. The provisions of the Departments Structures Design Guidelines.

450-6 Forms.

450-6.1 General: Use metal side and bottom forms, unless otherwise specified in the Contract Documents. For members with special shapes such as corner sheet piles, wood forms are permitted. Slab units and sheet piles may be cast on concrete surfaces meeting the profile dimensional tolerances of 450-6.3. Apply release agents in accordance with the manufacturer's recommendations. Liquid membrane curing compounds may be used to prevent bonding of slab products and sheet piles to the existing concrete surface, when applied in two or more coating. Ensure the last application of liquid membrane is applied immediately before placement of the slab or sheet pile.

For all beam members, use side forms designed to be removed without damaging the top flange of the beam. Remove the forms horizontally away from the beam by a method that prevents any contact of the form with the top flange after release of the form. Do not subject the top flange to any vertical force at any time. Include the form details and method of removal in the Quality Control Plan.

For all Florida-I Beams, use forms that do not have more than two horizontal joints.

Use void forms of a type for which service adequacy has been demonstrated, having sufficient strength to provide stability during handling and placing and to withstand hydrostatic pressures and other forces imposed upon them during concrete placement. Use form material that is neutral with respect to the generation of products harmful to the physical and structural properties of the concrete. Ensure that the presence of the form materials does not cause any

detrimental effect to the concrete or other materials within the member. Positively vent all voids to the outside of the member. For end headers and inside forms, other materials capable of resisting the pressure from concrete are permitted.

Use end headers so designed that they can be placed and maintained in correct position between the side forms. Hold the headers in place with devices capable of being removed or loosened after the concrete has attained its initial set allowing free form expansion during curing methods that involve heat. Use end headers with openings conforming to the prestressing steel pattern to permit passage of the prestressing steel. Locate the openings accurately within 1/8 inch of planned location of prestressing steel elements.

Construct circular openings for strands a maximum of 1/4 inch larger than the nominal strand diameter. Construct square or rectangular openings a maximum of 1/4 inch larger, horizontally and vertically, than the nominal strand diameter. Ensure that all headers are mortar tight.

450-6.2 Supports: Use forms of sufficient thickness, with adequate external bracing and stiffeners, which are anchored to withstand the forces due to placement and vibration of concrete. Ensure that joints in forms are mortar tight. Support bottom forms on concrete pallets with metal stiffeners, wales or shims. Do not use timber elements between the bottom metal form and concrete pallets.

450-6.3 Alignment: Make and maintain during their use, forms and centering true to the shapes and dimensions for the product being produced. Plumb, align, and secure forms for each product in position before each reuse.

Apply the following tolerances to form alignment and pallets or beds used in prestressed construction:

1. Horizontal Alignment (horizontal deviation of side forms either side of a vertical plane within the length of a product) = 1/8 inch,

2. Vertical Alignment (vertical deviation of the bed or pallet from a horizontal plane within the length of a product) = 1/8 inch,

3. For vertical joints, Offset Between Adjacent Form Sections = 1/8 inch.

4. For horizontal joints, Offset Between Adjacent Form Sections = 1/16 inch.

450-6.4 End Header Locations:

450-6.4.1 General: Provide a minimum of 18 inches of exposed strands from the end header to the stressing anchorage and between adjacent ends of all products except 24 inches square and smaller piles. Provide a minimum of 6 inches of exposed strands between adjacent ends of 24 inches square and smaller piles.

450-6.4.2 Cold Weather: Provide a distance of at least 5 feet from the end header to the stressing anchorage, when the ambient temperature is expected to be below 55ºF between the time of tensioning and detensioning. When the ambient temperature is expected to be below 55ºF between the time of tensioning and detensioning and the products' exposed strands between the stressing anchorages are not protected, maintain a 25 foot minimum free length of stressed strands, between the end header and the stressing anchorage at each end of a bed line. When cold weather concrete conditions as specified in 450-10.1 are in

effect, protect all exposed strands between stressing anchorages regardless of length. When the products and strands between stressing anchorages are protected, provide protection adequate to maintain the ambient temperature of the air around the products and strand above 55ºF until the products are detensioned.

450-6.5 Surface Conditions: Use clean, rust free form surfaces against which concrete is to be cast. Inspect forms and, if necessary, recondition them.

450-6.6 Form Ties: Ensure that no form wires or metal pieces are left within 2 inches of the surface of the finished concrete.

450-6.7 Corners, Angles and Joints: Ensure corners and angles are chamfered, mitered, or rounded with a radius of 3/4 inch, unless otherwise specified or shown on the plans. Provide smooth mortar tight joints between panel forms within the alignment tolerances.

450-6.8 Form Release Agent: Before placing concrete, treat the facing of all forms with a form release agent in accordance with the manufacturer's requirements. Ensure the application of form release agents do not contaminate prestressing strands and/or reinforcing steel.

450-7 Protection and Placement of Prestressing Steel.

450-7.1 Protection of Prestressing Steel: Maintain and store prestressing steel above the ground surface on platforms, skids, or other supports, to prevent contamination from below, and protect them from mechanical injury. Do not use any packaging or wrapping material that retains moisture at the bottom of the reel. Clean contaminated prestressing steel before use or otherwise reject it. Handle prestressing steel carefully to prevent nicks or kinks and do not expose it to temperatures greater than 200ºF at any time. Do not use arc welding equipment, including welding electrode lines, within 2 feet of prestressing steel. Do not perform any welding on forms that have been set in place after the prestressing steel is placed in the bed. Reject prestressing steel that has sustained any physical damage at any time.

450-7.2 Placing Prestressing Steel: Use care during placement of prestressing steel to avoid physical damage and contamination. Reject damaged strands. Do not use prestressing steel containing nicks, kinks, or former chuck grip marks. Do not use steel showing evidence of scale formation or which has become pitted. Remove and replace any damaged prestressing steel in the bed.

450-7.3 Cleanliness of Prestressing Steel: Inspect the prestressing steel for any evidence of contamination. Use steel that is free of deleterious materials such as grease, oil, wax, dirt, paint (except that used for marking identification) or other similar contaminants. Remove any contaminants detected from the steel before proceeding with fabrication activities. Rust on prestressing steel that can be removed by light rubbing is acceptable. Streaks or spots which may remain after rust removal are acceptable if no pitting is present.

450-7.4 Debonded Strands: Extend the tubular debonding material (sheathing) through the header for debonded prestressing steel. Tie and tape the debonding material at the terminus located at the inside of the member. Seal openings between strand and sheathing for debonded strands with 100% silicone sealant within 48 hours of detensioning. Use sheathing that is tubular non-slit, high-density plastic with a minimum wall thickness of 0.025 inch, and an inside

diameter exceeding the maximum outside diameter of the pretensioning strand by 0.025 inch to 0.14 inch, which does not react with concrete, coating, or steel and prevents the intrusion of water or cement paste during concrete placement.

Do not use strands debonded over the full length of a product.

450-8 Tensioning Equipment and Operations.

450-8.1 Equipment: Use a hydraulic jacking system that is adjustable to the automatic application and sustaining of a predetermined load, together with a pressure transducer or load cell built into the hydraulic system. Connect such pressure gage or transducer to a dial or digital readout and printer (manual recording of the tensioning operations is permitted) which will provide an instantaneous readout and record of the applied load in pounds. Use a jacking system with the capacity to induce the required load. Base the use of this system on demonstrated accuracy and repeatability of ±2% of anticipated load verified through comparison with loads indicated by an independent load cell.

Calibrate all jacking systems before using and repeat calibration at intervals not exceeding 12 months. Calibrate and recalibrate in accordance with the equipment manufacturer's recommendations, by qualified calibration agency or by plant personnel under the supervision of a Specialty Engineer.

Calibrate gages, jacks and pumps as a system in the same manner they are used in tensioning operations with the cylinder extension in the approximate position that it will be in actual use at final jacking force. In multi-strand tensioning systems, gages may be calibrated against a master gage of known accuracy, provided that the other units of the system are calibrated against the same master gage. Ensure calibrations cover the load ranges that will be used during production. Verify the accuracy setting of the automatic cutoff valves by running the desired cutoff load. Ensure a certified calibration curve accompanies each tensioning system. Load readings can be used directly if the calibration determines a reading is within ±2% tolerance of anticipated load. Ensure calibration of load cells or proving rings used to calibrate jacking systems are on compression force testing equipment that has been calibrated in accordance with ASTM E 74.

When any jack or gage appears to be giving erratic results, or if the jack force and elongation do not compare within specified limits and differences cannot be justified while work is in progress, recalibrate the equipment. Also verify the accuracy of the equipment after internal jacking system repairs or when gage and jacking units are switched.

Calibrate or recalibrate in accordance with ASTM E 4 using equipment that is calibrated in accordance with ASTM E 74. After calibration or recalibration has been completed, prepare a certificate and have it signed by the person in responsible charge of the verifications as outlined in ASTM E 4 and ASTM E 74. Ensure that the calibration report includes, the serial number of the equipment that is calibrated, calibration chart in a graph or tabular form, calibration date, temperature, full range of readings before and after calibration, National Institute of Standards and Technology's (NIST's) traceable number of calibration device, method of calibration, calibration agency, and laboratory or Engineer supervising the calibration.

Verify the accuracy of the jacking and recording system a minimum of once each week during tensioning operations by either an independently calibrated load cell, or by comparison with calculated strand elongation. When weekly verification is to be performed by comparison with calculated strand elongation, check a minimum of ten strands and the difference in the indicated load and the load determined from the elongation must agree within 5% of the computed theoretical load values. If the differences are greater than 5%, suspend the tensioning operation, evaluate the tensioning operation by qualified personnel and correct any deficiencies before proceeding.

When weekly verification is done by load cell, perform a minimum of five spot checks to the maximum anticipated load of strands. Use a load cell or proving ring that is calibrated in accordance with ASTM E 74 and the accuracy of the force must be traceable to NIST. Maintain written records of readings obtained from the force recording system and verifying standard. Ensure the weekly verification record includes the serial number of the equipment, verification date, verification agency, NIST traceable number of calibration standard, and name of the person making the spot checks. The load reading from the recording system must agree within ±2% of the anticipated load indicated by the load cell or proving ring that are calibrated annually.

450-8.2 Operations:

450-8.2.1 General: The tensioning operations consist of the application of the final force which is the force required by the plans and with the adjustments for abutment rotation, bed shortening, anchorage header movement, live end seating, dead end seating, splice chuck seating, friction in the jacking system and any other elements as applicable for the type of bed and anchorage being used. Also, adjust the force required by the plans when the temperature differential between the ambient temperature at time of stressing and the expected concrete temperature at time of placement is greater than 25ºF. Increase the force at the rate of 1% for each 10ºF increment that the ambient temperature at time of stressing is below the expected concrete temperature at time of placing. Decrease the force at the rate of 1% for each 10ºF that the ambient temperature at time of stressing is above the expected concrete temperature at the time of placing. Do not allow the stress in the prestressing steel to exceed 80% of the specified tensile strength of the strand, after seating. During each tensioning operation, for the verification of the live and dead end seating, check at least 4 strands or a minimum of 10% of the total number of strands, whichever is greater. Maintain a printed or manual record of the tensioning operation.

Compensation for temperature differential and abutment rotation are not required for self-stressing beds. However, adjust the final load for the effects of bed shortening due to the load from all the strands.

If the placement of concrete is delayed for more than seven calendar days after the completion of the stressing operation, check and adjust the final strand load as necessary before placement of concrete and maintain a printed or manual record of the stressing operation.

Accomplish tensioning by either single strand tensioning or multiple strand tensioning, and ensure that it is symmetrical about the vertical axis of the product. Tensioning methods, in general, consist of tensioning to the required

loads indicated by the jacking system, or tensioning to the required load while monitoring the elongation of the prestressing steel.

450-8.2.2 Single Straight Strand Tensioning: Apply an initial force of 5% to 25% of the final force to eliminate slack in the system. When single straight strand tensioning is used, tension the prestressing steel until the required final load is attained and elongation measurements have been recorded.

450-8.2.3 Multiple Straight Strand Tensioning: Apply the initial uniform tensioning load to each individual strand before the application of full tensioning load to the group of strands. The amount of the initial load will be influenced by the length of the casting bed and the size of strands in the group to be tensioned. The minimum initial tensioning load will be 5% of the required final load. Increase the magnitude of this load if deemed necessary but do not allow it to exceed 25% of the required final load. Then tension the strands by multiple strand tensioning to final load by pulling to elongation and checking against the jack load. Allow the required elongation to control the tensioning. The actual jack load must agree within 5% of the required load.

For uniform application of load to strands, the face of anchorage at final load must be in a plane parallel to its position under initial load. Verify this by measurement of movement on opposite sides of the anchorage and check its plumb position before and after application of the final load. During tensioning, allow the anchorage to move without restraint.

450-8.2.4 Draped Strand Tensioning: Tension draped strands by either partial tensioning and subsequent strains or by final tensioning in draped position.

Partial stressing and subsequent strains applies when the strands are tensioned through a combination of applied jack loads and strand uplift. To verify the final force, place a load cell between the tensioning anchorage and anchor chucks at the dead end on at least two draped strands. Other methods as approved by the Engineer may be used to verify the final force in the dead end. Bring the partially draped strand to an initial tension using a force in the range of 5% to 25% of the required final tensioning force. After application of the initial force, establish reference marks for measuring elongation. Apply a pre-calculated jacking force and measure elongations on a minimum of four strands. The average measured elongation must agree within 5% of the theoretical elongation for strand force measured by jack load, or the factors contributing to the difference must be identified and corrected before proceeding. Allow the load indicated by the jacking system to control the tensioning for the pre-calculated load. Obtain the required final force by lifting or depressing the strand simultaneously at all pickup or hold down points or in an approved sequence as shown on the shop drawings. On each different bed setup, after lifting or depressing the strands to their final position, check the final force at the dead end of at least two strands on the bed. If the load is below the required tensioning force by more than 5%, adjust it to the final load.

When the final stressing is performed in the draped position, apply the tensioning load in two increments with the tendons being held in their draped positions. To verify the final force, place a load cell between the tensioning anchorage and anchor chucks at the dead end on at least two draped strands.

Other methods as approved by the Engineer may be used to verify the final force in the dead end. Bring each strand to an initial tension of 5% to 25% of the final load before the application of the required final load. After application of the initial load, establish reference marks for measuring elongation. Then tension the strands to final load and measure the elongation. Allow the load indicated by the jacking system to control the tensioning for the initial and final loads. The measured elongation must agree within 5% of the theoretical elongation for the strand force measured by jack load, or the factors contributing to the difference must be identified and corrected before proceeding. When the jacking is performed at one end of the bed, check the applied load on two draped strands at the other end of the bed. If the load on the end opposite the jacking end is below the required value by more than 5%, adjust the load to the required final load.

450-8.2.5 Wire Breakage: Limit wire breakage to 2% of the total area of the strands in any product and verify that breakage is not indicative of a more extensive distress condition, otherwise reject all stranding. Replace individual strands with more than one wire failure.

450-8.2.6 Position of Prestressing Steel: Position prestressing steel as shown in the plans within the tolerances allowed in 450-2.1. Fix the required vertical and horizontal position of each prestressing strand at the ends of each product and at intervals within each product not exceeding 30 feet. Use the method of fixing the prestressing steel shown in the Quality Control Plan. When blocks are to be used for supporting prestressing steel, use those cast from concrete of the same mix design as used in the prestressed product. Stagger the location of blocks with an offset of 12 inches or greater and do not stack them.

450-9 Placement of Reinforcing Steel and Other Embedded Materials.

450-9.1 Reinforcing Steel: Tie and/or support in position all reinforcing steel in each product with other reinforcing steel in a manner that will accurately position the steel throughout the fabrication process. Use types of ties and methods of tying recommended by the CRSI, including lacing. Do not tie reinforcing steel to debonded prestressing steel within the limits of the sheathing material.

Tie or lace beam stirrup bars at a minimum of three points. Tie reinforcing steel, other than stirrup bars in beam ends, as a minimum, at every other intersection. Either tie or lace spiral wire in piling at all four corners in the 1 inch pitch area, at the top corners and bottom center in the 3 inch pitch area, and at the top corners in the center area. Tie the bottom center in the pile center area as necessary to maintain concrete cover. Bend all tie wires away from the form surface to provide maximum concrete cover.

When shown on the plans, weld reinforcing steel in accordance with the requirements of AWS Structural Welding Code D 1.4. Do not weld in the prestressing bed.

450-9.2 Placing Other Embedded Materials:

450-9.2.1 Inserts and Lifting Devices: Locate inserts and lifting devices in accordance with the tolerances listed in 450-2.1.

450-9.2.2 Bearing Assemblies: Set bearing assemblies designed to transmit reaction forces to the concrete in the position shown in the plans. Place

bearing plate assemblies or shoes which are to be cast in a product within appropriate tolerances as provided in 450-2.1. Check the assemblies for position after stripping from the forms.

450-10 Concrete Operations.

450-10.1 Temperature Restrictions: When the temperature of the surrounding air is expected to be below 40ºF within 24 hours after placing concrete, the temperature of the plastic concrete as placed must be 55ºF or greater. Maintain the temperature of the concrete after placement above 55ºF until the prestressing steel is detensioned. Make arrangements for heating, covering, insulating or housing the concrete work in advance of placement and maintain the required temperature without injury due to concentration of heat. Do not use direct fired heaters during the first 24 hours after concrete placement, unless actions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide. Continuously monitor the temperature of the concrete or the ambient air around the product until the product is detensioned. Monitor by the use of thermocouples located in the product cross-section or temperature recording devices located under the enclosure. Provide one thermocouple or temperature recording device for each 200 feet of bed length or part thereof. Locate the thermocouples within the products cross-section as shown in the Quality Control Plan or as approved by the Engineer. Record the temperature determined by each thermocouple or temperature recording device. If the temperature of the ambient air is monitored, maintain the air temperature above 60ºF to ensure that the concrete temperature is above 55ºF. Initially calibrate recording thermometers and recalibrate them at least annually in accordance with the manufacturer's recommendations.

Meet the requirements of Section 346 for temperature requirements and special measures for mixing concrete in hot weather.

Apply fog mist spray of water to prestressing strands, reinforcing steel and steel forms just before placing the concrete when the hot weather concreting special measures are in effect and the temperature of steel forms or reinforcing steel is greater than 120ºF.

450-10.2 Protection of Concrete from Weather: Have protection materials available before the concrete placement begins to cover the products in the event of rain during the placement of concrete. Protection materials may be tarps, curing blankets, or other impervious material that will not puncture when placed over protruding reinforcing steel and/or form elements. Include the method and materials for protection in the Quality Control Plan.

450-10.3 Concrete Placement:

450-10.3.1 General: Check forms, reinforcing steel, prestressing steel, vent pipes, anchorages and other embedded items for compliance with the Contract Documents before placing concrete. Place concrete in accordance with 400-7, except as modified herein.

For concrete operations conducted at night, provide enough lighting to allow visual inspection of the interior of the forms during the complete concrete placement operation.

Convey concrete by the use of buckets, conveyors, pumps, troughs, or other equipment specifically designed for concrete conveyance, provided the placement method consistently produces quality concrete with no segregation or separation of the mix. Locate the concrete conveyance equipment within 12 inches of the top of the forms or surface of the concrete to minimize the free fall of the concrete.

Multiple placements may be used within a bedline, provided compliance with 450-11.1 is maintained.

450-10.3.2 Requirements for Successive Layers: Except for self-consolidating (self-compacting) concrete, place concrete as described in 450-10.3.2.1 through 450-10.3.2.5 as shown in the Quality Control Plan or as approved in writing by the Engineer.

In any progressive concrete placement operation, do not allow the time between successive placements onto previously placed concrete to exceed 20 minutes, unless the previously placed concrete has not yet stiffened, as evidenced by the continued effective use of vibration.

450-10.3.2.1 AASHTO Type II, Florida-I Beam 36 and Double-T Beams, Piling and Precast Slab Units (Except Voided Piling and Slabs): Place concrete in one or more layers or lifts. If more than one layer is used for Double T-Beams, end the first layer such that the top of the concrete is slightly below the bottom of the flange.

450-10.3.2.2 AASHTO Type III, Type IV and Florida-I Beams 45 and 54 and Voided Units (Slabs and Piling): Place concrete in a minimum of two horizontal layers. The thickness of the first layer will be such that the top of the concrete is just above the top of the bottom flange. In voided units, end the first layer slightly above the middle height of the void. Fill the form by the last layer.

450-10.3.2.3 AASHTO Type V, Type VI and Florida-I Beams 63, 72 and 78: Place concrete in a minimum of three horizontal layers. The thickness of the first layer will be such that the top of the concrete is slightly above the top of the bottom flange. The thickness of the second layer will be such that the top of the concrete is slightly above the bottom of the top flange. Fill the beam forms by the last layer.

450-10.3.2.4 Pretensioned I Beams Containing Longitudinal Post-tensioning Ducts: Place concrete in one continuous lift beginning in the end block zone and progressing to the other end. Do not allow the progression of the concrete placement to proceed until previously placed concrete has been properly consolidated, and the rate of advancement equals the ability to fill the forms. In progression of the placement, deposit concrete within the forms on the surface of previously placed concrete.

450-10.3.2.5 Florida U Beams: Place the concrete in Florida U Beams in a minimum of two horizontal layers. The thickness of the first layer shall be such that the top of the concrete is above the top of the bottom flange.

450-10.4 Vibration of Concrete: Except for self-consolidating concrete, consolidate concrete by internal or external vibration, or combination of these methods. Design external form vibrators for the specific use. Design forms used in conjunction with external vibration and build them to effectively transmit

vibration to the concrete mass. Mount and operate form vibrators in compliance with the vibrator manufacturer's written recommendations, a copy of which must be on file at the prestressed concrete plant. Secure vibrators to the form mounts by positive locking devices so that maximum vibration is transmitted into the form. Modify or replace external form vibrator systems that are demonstrated to be ineffective. Operate vibrators at each mount location for the time necessary for complete concrete consolidation. Do not allow progressive points of vibration to exceed twice the visually effective radius of vibration. Keep forms equipped with external vibrators clean, and free of any buildup of hardened concrete.

Ensure internal vibrators are available before concrete placement is started. Use an internal vibrator with a head of such size that proper vibration of the concrete will be secured without causing movement of the prestressing steel or reinforcing steel. The vibrating frequency range must be 8,000 to 15,000 impulses per minute. Have at least one standby vibrator available on-site. Insert the vibrator in the concrete at points spaced to ensure uniform vibration of the entire mass of the concrete. Do not allow points of insertions to be further apart than the radius over which the vibrator is visibly effective. Allow the vibrator to sink into the concrete by its own weight and allow it to penetrate into the underlying layers sufficiently so that the two layers are thoroughly consolidated together. After the concrete is thoroughly consolidated, slowly withdraw the vibrator to avoid formation of holes.

Revise the existing placement and consolidation procedure to improve the consolidation of the concrete, if the existing placement and consolidation procedure have produced an unacceptable surface defects such as honeycombing, aggregate or mortar pockets, and excessive air bubbles.

450-10.5 Finishing:

450-10.5.1 General: When concrete incorporating silica fume is used, screed and finish with continuous water fog mist maintained above the concrete. Do not apply the fog directly toward the concrete. The Contractor may apply a monomolecular finishing aid approved by the Engineer in accordance with the manufacturer's recommendation.

450-10.5.2 Beams: Rough float the top surface of the beam and then scrub it transversely with a coarse brush or metal tine to produce a roughened surface for bonding. Unless otherwise specified, apply a Class 3 surface finish to the external surfaces of prestressed beams in accordance with Section 400. Remove mortar leakage and stains to produce beams with a uniform appearance.

450-10.5.3 Piling: Unless a Class 5 Applied Finish Coating is otherwise specified, apply a general surface finish as specified in Section 400 to pile surfaces, except that pointing with mortar will not be required for cosmetic chips and bug holes with a depth less than 1/4 inch and a diameter of less than 3/4 inch. All other general surface finish requirements will apply, including the pointing of material form tie cavities with mortar. Surface finish deficiencies that meet the definition of non-complying prestressed products must be corrected in accordance with 450-12. Miter or round the top corners similar to the corner radius of the pile forms. Surfaces exposed during casting must have a steel trowel finish.

450-10.5.4 Slabs and Double-T Beams: When the plans show the top surface of prestress slab or Double-T Beams units to be the riding surface, apply a Class 4 floor finish in accordance with Section 400. When the plans show the surface to be overlaid with asphalt or concrete, rough float the top surface and then scrub it transversely with a coarse brush to remove all laitance and to produce a roughened surface for bonding. Unless otherwise specified, apply a Class 3 surface finish to other exposed surfaces in accordance with Section 400.

450-10.6 Curing: Cure prestressed concrete as required for a minimum duration of 72 hours. If forms are loosened or removed before the 72 hour curing period is complete, expand the curing to cover the newly exposed surfaces by either coating with curing compound or extending the continuous moist cure area. Maintain concrete surface moisture at all times until curing is begun. If a water sheen is not present, apply supplemental moisture by fog misting or prevent water sheen loss on flat work by use of an evaporation retarder.

After the finishing operations have been completed and as soon as the concrete has hardened sufficiently to permit the application of curing material without marring the exposed surface, cover the exposed surfaces of all prestressed concrete products by one of the following procedures or other alternate curing methods. Alternate curing methods and details proposed by the Contractor must be included in the Quality Control Plan or otherwise approved by the Engineer. Base alternate curing methods upon a demonstrated ability to retain surface moisture of the concrete and to control curing temperatures within acceptable limits. Discontinue use of any alternate curing method other than those included herein upon any indication of noncompliance with this Specification.

450-10.6.1 Continuous Moisture: Place burlap on the surface and keep it continuously saturated for the curing period by means of soil soakers, leaking pipes, or automatic sprinklers. Do not apply moisture manually. If side forms are removed during the curing period, extend the burlap to completely shield the sides of the product. Water flow may be metered to cycle repetitively for five minutes on and five minutes off during the 72 hour curing period. When it is not practical to apply moisture or curing compound inside the voided piles, cover their ends with wet burlap to prevent moisture loss.

450-10.6.2 Membrane Curing Compound: Apply a white Type 2 curing compound to all surfaces in a single-coat, continuous operation, at a uniform coverage as recommended by the manufacturer but not less than 1 gal/150 ft^2. Apply the curing compound on the concrete surfaces that are still damp but no free standing water. Allow surfaces covered by the membrane curing compound to remain undisturbed for the curing period. Recoat any cracks, checks or other defects in the membrane seal which are detected during the curing period within one hour. If side forms are loosened during the curing period, remove them at that time and immediately coat the formed surfaces with a clear membrane curing compound and maintain the surface seal for the remainder of the curing period. Bottom surfaces must be similarly coated after removal of the forms. Remove membrane curing compound to applied surfaces of concrete products to which other concrete is to be bonded by sandblasting or water-blasting until all traces of membrane curing compound are removed.

When the curing compound is applied by spraying, use a compressor driven sprayer of sufficient size to provide uniform spray at the nozzle. Keep all nozzles clean to ensure a uniform application of compound. For compressor driven sprayers, provide a calibrated reservoir which will allow the quantity of applied materials to be accurately determined. Maintain standby equipment in case of mechanical failure. If a mechanical failure occurs, a hand held pump-up sprayer may be used to apply curing compound to the remainder of the products cast in the days production. Suspend additional concrete placements until the mechanical sprayer is functioning properly.

450-10.6.3 Curing Blankets: Curing blankets may be used for curing the top surfaces of products. Do not use curing blankets which have been torn or punctured. Securely fasten edges to provide as tight a seal as practical. Should the system fail to maintain a moist condition on the concrete surface, discontinue it. Allow curing blankets to remain in place for the curing period.

450-10.7 Accelerated Curing:

450-10.7.1 General: Use low-pressure steam curing, radiant heat curing or continuous moisture and heat curing. If accelerated curing is completed before the curing period has elapsed, continue curing for the remaining part of the curing period in accordance with one of the curing methods above.

If accelerated curing is used, furnish and use temperature recording devices that will provide accurate, continuous, and permanent records of the time and temperature relationship of the enclosure and concrete throughout the entire curing period. Place the temperature recording sensors at a minimum of two locations, spaced approximately at or near the third point of bed length, to measure the temperatures of the enclosure and concrete. Initially calibrate recording thermometers and recalibrate them at least annually in accordance with manufacturer's recommendations. Place the sensors at the center of gravity of the bottom flanges for beams. Place the sensors at center of gravity of the cross sections normal to pile length for solid piles, and at the midpoint of the wall thickness of the pile for voided piles.

When the ambient air temperature is equal to or higher than 50ºF, start the accelerated curing by supplying or retaining moisture and the application of the heat, following the initial set period of concrete. Determine the initial set time in accordance with ASTM C 403. During the application of heat, do not allow the temperature rise in the concrete product to exceed 36ºF per hour. The maximum curing temperatures of the enclosure and concrete must not exceed 160ºF. Maintain the maximum curing temperature uniform throughout the enclosure, with variation of not more than 20ºF from the maximum peak temperature until concrete reaches the required release strength. Allow the concrete element to cool gradually at the maximum cooling rate of 50ºF per hour and continue the cooling at this rate until the concrete temperature is 40ºF or less above the ambient temperature outside the curing enclosure.

When the ambient air temperature is below 50ºF cure the concrete in two stages. Start the accelerated curing of the first stage during the preset period by applying heat to increase the temperature of concrete at the maximum rate of 10ºF per hour. The total temperature gain of concrete during the initial set period cannot exceed 40ºF higher than the placement temperature, or 104ºF, whichever

is less. Upon obtaining the initial set, continue curing as stated above for ambient temperature of 50ºF or higher. To prevent moisture loss on exposed surfaces during the preheating period, cover products as soon as possible after casting or keep the exposed surfaces wet by fog spray or wet blankets. Use enclosures for heat curing that allow free circulation of heat about the product and that are constructed to contain the heat with a minimum moisture loss. The use of tarpaulins or similar flexible covers may be used provided they are kept in good repair and secured in such a manner to prevent the loss of heat and moisture. Use enclosures that cover the entire bed from stressing abutment to stressing abutment, including all exposed stranding.

450-10.7.2 Low-Pressure Steam: The steam must be in a saturated condition. Do not allow steam jets to impinge directly on the concrete, test cylinders, or forms. Cover control cylinders to prevent moisture loss and place them in a location where the temperature is representative of the average temperature of the enclosure.

450-10.7.3 Curing with Radiant Heat: Apply radiant heat by means of pipe circulating steam, hot oil or hot water, or by electric heating elements. To prevent moisture loss during curing, keep the exposed surfaces wet by fog spray or wet blankets.

450-10.7.4 Continuous Moisture and Heat: This method consists of heating the casting beds in combination with the continuous moisture method described above. Do not allow the heating elements to come in direct contact with the concrete or the forms. The initial covering of burlap and the continuous application of moisture will be as described in 450-10.6. An auxiliary cover in addition to the burlap for retention of the heat will be required over the entire casting bed. Support this cover a sufficient distance above the product being cured to allow circulation of the heat.

450-10.8 Curing Requirements for Silica Fume Concrete: Use either a 72-hour continuous moisture curing or a (12-24)-hour low-pressure steam curing in accordance with 450-10.7. Upon completion of the low-pressure steam curing, continue curing for the remaining part of the 72-hour curing period by application of the curing compound, continuous moisture curing, or use of the curing blankets.

If 72-hour continuous moisture is used, begin curing silica fume concrete immediately after the finishing operation is complete and keep a film of water on the surface by fogging until the curing blankets are in place. No substitution of alternative methods nor reduction in the time period is allowed. After completion of the 72-hour curing period, apply a membrane curing compound to all concrete surfaces. Apply curing compound according to 450-10.6.

450-10.9 Form Removal: Do not remove forms sooner than six hours after casting and not until the concrete strength is sufficient to avoid structural damage. For AASHTO Type V, Type VI, Florida-I Beams, and Bulb-T Beams, do not remove the forms supporting the top flange concrete sooner than 12 hours after casting unless the release strength has been reached.

450-11 Detensioning.

450-11.1 General: The required concrete strength at which the prestressing force may be transferred to the concrete in a product will be a minimum of 4,000 psi, unless specified otherwise in the plans. Verify the release strength by compressive strength cylinder tests or other approved means, no later than 24 hours after casting and every 24 hours thereafter until release strength is developed. In lieu of every 24 hour testing, contractor is permitted to estimate the strength development of concrete by the maturity method in accordance with ASTM C 1074 pulse velocity method in accordance with ASTM C 597, or any other nondestructive test method acceptable to Engineer, until the time of the detensioning. Before detensioning, verify the concrete release strength by testing the compressive strength test cylinders. Make a minimum of two compressive strength release test cylinders daily for each individual mix, or for each LOT of 50 cy or fraction of given concrete mix design where the daily consumption exceeds this volume or when non-continuous batching or dissimilar curing is used. The release strength test, representing the LOT, is the average compressive strength of two test cylinders, which are cured under the conditions similar to the product or match-cured test specimens, which are match cured until the time of release. For products cured using accelerated curing, release the prestressing force immediately after terminating curing. For products cured using methods other than accelerated curing release the prestressing force within 24 hours of verifying release strength by compressive strength cylinder test or other approved strength gain monitoring system, unless the required time for release occurs on a weekend or holiday. When the required time for release occurs on a weekend or holiday, cover the products and exposed strand with curing blankets or other similar materials, or detension the products. Detension the products immediately on the first workday after the weekend or holiday. Cure concrete cylinders used for detensioning strength tests in the same manner and location as the prestressed concrete products.

450-11.2 Method of Stress Transfer: In all detensioning operations, keep the prestressing forces nearly symmetrical about the vertical axis of the product and apply them in a manner that will minimize sudden shock or loading. Remove or loosen forms, ties, inserts, or other devices that would restrict longitudinal movement of the products along the bed. Release hold-downs for products with draped strands in a sequence as shown in the plans or Quality Control Plan. Cut dormant strands (partially tensioned strands) in top of beams before releasing any fully tensioned strands. Release fully bonded strands next, beginning with the lowest row and moving upwards, followed progressively by strands having the minimum length of tubular sheathing through to those strands having the maximum length of tubular sheathing. The Contractor may propose alternative detensioning patterns to suit the plant's particular operation. Specify the method of the stress transfer to be used either in the Quality Control Plan or the construction submittal.

Transfer prestressing forces to the concrete by either single strand release or multiple strand release.

450-11.3 Single Strand Detensioning: Detension the strand by using a low-oxygen flame in accordance with a pattern and schedule provided in the

approved shop drawings, or Quality Control Plan, or described in 450-5. Heat with a low-oxygen flame played along the strand for a minimum of 5 inches. Heat strands in such a manner that the failure of the first wire in each strand will occur after the torch has been applied for a minimum of five seconds. Release strands in all prestressed products simultaneously and symmetrically about the vertical axis at both ends of the bed and at all intermediate points between products to minimize sliding of products. As an alternate, strands in piles, sheet piles, slabs and AASHTO Type II girders may be released simultaneously and symmetrically about the vertical axis at both ends of the bed until all the strands are released, then proceeding in order to intermediate points nearest the bed ends, or to the single remaining point at the center and release strands at these points in the same manner until all strands are released.

450-11.4 Multiple Strand Detensioning: In this method, detension all strands simultaneously by hydraulic dejacking. The total force is taken from the header by the jack, then released gradually. Do not allow the overstress required to loosen the anchoring devices at the header to exceed the force in the strand by 5%. After detensioning, strands at all points may be cut progressively from one end of the bed to the other using equipment and methods described above.

450-11.5 Trimming Strands: Upon completion of the detensioning operation, cut the exposed strands to required length, using an oxygen flame or mechanical cutting device. On piles, use only mechanical cutting, unless specifications require strand to be burned below the pile surface. Do not use electric arc welders. Unless otherwise specified, allow all strands to protrude 2.5 ± 0.5 inches beyond the end of the product, except cut strands for piling back to be flush with or below the concrete surface.

450-12 Non-complying Prestressed Products.

450-12.1 General: When a precast prestressed concrete product does not comply with the requirements of this Section or is damaged, use the following provisions for evaluating and disposing of deficiencies. However, when precast prestressed concrete products have been installed, the disposition of concrete cracks shall be in accordance with 400-21. Apply these provisions in all cases that clearly fall under the circumstances described. Consider situations not covered by these specific circumstances on their individual merits. Consider and apply the following where practical.

The Quality Control Manager will examine all deficiencies to determine the applicable provisions and requirements of this Article and which course of action is appropriate. If the Quality Control Manager determines that a deficiency is a cosmetic or minor defect, appropriate repairs may be executed immediately in accordance with 450-13. Perform and complete cosmetic and minor defect repairs to the satisfaction of the Quality Control Manager. If the Quality Control Manager determines that a deficiency is a major deficiency, requiring an engineering evaluation, submit a repair proposal to the Engineer in accordance with 450-14. Make all repairs that require a repair proposal under the observation of and to the satisfaction of the Quality Control Manager.

The disposition of deficiencies and repair methods provided herein must at no time, and under no circumstances, be used as an excuse for or applied in

such a manner so as to relieve the Contractor of his responsibility for Quality Control. The number and type of deficiencies evaluated under this specification will, however, be used in evaluating the Contractor's Quality Control.

The Engineer will require a credit on any product with deficiencies that require engineering evaluation and are attributable to the Contractor, accepted for use in the structure. Bear the costs of repairs and any actions taken to rectify deficiencies at no expense to the Department.

450-12.2 Surface Deficiencies: Surface deficiencies are defined below. Regardless of the types of deficiencies, when the total surface area of all deficiencies within a single product exceeds 2.0 % of the product of the product's length times its depth, the product will require engineering evaluation and disposition in accordance with 450-14. The surface deficiencies include spall, chip, bug hole, surface porosity, and honeycomb.

450-12.2.1 Bug Hole: A bug hole is a void caused by air that is entrapped against the form and that has an area up to 3.0 in^2 and a depth up to 1.5 inches. Treat any bug hole with a dimension exceeding either of these dimensions as a honeycomb. The Engineer will not require the Contractor to repair any bug hole with a depth less than 0.25 inch and less than 0.75 inch in diameter, unless otherwise indicated in the plans or specifications. Consider all other bug holes cosmetic and repair them in accordance with 450-13.2.

450-12.2.2 Spall: A spall is a depression resulting when a fragment is detached from a larger mass by impact, action of weather, by pressure or by expansion within the larger mass.

A cosmetic spall is a circular or oval depression not greater than 1.0 inch in depth nor greater than 3.0 in^2 in area, and must be repaired in accordance with 450-13.2.

With the exception of the spalls at the top flange of the beam-ends, a minor spall is defined as a spall not larger than 2.0 ft^2 and no deeper than concrete cover. A spall located at the edge of the top flange, within 1/4 length from the beam-end, is considered minor spall if the total longitudinal length of the defect does not exceed 10 ft. Any of the lateral dimensions of the spall perpendicular to the longitudinal axis of the beam is not greater than 15% of the width of the top flange. Repair minor spalls in accordance with 450-13.4.

A major spall is a spall that any of its dimensions exceeds the dimensions that are described for minor spalls. A major spall requires engineering evaluation and disposition in accordance with 450-14.

450-12.2.3 Chip: A chip is the local breaking of the corners or edges of the concrete with the resulting void containing angular surfaces.

Cosmetic chips are chips where the sum of the two lateral dimensions perpendicular to the length does not exceed 2.0 inches. Regardless of length, it is not necessary to repair cosmetic chips except for visually exposed reinforcing steel, prestressing strand, insert, or weldments surfaces, which may require repair in accordance with 450-13.5.

Minor chips are chips where the sum of the two lateral dimensions perpendicular to the length exceeds 2.0 inches, but does not exceed 4.0 inches, and with a length of no more than 12.0 inches. Repair minor chips in accordance with 450-13.5.

Major chips are any chips larger than minor chips. Major chips require engineering evaluation and disposition in accordance with 450-14.

450-12.2.4 Surface Porosity: Surface porosity is considered a minor defect and is the localized porosity of a formed surface due to medium scaling. Medium scaling is defined as the loss of surface mortar up to 3/8 inch in depth and exposure of concrete aggregate. Repair surface porosity in accordance with 450-13.3.

450-12.2.5 Honeycombing: Honeycombing is voids in the concrete, loss of fines or other material from between the aggregate particles, the inclusion of air pockets between aggregate particles, or larger volumes of lost material. Remove honeycombing in its entirety to sound concrete before establishing the classification of the defect.

Minor honeycombing is a void no deeper than concrete cover and no larger than 2.0 ft^2 in area that results after the removal of unsound material. Repair minor honeycombing in accordance with 450-13.6.

Major honeycombing is a void deeper than concrete cover regardless of the surface area, or shallower but with a surface area greater than 2.0 ft^2 that results after the removal of unsound material. Major honeycombing requires engineering evaluation and disposition in accordance with 450-14.

450-12.3 Formed Surface Misshaping: Formed surface misshaping is the visual and measurable deficiency or excess of material from the specified tolerance on any surface of a product.

450-12.3.1 Pile Ends: Make square pile ends which are outside this Section's tolerances by grinding in accordance with 450-13.7, or any other means of removal as approved by the Engineer. Reshape the chamfer if more than 0.25 inch from the cast pile end is removed and such removal affects the chamfer dimension.

450-12.3.2 Pile Chamfers: Reshape chamfers outside of this Section's tolerances to within the tolerances in accordance with 450-13.7.

450-12.3.3 Other Surfaces: Any deficiency exceeding the plan dimensions for size, length, squareness, designated skew, plumbness, and the like by up to twice the specified plus (+) tolerance may be corrected by grinding to within the allowable tolerance in accordance with 450-13.7. Any deficiency exceeding the specified minus (-) tolerance or twice the specified plus (+) tolerance requires an engineering evaluation and disposition in accordance with 450-14.

450-12.4 Bearing Areas: Consider the bearing area to extend from the end of the product to 3 inches beyond the edge of the bearing contact area for the full product width. Treat minor defects in the bearing area in accordance with 400-11.

450-12.5 Cracks: A crack is the separation of a product or portion thereof which may appear before or after detensioning and may or may not cause separation throughout the product thickness or depth. Identify cracks by the classifications and locations described below and subject them to the disposition required by the identified crack. Regardless of the classifications and locations of cracks within any single product, if the total surface length of all cracks on any and all surfaces exceeds one-third of the product's length, the product requires

engineering evaluation and disposition in accordance with 450-14. Establish crack sizes subsequent to release of all pretensioning forces.

The Engineer will reject any pile that is cracked to the point that a transverse or longitudinal crack extends through the pile, shows failure of the concrete as indicated by spalling of concrete on the main body of the pile adjacent to the crack, or which in the opinion of the Engineer will not withstand driving stresses. Occasional hairline surface cracking caused by shrinkage or tensile stress in the concrete from handling will not be cause for rejection.

450-12.5.1 Classification of Cracks: Regardless of cause and for the purposes of this Specification, cracks in prestressed components, excluding piling, will be identified according to their surface appearance in accordance with the following classifications:

Cosmetic cracks are any cracks which are less than 0.006 inch wide and are in non-critical locations on the product. Treat cosmetic cracks after detensioning in accordance with Section 400 and Section 413.

Minor cracks are any cracks which are between 0.006 and 0.012 inch wide, inclusive, and are in non-critical locations on products. Repair minor cracks after detensioning in accordance with Section 400, and Section 411 or Section 413.

Major cracks are any cracks of any width which are located in critical locations on products or cracks in non-critical locations of the product, which are greater than 0.012 inch wide. Major cracks require an engineering evaluation including crack depth measurement and disposition in accordance with 450-14.

Cracks in the Riding Surface: Repair cracks in the top surface of components which will become the riding surface (with no overlays) in accordance with Section 400, and Section 411 or Section 413 regardless of the classification of the crack identified in accordance with this Specification.

450-12.5.2 Locations of Cracks: Regardless of cause and for the purposes of this Specification, cracks will be identified as occurring in either critical or non-critical locations of the product in accordance with the following criteria and conditions:

Critical locations of cracks are any locations in which a crack would tend to open under stresses occurring at any time during the service life of the structure, or which may reduce the ultimate capacity or fatigue life of the product. Specifically, critical locations of cracks are any locations in a product not defined and not included in 450-12.5.3 as non-critical. Cracks in critical locations require engineering evaluation and disposition in accordance with 450-14.

Non-critical locations of cracks are defined by the position within a product's length, the position within a product's depth, and the orientation of the crack.

450-12.5.3 Non-critical Locations of Cracks by Product Type:

450-12.5.3.1 Piles: Surface cracks in any direction and of a length not exceeding twice the width of the pile.

450-12.5.3.2 Simple Span Prestressed Beams: End zones (within a distance of three times the depth of the product from the end):

(a) One horizontal crack at either or both ends in the top flange and web of the product, not in the plane of nor intersecting any row of prestressing strands, and extending from the end of the product for a length not to exceed half the product's depth.

(b) Vertical cracks extending through the top flange not to exceed one quarter of the product's depth after detensioning.

Mid-span region (between end zones) before detensioning: Vertical cracks extending through the top flange and web of the product.

Any Location: Horizontal crack at the interface of the web and top flange which is not longer than the product's depth.

450-12.5.3.3 Simple Span Double-T Beams: End zones (within a distance of twice the depth of the product from the end): One horizontal crack at either or both ends and in the top flange of the product, not in the plane of nor intersecting any row of prestressing strands, and extending from the end of the product for a length not to exceed half the product's depth.

Mid-span Region (between end zones) before detensioning: Vertical cracks extending through the top flange and not exceeding half the web depth of the product.

Any Location: Horizontal crack at the interface of the web and top flange which is not longer than the product's depth.

450-12.5.3.4 Pretensioned I Beams Containing Longitudinal Post-tensioning Ducts: End zones (within a distance of twice the depth of the beam from the end): Vertical cracks in the bottom half of the beam within an end zone with no post-tensioning anchorages and where the post-tensioning ducts are located in the top of the beam at the location of a permanent substructure support.

Mid-span Region (between quarter points): Vertical cracks in the web and top flange of the beam provided the beam is to be supported at each end in its final position in the structure.

Horizontal cracks not longer than the beam's depth and only at the interface of the web and top flange provided the beam is to be supported at each end in its final position in the structure.

450-12.5.3.5 Simple Span Prestressed Slab Units: End Zones (within a distance of twice the depth of the product from the end): One horizontal crack at either or both ends in the top half of the product, which is not in the plane of nor intersecting any row of prestressing strands, and extending from the end of the product for a length not to exceed half the product's depth.

Mid-span Region (between end zones) before detensioning, Vertical cracks in the top half of the product's depth.

Any Location (after detensioning), Vertical cracks in the top half of the product's depth.

450-13 Repair Methods and Materials.

450-13.1 General: Before beginning the repair of bug holes, spalls, chips, surface porosity, and honeycomb, remove all laitance, loose material, form oil, curing compound and any other deleterious matter from repair area. Repair cosmetic and minor deficiencies by methods specified herein. The Contractor is permitted to elect an alternate repair method, provided the proposed repair

method is included in the Quality Control Plan. For each project maintain the record of deficiencies and their repair methods. Ensure the record includes information about product description, unit serial number, date cast, defect description including dimensions, repair method and materials, defect discovery date, and signature of producer's Quality Control Manager indicating concurrence with the information.

Cure repaired surfaces for the full 72 hour curing time or for the curing time as recommended by written recommendations from the manufacturer of the curing material. Ensure the repaired surfaces have a surface texture, finish and color which matches the appearance of the unaffected surrounding area of the product.

450-13.1.1 Product Acceptance on the Project: Use only non-shrink grout that are listed on the Qualified Products List.

450-13.2 Cosmetic Surface Filling: Repair areas to be filled with an approved high-strength, non-metallic, non-shrink grout meeting the requirements of Section 934. Mix, apply and cure the grout in accordance with the manufacturer's recommendations. Coating of the prepared surface with epoxy bonding agent before grout placement is not required.

450-13.3 Surface Restoration: Maintain the surface continuously wet for a minimum of three hours before application of repair material. Repair areas to be restored with a mortar mix consisting by volume of one part cement, 2.5 parts sand that will pass a No. 16 sieve, and sufficient water to produce a viscous slurry mix or repair areas to be restored with an approved high-strength, non-metallic, non-shrink grout meeting the requirements of Section 934. Mix, apply and cure the grout in accordance with the manufacturer's recommendations. Cure areas repaired with a mortar mix in accordance with 450-10.6. Coating of the prepared surface with epoxy bonding agent before grout placement is not required.

450-13.4 Cutting and Filling: Carefully cut all feathered edges of the area to be repaired back perpendicular to (or slightly undercut from) the surface to the depth of sound concrete or to a minimum depth of 1/2 inch, whichever is deeper. Coat the prepared surface with an approved epoxy bonding agent applied in accordance with the manufacturer's recommendations. Fill the cutout area with an approved high-strength, non-metallic, non-shrink grout mixed and applied in accordance with the manufacturer's recommendations. Firmly consolidate the grout mix in the cutout area.

450-13.5 Restoration of Surfaces and Edges: When reinforcing steel, prestressing strand, inserts or weldments are exposed, remove concrete from around the items to provide a 1 inch clearance all around. Form surfaces and edges to the original dimensions and shape of the product. Coat the prepared surface with an approved epoxy bonding agent applied in accordance with the manufacturer's recommendations. Restore surfaces and edges with an approved high-strength, non-metallic, non-shrink grout mixed and applied in accordance with the manufacturer's recommendations. Firmly consolidate the grout mix in the area to be repaired.

450-13.6 Removal and Restoration of Unsound Concrete: Carefully cut the area of unsound concrete to be repaired back perpendicular to (or slightly

undercut from) the surface and to the depth of sound concrete or to a minimum depth of 1 inch, whichever is deeper. When reinforcing steel, prestressing strand, inserts or weldments are exposed, remove the concrete from around the items to provide a 1 inch clearance all around. Coat the prepared surface with an approved epoxy bonding agent applied in accordance with the manufacturer's recommendations and then filled with an approved high-strength, non-metallic, non-shrink grout mixed and applied in accordance with the manufacturer's recommendations. Firmly consolidate the grout mix in the area to be repaired. Restore surfaces and edges to the original dimensions and shape of the product.

450-13.7 Surface Grinding: Grind off misshaped formed surfaces with an abrasive stone. Apply two coats of an approved penetrant sealant, listed on the current Qualified Products List, in accordance with the requirements of Section 413, to any surfaces which are not subsequently encased in concrete, immediately after grinding has been accepted. Do not apply a penetrant sealer to any surfaces to be subsequently encased in concrete.

450-13.8 Treatment of Cracks: Treat cracks in accordance with Section 400, and Section 411 or Section 413, as applicable.

450-14 Submittal of Proposal to Accept or Repair Deficiencies.

450-14.1 General: When a product has deficiencies unacceptable to the Engineer, the Contractor may propose repairs. Deficiencies discovered in the casting yard must be repaired before shipment. Do not ship products, which require repairs, from the casting yard to the project site until such repairs are complete and the Engineer has determined the product to be acceptable. Deficiencies discovered at the project site may be repaired at the site, subject to the Engineer's approval. All proposed repairs must be submitted for engineering evaluation and credit in accordance with 450-14.2, unless the specific repair methods have been submitted and approved in the Quality Control Plan. The plant may use the repair method that is previously approved in the Quality Control Plan, without submittal of the proposal for engineering evaluation or credit. The use of the previously approved repair method is only applicable to the same type of single deficiency that is exhibited in a product.

450-14.2 Submittal of Proposal for Engineering Evaluation: Proposals must include an evaluation of the product's relative ability to perform its intended function in the structure and its durability relative to other acceptable, similar products. Submit the proposal in writing to the Engineer as outlined below.

If the proposal is accepted by the Engineer, all Department costs associated with review of the proposal, including the cost of any and all engineering evaluation and/or testing services required, will be deducted from payment to the Contractor, but not to exceed 15% of the product value based on unit bid prices.

Prepare the proposal to consist of the following:

1. A cover letter prepared on the Contractor's letterhead describing the product and addressed to the Engineer,

2. Information describing the details of the non-compliance and the proposed repairs in a format acceptable to the Engineer,

3. A structural and durability evaluation of the product,

4. A proposed credit to the Contract proportionate to the product's deficiency. The credit is in addition to the cost for review and evaluation of the proposal,

5. Any other supportive information, pictures and sketches. The description of the proposed repair and/or the structural and durability evaluation of the product must be prepared by or under the direct supervision of the Contractor's Engineer of Record and must bear his/her signature and seal.

Include in the proposed credit consideration of the Department's added costs which may include but are not necessarily limited to re-inspection, testing, reduced durability, or increased maintenance cost. The Engineer will review and evaluate the Contractor's proposal and will notify the Contractor of its disposition. The Engineer's review of the Contractor's proposal does not amend or delete code requirements, unless such changes are specifically brought to the Engineer's attention and accepted by the Engineer. The Engineer's acceptance of a proposal does not relieve the Contractor of his responsibility to provide products that are structurally adequate to resist the loads specified in the Contract drawings and that maintain the intended aesthetic, durability and maintenance aspects of the product. The Engineer will not accept repaired products unless repairs are made as proposed or described, the resulting repairs are sound in all aspects, and the repairs are aesthetically acceptable. Replace a rejected product with a product meeting the requirements of the Contract Documents at no additional expense to the Department.

450-15 Repairs Before Approval.

If repairs to precast products are initiated in advance of the Engineer's approval, the affected product will only be considered for acceptability and use when the following conditions have been satisfied:

1. Before beginning the repairs, prepare and deliver to the Engineer a repair proposal in accordance with the requirements of 450-14.

2. All repair materials must meet the requirements of Section 930 and be selected from the Department's Qualified Product List (QPL) or otherwise be subsequently evaluated, tested by the Contractor as required by the Department, and/or approved by the Department for the specific use made of the material.

3. Repairs have been performed under the observation of the Quality Control Manager.

Accept responsibility for actions taken, and perform these actions at your own risk. It is intended that repairs be made only after the proposed methods have been accepted to ensure that the proposal will not be modified or rejected, and the work will be accepted if the repair proves to be adequate.

450-16 Handling, Storage, Shipping and Erection.

450-16.1 Handling: All products which are pretensioned may only be handled after transfer of the prestressing force. For products that are prestressed by a combination of pretensioning and post-tensioning do not handle before sufficient prestress has been applied to sustain all forces and bending moments due to handling. Exercise care in handling to prevent damage to products. Lift

and move products so as to minimize stresses due to sudden changes in momentum. Calculate pick up and dunnage points. Pick up products only at points designated as pickup points as shown on the Contract plans or shop drawings. Maintain all beams in an upright position at all times.

Evaluate the temporary stresses and stability of beams during their handling. The temporary stresses induced into the products during handling must be within the acceptable stresses at release listed in the Department's Structures Design Guidelines. Take appropriate action to increase the stability of products during handling when the factor of safety against lateral buckling instability is below 2.0. Include the expected fabrication tolerance for sweep in the analysis. The analysis procedure provided by the Precast/Prestressed Concrete Institute or similar procedures may be used for the stability evaluation.

Verify lifting devices for capacity in lifting and handling products, taking into account various positions during handling. Keep multiple component lifting devices matched to avoid non-compatible use. When a product has multiple lifting devices, use lifting equipment capable of distributing the load at each device uniformly to maintain the stability of the product. When the lifting devices are grouped in multiples at one location, align them for equal lifting.

Take appropriate steps to prevent the occurrence of cracking. When cracking occurs during handling and transportation, revise handling and transporting equipment and procedures as necessary to prevent cracking for subsequent products.

450-16.2 Storage: Store precast prestressed beams, Double-T Beams and slab units on only two points of support located within 18 inches of the end of the product or as calculated. Support skewed beams, Double-T Beams or slab units within 18 inches of the end of the full product section or as calculated. Support other products on an adequate number of supports so as to keep stresses in the products within the allowable stresses at release listed in the Department's Structures Design Guidelines. Locate multiple supports (more than two) within 1/2 inch of a horizontal plane through the top surface of the supports. Adequately brace beams as necessary to maintain stability.

All supports must be level and on adequate foundation material that will prevent shifting or differential settlement which may cause twisting or rotation of products. Immediately pick up products in storage that have rotated or twisted and adjust the supports to provide level and uniform support for the product.

Support prestressed products that are stacked by dunnage placed across the full width of each bearing point and aligned vertically over lower supports. Do not use stored products as a storage area for either shorter or longer products or heavy equipment.

Where feasible, base the selection of storage sites, storage conditions and orientation upon consideration of minimizing the thermal and time-dependent creep and shrinkage effects on the camber and/or sweep of the precast pretensioned products.

Continuous application of water during the initial seventy-two hour moist curing period may be interrupted for a maximum of one hour to allow relocation of precast/prestressed concrete elements within the manufacturing facility. Keep the moist burlap in place during relocation of the element.

Measure and record the sweep and camber of beams monthly. Keep the measurement records on file for review at any time by the Engineer, and upon request, transmit a copy of these measurements to the Engineer. If the camber exceeds by 1 inch the design camber shown in the plans, take appropriate actions in accordance with 400-7.13.1 to accommodate the product in the structure.

If the sweep exceeds the tolerance specified, take immediate measures to bring the sweep of the product back to within tolerance.

Notify the Engineer immediately when the sweep or camber exceeds the specified tolerances. Special storage conditions for the purpose of removing excessive sweep will not be restricted by requirements of this Subarticle nor contained in 450-2.1. If the sweep of the product exceeds the tolerance specified and cannot be removed, the disposition of the product will be in accordance with 450-12.1 and 450-14.

450-16.3 Shipping: Do not ship precast prestressed products before the concrete attains the required 28-day strength. The contractor is permitted to verify the shipping strength test, before 28 days, by testing compressive strength cylinders that are cured under the conditions similar to the product or by testing temperature match cured cylinders. The use of maturity method, ASTM C 1074, pulse velocity method in accordance with ASTM C 597, or any other nondestructive test method acceptable to Engineer, is permitted to estimate the strength before its verification by test cylinders. The shipping strength test is the average compressive strength of two test cylinders. Do not ship products until accepted and stamped by the Quality Control Manager or the inspectors under the direct observation of the Quality Control Manager. At the beginning of each project, provide a notarized statement to the Engineer from a responsible company representative certifying that the plant will manufacture the products in accordance with the requirements set forth in the Contract Documents and plant's Quality Control Plan. The Quality Control Manager's stamp on each product indicates certification that the product was fabricated in conformance with the Contractor's Quality Control Plan, the Contract, and this Section. Ensure that each shipment of prestressed concrete products to the project site is accompanied with a signed or stamped delivery ticket providing the description and the list of the products.

Evaluate the temporary stresses and stability of all products during shipping and locate supports, generally within 18 inches from the beam end, in such a manner as to maintain stresses within acceptable levels. Include impact loadings in the evaluation.

450-16.4 Erection: Erect precast prestressed products without damage. Meet the handling and storage requirements of 450-16.1 and 450-16.2 for field operations. Before casting diaphragms and the deck slab, do not allow the horizontal alignment of prestressed concrete beams to deviate from a straight line connecting similar points of beam ends by more than the sweep tolerances specified in 450-2.1. Adequately brace beams as necessary to maintain stability.

450-17 Measurement and Payment.

450-17.1 General: The work specified in this Section will be measured and paid for as shown below for the particular item involved. Precast prestressed

concrete members are acceptable to the Department for full payment when all requirements of the Contract have been met. No partial payments will be made for precast prestressed concrete members until the 28-day strength requirement, along with other applicable specification requirements, have been met.

450-17.2 Prestressed Concrete Piling: Payment will be made at the Contract unit price per foot for the particular type of piling, measured and paid for as specified in Section 455, including the provisions for cutoffs and splices.

450-17.3 Prestressed Concrete Beams: Payment will be made at the Contract unit price per foot for Prestressed Beams, complete in place and accepted. Final pay lengths will be plan quantity based on casting lengths, as detailed on the plans, subject to the provisions of 9-3.2.

450-17.4 Prestressed Concrete Slab Units: Payment will be made at the Contract unit price per foot for the units, complete in place and accepted. Final pay lengths will be plan quantity based on casting lengths, as detailed in the plans, subject to the provisions of 9-3.2.

450-18 Basis of Payment.

Price and payment will be full compensation for all work and materials specified in this Section, including steel reinforcement, pretensioning steel, embedded ducts, hardware, inserts and other materials as required, to fabricate, transport and place the product into its permanent position in the structure.

Payment for the items will be made under the following:

Item No. 450- 1-	Prestressed Beams - per foot.
Item No. 450- 2	Prestressed Beams: Florida-I Beams – per foot.
Item No. 450- 3-	Prestressed Slab Units - per foot.
Item No. 450- 4-	Prestressed Beam U-beams - per foot.
Item No. 450- 88-	Prestressed Slab Units Transversely Post-Tensioned - square foot.

SECTION 451
PRESTRESSED SOIL ANCHORS

451-1 Description.

Construct prestressed soil anchors consisting of a high strength steel tendon anchored to the retaining wall on one end and to the soil on the other end through a bulb of pressure injected portland cement concrete grout. Test each anchor by prestressing to the load indicated in the Contract Documents before locking off to the retaining wall.

Select the prestressed soil anchor type and the installation method, and determine the bond length and anchor diameter. Assume responsibility for installing prestressed soil anchors that develop the load-carrying capacity indicated on the plans in accordance with 451-7.

Provide corrosion protection for permanent prestressed soil anchors. The Engineer will not require corrosion protection for temporary prestressed soil

anchors. Protect anchor tendons from corrosion as shown on the plans in accordance with 451-8.

451-2 Definitions.

(a) Anchorage Devices: The anchor head wedges or nuts which grip the prestressing steel.

(b) Bearing Plate: The steel plate which distributes the prestressed soil anchor force to the structure.

(c) Bond Length: The length of the prestressed soil anchor which is bonded to the ground and transmits the tensile force to the soil or rock. For a compression prestressed soil anchor, the bond length will be different from the tendon bond length.

(d) Design Load: The maximum anticipated load that will be applied to the prestressed soil anchor during its service life after completing stressing and testing. The design load includes appropriate load factors to ensure that the overall structure has adequate strength for its intended use.

(e) Fine-grained Soils: Soils with at least 50% of the material smaller than the No. 200 sieve size.

(f) Tendon: The complete anchor assembly, excluding grout, consisting of anchorage and prestressing steel with sheathing and coating when required.

(g) Coupling: The means by which the prestressing force may be transmitted from one partial-length of prestressing tendon to another.

(h) Sheathing: Enclosure around the prestressing steel to avoid temporary or permanent bond between the prestressing steel and the surrounding grout or to provide corrosion protection.

(i) Coating: Material used to protect against corrosion or lubricate the prestressing steel.

(j) Anchor Grout: Portland cement grout that is injected into the anchor hole to provide anchorage at the bond length of the tendon.

(k) Proof Load: Temporary prestressing load in an anchor at a force level greater than its design load for testing purposes.

(l) Transfer (Lock-Off) Load: Prestressing force in an anchor after proof loading immediately after the force has been transferred from the jack to the stressing anchorage.

(m) Stressing Anchorage: That portion of assembly not within the earth fill.

(n) Alignment Load: A nominal load maintained on a performance tested anchor when the anchor is unloaded. This load is left in the anchor to keep the testing equipment positioned.

(o) Performance Test: Incremental test loading and unloading of a prestressed anchor recording the movement of the tendon at each increment.

(p) Proof Test: Incremental loading of a prestressed anchor recording the movement of the tendon at each increment.

(q) Creep Test: A test to determine the movement of the tendon at constant load during a certain period of time.

(r) Lift-Off Reading: A check made to determine that the actual transfer load is within 5% of the desired transfer load. This check is made immediately after transferring the load to the stressing anchorage.

(s) Residual Movement: The non-elastic (non-recoverable) movement of an anchor measured during a performance test.

(t) Elastic Movement: The recoverable movement of an anchor measured during a performance test.

(u) Prestressed Soil Anchor: A system, referred to as a tieback or a ground anchor, used to transfer tensile loads to soil or rock. A prestressed soil anchor includes all prestressing steel, anchorage devices, bearing plates, grout, coatings, corrosion protection, sheathings and couplers if used.

(v) Minimum Specified Ultimate Tensile Strength: The minimum breaking strength of the prestressing steel as defined by the specified standard.

(w) Tendon Bond Length: The length of the tendon which is bonded to the anchor grout.

(x) Total Anchor Length: The unbonded length plus the tendon bond length.

(y) Unbonded Length (Stressing Length): The length of the tendon which is not bonded to the grout and free to elongate during stressing. The grout surrounding the unbonded length is a void filler and provides corrosion protection.

451-3 Qualifications.

The Contractor or subcontractor performing the work described in this Section shall have installed prestressed soil anchors for a minimum of five years. At the preconstruction conference, the Contractor shall submit a list containing at least five projects, completed within the last five years, where the Contractor has installed prestressed soil anchors. Include a brief description of each project and a reference for each project listed. As a minimum, include with the reference an individual's name and current phone number.

Prior to the start of work, the Contractor shall submit a list identifying his engineer, drill operators, and on-site supervisors who will be assigned to the project. Include in the list a summary of each individual’s experience.

Assign a Specialty Engineer to supervise the work with at least five years of experience in the design and construction of permanently-anchored structures. Do not use consultants or manufacturers' representatives in order to meet the requirements of this Section. Provide drill operators and on-site supervisors that have a minimum of one year experience installing permanent prestressed soil anchors with the Contractor’s organization.

The Engineer will approve or reject the Contractor’s qualifications and staff within 15 working days after receipt of the submission. Do not start work on any prestressed soil anchor wall system or order materials until receiving approval of the qualifications. The Engineer may suspend the prestressed soil anchor work if the Contractor or subcontractor substitutes unqualified personnel for approved personnel during construction. If work is suspended due to the substitution of unqualified personnel, the Contractor is fully liable for additional costs resulting from the suspension of work and the Department will not allow any adjustment in Contract Time resulting from the suspension of work.

451-4 Materials.

451-4.1 General: Meet the following requirements:

Concrete .....Section 346
Prestressed Construction .....Section 450
Structural Steel and Miscellaneous Metals.....Section 460

451-4.2 Prestressing Steel: Use prestressed soil anchor tendons fabricated from single or multiple elements of one of the following prestressing steels:

(a) Steel bars meeting the requirements of AASHTO M 275.

(b) 7-wire, low-relaxation strands meeting the requirements of AASHTO M 203.

(c) "Compact" 7-wire, low-relaxation strands meeting the requirements of ASTM A 779.

451-4.3 Anchorage Covers (not applicable for temporary anchors): Use exposed anchorage covers fabricated from steel or ductile cast iron with a minimum thickness of 0.10 inch. Ensure that the cover is securely attached to the anchorage device or bearing plate. If the cover is to be grease filled, then ensure that the cover forms a permanent watertight enclosure for the anchorage device.

451-4.4 Anchorage Devices: Use anchorage devices capable of developing 95% of the minimum specified ultimate tensile strength of the prestressing steel tendon. Use anchorage devices that meet the static strength requirements of Section 3.1.6(1) and Section 3.1.8(1) of the Post Tensioning Institute "Guide Specification for Post-tensioning Materials". Use couplers for tendon sections capable of developing 95% of the minimum specified ultimate tensile strength.

451-4.5 Cement Grout: Use grout for anchorage consisting of a pumpable mixture of Type I, II, or III portland cement meeting the requirements of AASHTO M 85, sand, water, and admixtures. The Contractor may use admixtures which control bleed, improve flowability, reduce water content, and retard set in the grout subject to the approval of the Engineer. The Contractor may only add expansive admixtures to the grout used for filling sealed encapsulations, trumpets, and anchorage covers. Do not use accelerators. Use admixtures compatible with the prestressing steels and mixed in accordance with the manufacturer's recommendations.

Do not perform strength testing as system performance will be measured by proof-testing each anchor. The Department may require grout cube testing if the Contractor uses admixtures or irregularities occur in anchor testing. Use grout that attains a minimum cube strength of 3,400 psi within seven days.

451-4.6 Bearing Plate: Use bearing plates fabricated from steel meeting the requirements of AASHTO M 183 or AASHTO M 222.

451-4.7 Bondbreaker: Use bondbreaker fabricated from a smooth plastic tube or pipe having the following properties:

(a) Resistant to chemical attack from aggressive environments, grout, or grease;

(b) Resistant to aging by ultra-violent light;

(c) Fabricated from material non-detrimental to the tendon;

(d) Capable of withstanding abrasion, impact, and bending during handling and installation;

(e) Enable the tendon to elongate during testing and stressing; and

(f) Allow the tendon to remain unbonded after lock-off.

451-4.8 Centralizers: Use centralizers fabricated from plastic, steel, or material which is nondetrimental to the prestressing steel. Do not use wood. Ensure that the centralizer is able to support the tendon in the drill hole, and position the tendon so a minimum of 0.5 inch of grout cover is provided over the tendon bond length. In addition, locate the upper centralizer a maximum of 5 feet from the top of the tendon bond length, and locate the lower centralizer a maximum of 12 inches from the bottom of the tendon bond length. The Engineer will not require centralizers on pressure injected tendons if the Contractor installs the anchor in coarse grained soils using grouting pressures greater than 150 psi. The Engineer will not require centralizers if the Contractor installs the anchors and grouts them through a hollow stem auger and maintains the hole full of stiff grout (slump less than 9 inches) during extraction of the auger.

451-4.9 Corrosion Inhibiting Grease (not applicable for temporary anchors): For corrosion inhibiting grease, meet the requirements of Section 3.2.5 of the Post Tensioning Institute Specification for Unbonded Single Strand Tendons.

451-4.10 Heat Shrinkable Tubes: Use heat shrinkable tubes fabricated from a radiation cross-linked polyolefin tube internally coated with an adhesive sealant. Prior to shrinking, ensure that the tube has a nominal wall thickness of 24 mils. Ensure that the adhesive sealant inside the tube has a nominal thickness of 20 mils.

451-4.11 Sheath (not applicable for temporary anchors): Use a sheath as part of the corrosion protection system for the unbonded length portion of the tendon fabricated from one of the following:

(a) A polyethylene tube pulled or pushed over the prestressing steel. Use polyethylene Type II, III, or IV as defined by ASTM D 1248 or approved equal, with a minimum wall thickness of 60 ± 10 mils.

(b) A hot-melt extruded polypropylene tube. Use polypropylene cell classification PP 210 B5554211 as defined by ASTM D 4101 or approved equal, with a minimum wall thickness of 60 ± 10 mils.

(c) A hot-melt extruded polyethylene tube. Use polyethylene high density Type III as defined by ASTM D 3350 and ASTM D 1248 (or approved equal), with a minimum wall thickness of 60 ± 10 mils.

(d) Steel tubing meeting the requirements of ASTM A 500, with a minimum wall thickness of 0.20 inch.

(e) Steel pipe meeting the requirements of ASTM A 53, Schedule 40 minimum.

(f) Plastic pipe meeting the requirements of ASTM D 1785, Schedule 40 minimum.

(g) A corrugated tube meeting the requirement of the tendon bond length encapsulation.

451-4.12 Spacers: Use spacers to separate elements of a multi-element tendon and which permit grout to flow freely up the drill hole. Use spacers fabricated from plastic, steel, or material which is nondetrimental to the prestressing steel. Do not use wood. The Contractor may use a combination centralizer-spacer.

451-4.13 Tendon Bond Length Encapsulations (not applicable for temporary anchors): When the Contract Drawings require the tendon bond length to be encapsulated to provide additional corrosion protection, use encapsulation fabricated from one of the following:

(a) High density corrugated polyethylene tubing meeting the requirements of AASHTO M 252, with a minimum wall thickness of 30 mils.

(b) Deformed steel tubing or pipes with a minimum wall thickness of 25 mils.

(c) Corrugated, PVC tubes manufactured from rigid PVC compounds meeting the requirements of ASTM D 1784, Class 13464-B.

451-4.14 Trumpet (not applicable for temporary anchors): Use a trumpet to provide a transition from the anchorage to the unbonded length corrosion protection fabricated from a steel pipe or tube meeting the requirements of ASTM A 53 for pipe or ASTM A 500 for tubing. Use a trumpet that has a minimum wall thickness of 0.125 inch for diameters up to 4 inches and 0.20 inch for larger diameters.

451-4.15 Water: Use potable water for mixing grout.

451-4.16 Grout Tube: Use a grout tube fabricated from a high density polyethylene tube, or a PVC pipe, or a steel pipe with a 0.5 inch minimum I.D.

451-5 Tendon Fabrication.

Provide tendons that are either shop or field fabricated. Fabricate the tendon as shown on the approved Shop Drawings.

Ensure that tendons are free of dirt, rust, or any other deleterious substance. Degrease the bond length.

Handle and protect tendons, prior to installation, in a manner to avoid corrosion and physical damage. The Engineer will consider damage such as abrasion kinks, welds and weld splatters, cuts, and nicks which impair the proper performance of the tendon cause for rejection.

Sheath tendons in the stressing length to prevent contact of the anchor tendon with the drill hole wall. The Contractor may use sheathing that consists of tubes surrounding individual tendon elements or a single tube surrounding the elements altogether.

The Contractor may use sheathing material of either steel, plastic, or any other material non-detrimental to the high strength prestressing steel. The Contractor may use tape to prevent grout from entering under the sheath on individually sheathed elements.

Select the type of tendon to be used. Size the tendon so the design load does not exceed 60% of the minimum specified ultimate tensile strength of the tendon. In addition, size the tendon so the maximum test load does not exceed 80% of the minimum specified ultimate tensile strength of the tendon.

Assume responsibility for determining the bond length necessary to develop the design load indicated on the plans or the Shop Drawings. Use a minimum bond length of 10 feet in rock and 15 feet in soil. Ensure that the minimum tendon bond length is 10 feet.

451-6 Installation.

451-6.1 General:

451-6.1.1 Drilling: Core drilling, rotary drilling, percussion drilling, auger drilling, or driven casing may be used. At the ground surface, locate the drill hole within 12 inches of the location shown on the plans or the approved Shop Drawings. Locate the drill hole so that the longitudinal axis of the drill hole and the longitudinal axis of the tendon are parallel. In particular, do not drill the prestressed soil anchor hole in a location that requires the tendon to be bent in order to connect the bearing plate to the supported structure. At the point of entry, install the prestressed soil anchor within ±3 degrees of the inclination from horizontal shown on the plans or the approved Shop Drawings. At the point of entry, make the horizontal angle formed by the prestressed soil anchor and the structure to within ±3 degrees of a line drawn perpendicular to the plane of the structure unless otherwise shown on the plans or approved Shop Drawings. Do not allow the prestressed soil anchors to extend beyond the right-of-way or easement limits shown on the plans.

451-6.1.2 Tendon Insertion: Insert the tendon into the drill hole to the desired depth. When the tendon cannot be completely inserted, remove the tendon from the drill hole, and then clean or re-drill the hole to permit insertion. Do not drive or force partially inserted tendons into the hole.

451-6.1.3 Installation of Trumpet and Anchorage: When corrosion protection is required, extend that portion of the corrosion protection surrounding the unbonded length of the tendon, up beyond the bottom seal of the trumpet or 12 inches into the trumpet if no trumpet seal is provided. If the protection does not extend beyond the seal or sufficiently far enough into the trumpet, extend the corrosion protection, or lengthen the trumpet.

When required, ensure that the corrosion protection surrounding the unbonded length of the tendon does not contact the bearing plate or the anchor head during testing and stressing. If the protection is too long, trim the corrosion protection to prevent contact.

Place the bearing plate and anchor head so the axis of the tendon is perpendicular to the bearing plate within ±3 degrees and the axis of the tendon passes through the center of the bearing plate.

If using grout protected tendons, electrically isolate the bearing plate, anchor head, and trumpet from the surrounding concrete, soldier pile, or any metallic element embedded in the structure.

Completely fill the trumpet with corrosion inhibiting grease or grout. Trumpet grease may be placed any time during construction. Place trumpet grout after the prestressed soil anchor has been tested and stressed. Demonstrate to the Engineer that the procedures selected for placement of either grease or grout will produce a completely filled trumpet.

For permanent soil anchors, cover all anchorages permanently exposed to the atmosphere with a corrosion inhibiting grease-filled or grout-filled cover. Demonstrate to the Engineer that the procedures selected for placement of either grease or grout will produce a completely filled cover. If the plans require restressable anchorages, use corrosion inhibiting grease to fill the anchorage cover.

451-6.2 Anchor Grouting: Provide grouting equipment that produces a grout free of lumps and undispersed cement. Use a positive displacement grout pump equipped with a pressure gauge to monitor grout pressures. Ensure that the pressure gauge is capable of measuring pressures of at least 150 psi or twice the actual grout pressures used, whichever is greater. Size the grouting equipment to enable the grout to be pumped in one continuous operation. Ensure that the mixer is capable of continuously agitating the grout.

Inject the grout from the lowest point of the drill hole. Grout may be pumped through grout tubes, casing, hollow-stem-augers, or drill rods. The grout may be placed before or after insertion of the tendon. Record the quantity of the grout and the grout pressures. Control the grout pressures and grout takes to prevent excessive heave or fracturing.

Except where indicated below, the grout may be placed above the top of the bond length at the same time as the bond length grout but may not be placed under pressure. Ensure that the grout at the top of the drill hole does not contact the back of the structure or the bottom of the trumpet.

If the prestressed soil anchor is installed in a fine-grained soil using drill holes larger than 6 inches in diameter, place the grout above the top of the bond length after testing and stressing the prestressed soil anchor. The Engineer will allow the entire drill hole to be grouted at the same time if it can be demonstrated that the particular prestressed soil anchor system does not derive a significant portion of its load-carrying capacity from the soil above the bond length portion of the prestressed soil anchor.

If using grout protected tendons for prestressed soil anchors anchored in rock, use pressure grouting techniques. For pressure grouting, seal the drill hole, and inject grout until a 50 psi grout pressure (measured at the top of the drill hole) can be maintained on the grout for five minutes.

Upon completion of grouting, the grout tube may remain in the hole, but it must be filled with grout.

After grouting, do not load the tendon for at least three days.

Record the following data concerning the grouting operation:

(a) Type of mixer
(b) Water/cement ratio
(c) Types of additives (if any)
(d) Grout pressure
(e) Type of cement
(f) Strength test samples (if any)
(g) Volume of first and second stage grout

451-7 Prestressed Soil Anchor Testing and Stressing.

451-7.1 Criteria for Performing a Performance Test: Test each prestressed soil anchor. Perform performance tests as follows:

(a) on the first two soil anchors installed on the project prior to the grouting of any additional soil anchors. The purpose of these initial tests is to verify the Contractor's installation procedures as well as the design loads.

(b) as shown on the plans.

(c) on 10% of the prestressed soil anchors or a minimum of three, whichever is greater.

Perform creep testing as follows:

(a) as shown on the plan.

(b) on 5% of the prestressed soil anchors.

The Engineer will select the prestressed soil anchors to be performance tested and those to be creep tested and, at his discretion, may increase or decrease the number of tests.

Perform proof tests on all prestressed soil anchors, not subjected to a performance test or a creep test. Record the results of each test on forms approved by the Engineer, such as the testing forms provided in the appendix of the AASHTO/AGC/ARTBA Joint Committee Task Force 27 Report. Submit a separate form for each test. Submit the test results to the Engineer on a weekly basis within one week of testing. Do not apply a load greater than 10% of the design load to the prestressed soil anchor prior to testing. For the maximum test load, do not exceed 80% of the minimum specified ultimate tensile strength of the tendon. Simultaneously apply the test load to the entire tendon. Do not perform stressing of single elements of multi-element tendons.

Provide testing equipment that consists of:

(a) a dial gauge or vernier scale capable of measuring to 0.001 inch to measure the ground anchor movement. Use a movement-measuring device that has a minimum travel equal to the theoretical elastic elongation of the total anchor length at the maximum test load and that has adequate travel so the prestressed soil anchor movement can be measured without resetting the device.

(b) a hydraulic jack and pump to apply the test load. Use the jack, with a minimum ram travel of not less than the theoretical elastic elongation of the total anchor length at the maximum test load, and a calibrated pressure gauge, graduated in 100 psi increments or less, to measure the applied load. Ensure that the jack and pressure gauge are calibrated by an independent firm as a unit and that the calibration is performed within 45 working days of the date submitted. Obtain the Engineer's approval of the calibration before testing commences.

(c) Keep a calibrated reference pressure gauge at the site in possession of the Engineer. Ensure that the reference gauge is calibrated with the test jack and pressure gauge.

(d) Provide an electrical resistance load cell and readout to be used when performing a creep test.

(e) Place the stressing equipment over the prestressed soil anchor tendon in such a manner that the jack, bearing plates, load cells and stressing anchorage are axially aligned with the tendon and the tendon is centered within the equipment.

451-7.2 Criteria for Performing a Performance Test and a Proof Test: Raise the load from one increment to another immediately after recording the prestressed soil anchor movement. Measure and record the prestressed soil anchor movement to the nearest 0.001 inch with respect to an independent fixed reference point at the alignment load and at each increment of load. Monitor the load with a pressure gauge. At load increments other than the maximum test load, hold the load just long enough to obtain the movement reading.

Hold the maximum test load in a proof test for at least ten minutes. Repump the jack as necessary in order to maintain a constant load. Start the load-hold period as soon as the maximum test load is applied, and measure and record the prestressed soil anchor movement, with respect to an independent fixed reference, at 1, 2, 3, 4, 5, 6, and 10 minutes. If the prestressed soil anchor movement between one minute and ten minutes exceeds 0.04 inch, hold the maximum test load for an additional 50 minutes. If extending the load-hold, record the prestressed soil anchor movements at 15 minutes, 20, 25, 30, 45 and 60 minutes.

451-7.2.1 Performance Test: Place the reference pressure gauge in series with the pressure gauge during each performance test. If the load determined by the reference pressure gauge and the load determined by the pressure gauge differ by more than 10%, recalibrate the jack, pressure gauge, and reference pressure gauge at no expense to the Department.

Perform the performance test by incrementally loading and unloading the prestressed soil anchor in accordance with the following schedule:

Performance Test Schedule	
Load	Load
AL	AL
0.25DL*	0.25DL
AL	0.50DL
0.25DL	0.75DL
0.50DL*	1.00DL
AL	1.20DL*
0.25DL	AL
0.50DL	0.25DL
0.75DL*	0.50DL
AL	0.75DL
0.25DL	1.00DL
0.50DL	1.20DL
0.75DL	1.33DL*
1.00DL*	Reduce to lock-off load
AL - is the alignment load. DL - is the prestressed soil anchor design load.	

Plot the prestressed soil anchor movement versus load for each load increment marked with an asterisk (*) in the performance test schedule, and plot the residual movement of the tendon at each alignment load versus the highest previously applied load.

451-7.2.2 Proof Test: Perform the proof test by incrementally loading the prestressed soil anchor in accordance with the following schedule:

Proof Test Schedule	
Load	Load
AL	1.00DL

Proof Test Schedule	
0.25DL	1.20DL
0.50DL	1.33DL
0.75DL	Reduce to lock-off load

Compare the proof test results to the performance test results. If there is any significant variation from the performance test results, perform a performance test on the next anchor.

Plot the prestressed soil anchor movement versus load for each load increment in the proof test.

451-7.3 Criteria for Performing a Creep Test: Perform the creep test by incrementally loading and unloading the prestressed soil anchor in accordance with the performance test schedule given above. At the end of each loading cycle, hold the load constant for the observation period indicated in the creep test schedule below. Use the following times for reading and recording the prestressed soil anchor movement during each observation period: 1, 2, 3, 4, 5, 6, 10, 15, 20, 25, 30, 45, 60, 75, 90, 100, 120, 150, 180, 210, 240, 270, and 300 minutes as appropriate. Start each load-hold period as soon as applying the test load. In a creep test, use the pressure gauge and reference pressure gauge to measure the applied load, and use the load cell to monitor small changes in load during a constant load-hold period. Re-pump the jack as necessary in order to maintain a constant load.

Plot the prestressed soil anchor movement and the residual movement measured in a creep test as described for the performance test above, and plot the creep movement for each load-hold as a function of the logarithm of time.

Creep Test Schedule	
Load	Observation Period (minutes.)
AL	
0.25DL	10
0.50DL	30
0.75DL	30
1.00DL	45
1.20AL	60
1.33DL	300

451-7.4 Lock-Off: Upon satisfactory completion of all testing, reduce the load to the lock-off load, and transfer the load to the anchorage device. Use a lock-off load that is 80% of the prestressed soil anchor design load. The Contractor may completely unload the prestressed soil anchor prior to lock-off. After transferring the load and prior to removing the jack, take a lift-off reading. Use a lift-off reading that is within 10% of the specified lock-off load. If the load is not within 10% of the specified lock-off load, reset the anchorage, and take another lift-off reading. Repeat this process until obtaining the desired lock-off load.

451-7.5 Cutting of Tendon Protrusions: After an anchor has been accepted by the Engineer, saw cut the portion of the anchor tendon extending beyond the anchorage. Take care not to damage the tendon or the tendon anchorage.

451-7.6 Prestressed Soil Anchor Load Test Acceptance Criteria: The Engineer will accept a performance or proof-tested prestressed soil anchor with a ten minute load hold if the:

(a) prestressed soil anchor carries the maximum test load with less than 0.04 inch of movement between one minute and ten minutes; and

(b) total movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.

The Engineer will accept a performance or proof-tested prestressed soil anchor with a 60 minute load hold if the:

(a) prestressed soil anchor carries the maximum test load with a creep rate that does not exceed 0.08 inch/log cycle of time; and

(b) total movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.

The Engineer will accept a creep tested prestressed soil anchor if the:

(a) prestressed soil anchor carries the maximum test load with a creep rate that does not exceed 0.08 inch/log cycle of time; and

(b) total movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.

If the total movement of the prestressed soil anchors at the maximum test load does not exceed 80% of the theoretical elastic elongation of the unbonded length, replace the prestressed soil anchor at no cost to the Department.

Incorporate prestressed soil anchors which have a creep rate greater than 0.08 inch/log cycle of time in the finished work at a load equal to one-half its failure load. The failure load is the load carried by the prestressed soil anchor after the load has been allowed to stabilize for ten minutes.

When a prestressed soil anchor does not satisfy the load test acceptance criteria, the Contractor may modify the design and/or the construction procedures. These modifications may include, but are not limited to, installing replacement prestressed soil anchors, reducing the design load by increasing the number of prestressed soil anchors, modifying the installation methods, increasing the bond length or changing the prestressed soil anchor type. Obtain the Engineer's approval prior to making any modification which requires changes to the structure. Perform any modifications at no additional cost to the Department. The Department will not allow additional Contract Time for modifications. The Engineer will not allow retesting of the failed prestressed soil anchor.

451-8 Corrosion Protection (not applicable for temporary anchors).

451-8.1 General: Protect prestressed soil anchors against corrosion using materials and procedures described herein. The following materials may be used independently or in various combinations:

(a) Portland cement grout.

(b) Plastic pipe or tubing.

(c) Steel pipe or tubing.

(d) Greases specially compounded for post-tensioning.

(e) Bitumens.

(f) Heat shrinkable polyethylene tubing.

Use corrosion protection materials with properties that are not detrimental to the prestressing steel and that prevent the intrusion of corrosive environments. Use coating materials that also have the following properties:

(a) Free from cracks and not brittle or fluid over the entire anticipated range of temperature.

(b) Chemically stable for the life of the tendon.

(c) Nonreactive with the surrounding materials such as concrete, tendons, or sheathing.

(d) Corrosion-inhibiting.

(e) Impervious to moisture.

When acidic water can enter the bore hole during the period subsequent to the drilling and flushing operation and prior to tendon insertion and grouting, introduce chemical additives for neutralizing purposes. A minimum pH of 9.0 is generally considered acceptable when the prestressing steel is in contact with this water. During prolonged periods, monitor the pH at regular intervals, and add additional neutralization as required. Concentrated sodium hydroxide and calcium hydroxide have proven effective for this purpose.

451-8.2 Protection Systems:

451-8.2.1 Bond Length:

(a) When the plans require grout protected prestressed soil anchor tendons, meet the following requirements:

1. Provide corrosion protection of the tendon bond length by the cement grout cover.

2. Use spacers along the tendon bond length of multi-element tendons to separate each of the individual elements of the tendon so the prestressing steel will bond to the grout. Position spacers so their center to center spacing does not exceed 10 feet. In addition, locate the upper spacer a maximum of 5 feet from the top of the tendon bond length, and locate the lower spacer a maximum of 5 feet from the bottom of the tendon bond length.

3. Use centralizers to ensure a minimum of 0.5 inch of grout cover over the tendon bond length. Position centralizers so their center to center spacing does not exceed 10 feet. In addition, locate the upper centralizer a maximum of 5 feet from the top of the tendon bond length, and locate the lower centralizer a maximum of 12 inches from the bottom of the tendon bond length.

4. The Engineer will not require centralizers on pressure-injected prestressed soil anchor tendons if the prestressed soil anchor is installed in coarse-grained soils using grouting pressures greater than 150 psi.

5. The Engineer will not require centralizers on hollow-stem-augured prestressed soil anchor tendons if the prestressed soil anchor is grouted through the auger and the hole is maintained full of a stiff grout, (9 inch slump or less) during extraction of the auger.

(b) When the plans require the tendon bond length to be encapsulated:

1. Protect the tendon bond length portion of the tendon against corrosion by encapsulating the tendon in a grout-filled corrugated plastic or deformed steel tube. Grout the tendon inside the encapsulation prior to inserting the tendon in the drill hole or after the tendon has been placed in the drill hole. Mix expansive admixtures with the encapsulation grout if the tendon is grouted inside the encapsulation prior to inserting it in the drill hole. Centralize the tendon within the tendon bond length encapsulation with a minimum of 0.10 inch of grout cover. Use spacers along the tendon bond length of multi-element tendons to separate the elements of the tendon so the prestressing steel will bond to the encapsulation grout.

2. Use centralizers to provide a minimum of 0.5 inch of grout cover over the tendon bond length encapsulation. Position centralizers so their center to center spacing does not exceed 10 feet. In addition, locate the upper centralizer a maximum of 5 feet from the top of the tendon bond length, and locate the lower centralizer a maximum of 12 inches from the bottom of the tendon bond length.

3. The Engineer will not require centralizers on encapsulated, pressure-injected prestressed soil anchor tendons if the prestressed soil anchor is installed in coarse-grained soils using grouting pressures greater than 150 psi.

4. The Engineer will not require centralizers on encapsulated, hollow-stem-augured prestressed soil anchor tendons if the prestressed soil anchor is grouted through the auger and the hole is maintained full of a stiff grout (9 inch slump or less) during extraction of the auger.

451-8.2.2 Unbonded Length: For the minimum unbonded length of the tendon, use 15 feet or as indicated on the plans or the approved Shop Drawings, whichever is greater.

If grouting the entire drill hole (tendon bond length and unbonded length) in one operation, provide the corrosion protection of the unbonded length by a sheath completely filled with corrosion inhibiting grease or grout, or a heat shrinkable tube internally coated with an elastic adhesive. If using grease under the sheath, make provisions to prevent the grease from escaping at the ends of the sheath. With grease, completely coat the tendon, fill the void between the tendon and the sheath, and fill the interstices between the wires of the seven-wire strands. Ensure that the Shop Drawings show how to provide a transition between the bond length and the unbonded length corrosion protection. If the sheath is grout filled, provide a separate bondbreaker that prevents the tendon from bonding to the grout surrounding the unbonded length.

If providing grease-filled sheath corrosion protection and the drill hole above the bond length is grouted after locking off the prestressed soil anchor, grout the tendon inside a second sheath.

451-8.2.3 Anchorage and Trumpet: Use non-restressable anchorage devices except where indicated on the plans. Provide restressable anchorages on those prestressed soil anchors designated as restressable on the plans. Ensure that the post-tensioning supplier provides a restressable anchorage compatible with the post-tensioning system provided along with written recommendations concerning the restressing of the tendons.

If using strand tendons, provide written recommendations from the post-tensioning supplier for seating the wedges. Include with the recommendations the minimum load required to properly seat the wedges in the anchor head.

Size the bearing plates so that:

(a) the bending stresses in the plate do not exceed the yield strength of the steel when applying a load equal to 95% of the minimum specified ultimate tensile strength of the tendon; and

(b) the average bearing stress on the concrete does not exceed that recommended in Section 3.1.7 of the Post Tensioning Institute Guide Specification for Post-Tensioning Materials.

Weld the trumpet to the bearing plate. Provide a trumpet that has an inside diameter equal to or larger than the hole in the bearing plate. Ensure that the trumpet is long enough to accommodate movements of the structure during testing and stressing. For strand tendons with encapsulation over the unbonded length, provide a trumpet that is long enough to enable the tendon to make a transition from the diameter of the tendon in the unbonded length to the diameter of the tendon at the anchor head without damaging the encapsulation. Ensure that trumpets filled with corrosion-inhibiting grease have a permanent Buna-N synthetic rubber or approved equal seal provided between the trumpet and the unbonded length corrosion protection. Ensure that trumpets filled with grout have a temporary seal provided between the trumpet and the unbonded length corrosion protection or that the trumpet overlaps the unbonded length corrosion protection by a minimum of 12 inches and fits tightly over the unbonded length corrosion protection.

451-9 Submittals.

Prepare and submit to the Engineer for review and approval Shop Drawings and a design submission describing the prestressed soil anchor system or systems intended for use. Submit the Shop Drawings and design submission 30 working days prior to the commencement of the prestressed soil anchor work. Include the following in the Shop Drawings and design submission:

(a) A prestressed soil anchor schedule giving:

1. Prestressed soil anchor number;
2. Prestressed soil anchor design load;
3. Type and size of tendon;
4. Minimum total anchor length;
5. Minimum bond length;
6. Minimum tendon bond length; and
7. Minimum unbonded length.

(b) A drawing of the prestressed soil anchor tendon and the corrosion protection system. Include details for the following:

1. Spacers and their location;
2. Centralizers and their location;
3. Unbonded length corrosion protection system;
4. Bond length corrosion protection system;
5. Anchorage and trumpet; and

6. Anchorage corrosion protection system.

(c) Certificates of Compliance for the following materials, if used, stating that the material or assemblies to be provided will fully comply with the requirements of the Contract.

1. Prestressing steel, strand or bar;
2. Portland cement;
3. Prestressing hardware;
4. Bearing plates; and
5. Corrosion protection system.

The Engineer will approve or reject the Shop Drawings and design submission within 30 working days after receipt of the submission.

Submit to the Engineer for review and approval or rejection mill test reports for the prestressing steel and the bearing plate steel. The Engineer may require the Contractor to provide samples of any prestressed soil anchor material intended for use on the project. The Engineer will approve or reject the prestressing steel and bearing plate steel within five working days after receipt of the test reports. Do not incorporate the prestressing steel and bearing plates in the work without the Engineer's approval.

Submit to the Engineer for review and approval or rejection calibration data for each test jack, pressure gauge, and reference pressure gauge to be used. The Engineer will approve or reject the calibration data within fiveworking days after receipt of the data. Do not commence testing until the Engineer has approved the jack, pressure gauge, and reference pressure gauge calibrations.

Submit to the Engineer within 20 calendar days after completion of the prestressed soil anchor work a report containing:

(a) Prestressing steel manufacturer's mill test reports for the tendons incorporated in the installation;

(b) grouting records indicating the cement type, quantity injected, and the grout pressures; and

(c) prestressed soil anchors test results and graphs.

451-10 Tendon Storage and Handling.

Handle and store tendons in a manner to avoid damage or corrosion. The Engineer will consider damage to the prestressing steel as a result of abrasions, cuts, nicks, welds and weld splatter cause for rejection. Protect the prestressing steel if performing welding in the vicinity. Do not ground welding leads to the prestressing steel. Protect prestressing steel from dirt, rust, or deleterious substances.

The Engineer will allow a light coating of rust on the steel. If heavy corrosion or pitting is noted, the Engineer will reject the affected tendons.

Use care in handling and storing the tendons at the site. Prior to inserting a tendon in the drill hole, examine the tendon for damage to the encapsulation and the sheathing. If, in the opinion of the Engineer, the encapsulation is damaged, repair the encapsulation in accordance with the tendon supplier's recommendations. If, in the opinion of the Engineer, the smooth sheathing has been damaged, repair it with ultra high molecular weight polyethylene tape.

Spiral wind the tape around the tendon to completely seal the damaged area at a pitch that ensures a double thickness at all points.

451-11 Method of Measurement.

Unless otherwise shown on the plans, the quantity to be paid for will be the number of prestressed soil anchors, installed and accepted. For prestressed soil anchors that do not meet the acceptance criteria, the original prestressed soil anchor and any required additional work or prestressed soil anchors will be, in sum, considered to be one prestressed soil anchor for payment purposes.

451-12 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including furnishing the materials necessary to complete the anchors in place and accepted. The quantity of performance and creep tests to be paid for will be the number of tests performed on accepted anchors.

The cost of proof testing will be included in Item No. 451-70.

No payment will be made for tests performed on unaccepted anchors.

Payment will be made under:

Item No. 451- 70-	Prestressed Soil Anchors - each.
Item No. 451- 70-1	Prestressed Soil Anchor (Performance Tests) - each.
Item No. 451- 70-2	Prestressed Soil Anchors (Creep Tests) - each.

SECTION 455
STRUCTURES FOUNDATIONS

Index

A. GENERAL

455-1 General Requirement.

The Contractor may examine available soil samples and/or rock cores obtained during the soil boring operations at the appropriate District Materials Office.

455-1.1 Protection of Existing Structures: When the plans require foundation construction operations in close proximity to existing structures, take all reasonable precautions to prevent damage to such structures. The requirements described herein apply to all types of structures (on or off the right-

of-way) that may be adversely affected by foundation construction operations (including phase construction) due to vibrations, ground loss, ground heave, or dewatering. Protect utilities as described in-the applicable provisions of Section 7.

Monitor structures for settlement in a manner approved by the Engineer, recording elevations to 0.001 foot. Monitor the following structures:

(1) shown in the plans.

(2) within a distance, in feet, of pile driving operations equal to 0.5 times the square root of the impact hammer energy, in foot-pounds . Take required measurements before the initiation of driving and then daily on days when driving occurs or as indicated in the plans and weekly for two weeks after driving has stopped.

(3) within a distance of ten shaft diameters or the estimated depth of excavation, whichever is greater.

(4) within a distance of three times the depth of excavation for the footing.

Obtain the Engineer's approval of the number and location of monitoring points. Take elevation;

(1) before beginning construction,

(2) daily during the driving of any casings, piling, or sheeting,

(3) weekly for two weeks after stopping driving,

(4) during excavation,

(5) during blasting,

(6) or as directed by the Engineer.

Notify the Engineer of any movements detected and immediately take any remedial measures required to prevent damage to the existing structures.

Employ a qualified Specialty Engineer to survey all structures, or portions thereof, within:

(1) a distance, in feet, of pile driving operations equal to 0.25 times the square root of the impact hammer energy, in foot-pounds

(2) a distance of ten shaft diameters or the estimated depth of excavation, whichever is greater

(3) three times the excavation depth for footings and caps

(4) or as shown in the plans

The Department will make the necessary arrangements to provide right-of-way entry for the Contractor's engineer to survey. Adequately document the condition of the structures and all existing cracks with descriptions and pictures. Prepare two reports documenting the condition of the structures: one report before beginning foundation construction operations and a second report after completing foundation construction operations. The Department will take ownership of both reports. Do not perform pre-driving and post-driving surveys of the condition of bridges owned by the Department except when shown in the Contract Documents.

When shown in the Contract Documents, employ a qualified Specialty Engineer to monitor and record vibration levels during the driving of casings, piling, sheeting, or blasting operations. Provide vibration monitoring equipment capable of detecting velocities of 0.1 in/s or less.

Upon detecting settlement or heave of 0.005 foot, vibration levels reaching 0.5 in/s, levels otherwise shown in the Contract Documents, or damage to the structure, immediately stop the source of vibrations, backfill any open drilled shaft excavations, and contact the Engineer for instructions.

When the plans require excavations for construction of footings or caps, the Contractor is responsible for evaluating the need for, design of, and providing any necessary features to protect adjacent structures. When sheeting and shoring are not detailed in the plans, employ a Specialty Engineer to design the sheeting and shoring, and to sign and seal the plans and specification requirements. Send these designs to the Engineer for his record before beginning construction.

When shown in the Contract Documents or when authorized by the Engineer, install the piling to the depth required to minimize the effects of vibrations or ground heave on adjacent structures by approved methods other than driving (preformed holes, predrilling, jetting, etc.). In the event the Department authorizes the use of preformed pile holes to meet this requirement, the Department will pay for this work as described in 455-5.9.3.

If not otherwise provided in the plans, the Contractor is responsible for evaluating the need for, design of, and providing all reasonable precautionary features to prevent damage, including, but not limited to, selecting construction methods and procedures that will prevent damaging caving of the shaft excavation and monitoring and controlling the vibrations from construction activities, including driving of casings, driving of sheeting, and blasting.

When shown in the plans or directed by the Engineer, install a piezometer near the right-of-way line and near any structure that may be affected by lowering the ground water when dewatering is required. Monitor the piezometer and record the ground water elevation level daily. Notify the Engineer of any ground water lowering near the structure of 12 inches or more.

455-1.2 Excavation: Complete all excavation of the foundations prior to installing piles or shafts unless otherwise authorized by the Engineer. After completing pile/shaft installation, remove all loose and displaced materials from around the piles/shafts, leaving a clean, solid surface. Compact the soil surface on which concrete is to be placed or which will support the forming system for the concrete to support the load of the plastic concrete without settling or causing the concrete to crack, or as shown in the Contract Documents. The Engineer will not require the Contractor to compact for excavations made below water for seals or when the footing or cap or forming system (including supports) does not rest on the ground surface.

455-1.2.1 Abutment (End Bent) Fill: Place and compact the fill before installing end-bent piling/shafts, except when:

(1) driving specified test piling in end bents or,

(2) the plans show uncased piles through proprietary retaining wall fills.

When installing piles/shafts or casing prior to placing fill, take necessary precautions to prevent displacement of piles/shafts during placing and compacting fill materials within 15 feet of the piles/shafts or casing. Reference and check the position of the piles/shafts or casing at three approximately equal intervals during construction of the embankment.

Place embankment material in 6 inch loose lifts in the 15 foot area around the piles/shafts or casing. Compact embankment material within the 15 foot area adjacent to the piles/shafts or casing to the required density with compaction equipment weighing less than 1,000 pounds. When installing piles/shafts prior to the completion of the surrounding fills, do not cap them until placing the fills as near to final grade as possible, leaving only the necessary working room for construction of the caps.

Provide permanent casings installed prior to placement of the fill, for all drilled shafts through mechanically stabilized fills (for example, behind proprietary retaining walls) for shafts installed after fill placement. Install temporary casings through the completed conventional fill when permanent casings are not required.

Provide permanent casings, if required, before the fill is placed extending a sufficient distance into the existing ground to provide stability to the casings during construction of the abutment fill.

455-1.3 Cofferdams: Construct cofferdams as detailed in the plans. When cofferdams are not detailed in the plans, employ a Specialty Engineer to design cofferdams, and to sign and seal the plans and specification requirements. Send the designs to the Engineer for his records before beginning construction.

Provide a qualified diver and a safety diver to inspect the conditions of the foundation enclosure or cofferdam when the Contract Documents require a seal for construction. Equip these divers with suitable voice communications, and have them inspect the foundation enclosure and cofferdam periphery including each sheeting indentation and around each piling or drilled shaft to ensure that no layers of mud or other undesirable materials were left above the bottom of seal elevation during the excavation process. Also have the divers check to make sure the surfaces of the piles or drilled shafts are sufficiently clean to allow bond of the concrete down to the minimum bottom of seal elevation. When required, ensure that there are no mounds of stone, shell, or other authorized backfill material left after placement and grading. Assist the Engineer as required to ensure that the seal is placed as specified and evaluate the adequacy of the foundation soils or rock. Correct any deficiencies found by the divers. Upon completion of inspection by the divers, the Department may also elect to inspect the work before authorizing the Contractor to proceed with subsequent construction operations. Furnish the Engineer a written report by the divers indicating the results of their underwater inspection before requesting authorization to place the seal concrete.

455-1.4 Vibrations on Freshly Placed Concrete (Drilled Shafts and Piers): Ensure that freshly placed concrete is not subjected to vibrations greater than 1.5 in/sec from pile driving and/or drilled shaft casing installation sources located within the greater dimension of three shaft diameters (measured from the perimeter of the shaft closest to the vibration source) or 30 feet (from the nearest outside edge of freshly placed concrete to the vibration source) until that concrete has attained its final set as defined by ASTM C-403 except as required to remove temporary casings before the drilled shaft elapsed time has expired.

455-2 Static Compression Load Tests.

455-2.1 General: Employ a professional testing laboratory, or Specialty Engineer with prior load test experience on at least three projects, to conduct the load test in compliance with these Specifications, to record all data, and to furnish reports of the test results to the Engineer except when the Contract Documents show that the Department will supply a Geotechnical Engineer to provide these services.

Perform the load test by applying a load up to the load required in the Contract Documents or to the failure load, whichever occurs first.

Do not apply test loads to piles sooner than 48 hours (or the time interval shown in the plans) after driving of the test pile or reaction piles, whichever occurs last.

Allow up to four weeks after the last load test for the analysis of the load test data and to provide all the estimated production tip elevations. If the Contractor is willing to construct production foundation elements in areas designated by the Engineer, tip elevations will be determined in these areas beginning seven days after the receipt of the load test data which represents the designated area.

Do not begin static load testing of drilled shafts until the concrete has attained a compressive strength of 3,400 psi. The Contractor may use high early strength concrete to obtain this strength at an earlier time to prevent testing delays.

Load test piles/shafts in the order directed by the Engineer. The Department will furnish certain load test equipment and/or personnel when shown in the plans. Inspect all equipment to be furnished by the Department at least 30 days prior to use, and notify the Engineer of any equipment that is not in satisfactory operating condition. The Department will consider any necessary repairs ordered by the Engineer to place the equipment in satisfactory operating condition as Unforeseeable Work. Provide the remainder of the equipment and personnel needed to conduct the load tests. Unless shown otherwise in the Contract Documents, provide all equipment, materials, labor, and technical personnel required to conduct the load tests, including determination of anchor reaction member depths. In this case, provide a loading apparatus designed to accommodate the maximum load plus an adequate safety factor.

While performing the load test, provide safety equipment, and employ safety procedures consistent with the latest approved practices for this work. Include with these safety procedures adequate support for the load test plates and jack to prevent them from falling in the event of a release of load due to hydraulic failure, test pile/shaft failure, or any other cause.

Include in the bid the cost of transporting load test equipment and instrumentation supplied by the Department from their storage location to the job site and back. Handle these items with care. The Contractor is responsible for the safe return of these items. After completion of the static load tests, return all Department furnished equipment in satisfactory operating condition. Repair all damage to the test equipment furnished by the Department to the satisfaction of the Engineer. Clean all areas of rust on structural steel items, and recoat those

areas in accordance with Section 560. Return all load test equipment supplied by the Department within 30 days after completing the load tests.

The Contractor is responsible for the equipment from the time it leaves its storage area until the time it is returned. During this time, insure the equipment against loss or damage for the replacement cost thereof (the greater of $150,000 or the amount shown in the plans) or for the full insurable value if replacement cost insurance is not available.

Notify the Engineer at the preconstruction conference or no later than 30 days before beginning test pile installation of the proposed testing schedule so that items supplied by the Department may be reserved. Notify the Department at least ten working days before pick-up or return of the equipment. During pick-up, the Department will complete a checklist of all equipment placed in the Contractor's possession. The Department will later use this checklist to verify that the Contractor has returned all equipment. Provide personnel and equipment to load or unload the equipment at the Department's storage location. Provide lifting tongs or nylon slings to handle Department owned test girders. Do not perform cutting, welding, or drilling on Department owned girders, jacks, load cells, or other equipment.

455-2.2 Loading Apparatus: Provide an apparatus for applying the vertical loads as described in one of the following:

(1) As shown and described in the Contract Documents.

(2) As supplied by the Contractor, one of the following devices designed to accommodate a load at least 20% higher than that shown in the Contract Documents or described herein for test loads:

(a) Load Applied by Hydraulic Jack Acting Against Weighted Box or Platform: Construct a test box or test platform, resting on a suitable support, over the pile, and load it with earth, sand, concrete, pig iron, or other suitable material with a total weight greater than the anticipated maximum test load. Locate supports for the weighted box or platform at least 6 feet or three pile/shaft diameters, whichever is greater, measured from the edge of the pile or shaft to the edge of the supports. Insert a hydraulic jack with pressure gauge between the test pile or shaft and the underside of the reaction beam, and apply the load to the pile or shaft by operating the jack between the reaction beam and the top of the pile or shaft.

(b) Load Applied to the Test Pile or Shaft by Hydraulic Jack Acting Against Anchored Reaction Member: Construct reaction member anchorages as far from the test piles/shafts as practical, but in no case closer than the greater of 3 pile/shaft diameters or 6 feet from the edge of the test pile/shaft. Attach a girder(s) of sufficient strength to act as a reaction beam to the upper ends of the anchor piles or shafts. Insert a hydraulic jack with pressure gauges between the head of the test pile/shaft and the underside of the reaction beam, and apply the test load to the pile/shaft by operating the jack between the reaction beam and the pile/shaft head.

If using drilled shafts with bells as reaction member anchorages, locate the top of the bell of any reaction shaft anchorage at least three shaft diameters below the bottom of the test shaft.

(c) Combination Devices: The Contractor may use a combination of devices (a) and (b), as described above, to apply the test load to the pile or shaft.

(d) Other Systems Proposed by the Contractor and Approved by the Engineer: When necessary, provide horizontal supports for loading the pile/shaft, and space them so that the ratio of the unsupported length to the minimum radius of gyration of the pile does not exceed 120 for steel piles, and the unsupported length to the least cross-section dimension does not exceed 20 for concrete piles or drilled shafts. Ensure that horizontal supports provide full support without restraining the vertical movement of the pile in any way.

When required by the Contract Documents, apply a horizontal load to the shaft either separately or in conjunction with the vertical load. Apply the load to the test shaft by hydraulic jacks, jacking against Contractor provided reaction devices. After receiving the Engineer's approval of the proposed method of load application, apply the horizontal load in increments, and relieve it in decrements as required by the Contract Documents.

455-2.2.1 Modified Quick Test:

(a) Loading Procedure: Apply vertical loads concentric with the longitudinal axis of the tested pile/shaft to accurately determine and control the load acting on the pile/shaft at any time. Place the load on the pile/shaft continuously, in increments equal to approximately 5% of the maximum test load specified until approaching the failure load, as indicated by the measuring apparatus and/or instruments. Then, apply increments of approximately 2.5% until the pile/shaft "plunges" or attains the limiting load. The Engineer may elect to stop the loading increments when he determines the Contractor has met the failure criteria or when a settlement equal to 10% of the pile/shaft width or diameter is reached. Apply each load increment immediately after taking and verifying the complete set of readings from all gauges and instruments. Apply each increment of load within the minimum length of time practical, and immediately take the readings. Complete the addition of a load increment and the completion of the readings within five to 15 minutes. The Engineer may elect to hold the maximum applied load up to one hour.

Remove the load in decrements of about 10% of the maximum test load. Remove each decrement of load within the minimum length of time practical, and immediately take the readings. Complete the removal of a load decrement and the taking of the readings within five to 15 minutes. The Engineer may also require up to two reloading cycles with five loading increments and three unloading decrements. Record the final recovery of the pile/shaft until movement is essentially complete for a period up to one hour after the last unload interval.

(b) Failure Criteria and Nominal Resistance: Use the criteria described herein to establish the failure load. The failure load is defined as the load that causes a pile/shaft top deflection equal to the calculated elastic compression plus 0.15 inch plus 1/120 of the pile/shaft minimum width or the diameter in inches for piles/shafts 24 inches or less in width, and equal to the calculated elastic compression plus 1/30 of the pile/shaft minimum width or diameter for piles/shafts greater than 24 inches in width. Consider the nominal resistance of

any pile/shaft so tested as either the maximum applied load or the failure load, whichever is smaller.

455-2.3 Measuring Apparatus: Provide an apparatus for measuring movement of the test piles/shafts that consists of all of the following devices:

(1) Wire Line and Scale: Stretch a wire as directed by the Engineer between two supports located at a distance at least:

(a) 10 feet from the center of the test pile but not less than 3.5 times the pile diameter or width.

(b) 12 feet from the centerline of the shaft to be tested but not less than three shaft diameters.

Locate the wire supports as far as practical from reaction beam anchorages. At over-water test sites, the Contractor may attach the wire line as directed by the Engineer to the sides of the service platform. Mount the wire with a pulley on one support and a weight at the end of the wire to provide constant tension on the wire. Ensure that the wire passes across the face of a scale mounted on a mirror attached to the test pile/shaft so that readings can be made directly from the scale. Use the scale readings as a check on an average of the dial readings. When measuring both horizontal and vertical movement, mount separate wires to indicate each movement, horizontal or vertical. Measure horizontal movements from two reference wires set normal to each other in a horizontal.

(2) Wooden Reference Beams and Dial Gauges: Attach wooden reference beams as detailed in the plans or approved by the Engineer to independent supports. For piles, install the greater of 3.5 times the pile diameter or width or 10 feet from the centerline of the test pile. For drilled shafts install at the greater of three shaft diameters or 12 feet from the centerline of the shaft to be tested. Locate the reference beam supports as far as practical from reaction beam anchorages. For over-water test sites, the Contractor may attach the reference beams as directed by the Engineer between two diagonal platform supports. Attach dial gauges, with their stems resting either on the top of the pile/shaft or on lugs or similar reference points on the pile/shaft, to the fixed beams to record the movement of the pile/shaft head. Ensure that the area on the pile/shaft or lug on which the stem bears is a smooth surface which will not cause irregularities in the dial readings.

For piles, the minimum acceptable method for measuring vertical movement is two dial gauges, each with 0.001 inch divisions and with 2 inch minimum travel, placed at 180 degrees or at the diagonal corners of the pile.

For shafts, ensure that three dial gauges, each with 0.001 inch divisions and with 2 inch minimum travel, placed at 120 degree intervals around the shaft, are the minimum acceptable method for measuring vertical movement. Ensure that four dial gauges, each with 0.001 inch divisions and with 2 inch minimum travel, placed at 90 degree intervals are the minimum required for measuring horizontal movement.

(3) Survey Level: As a check on the dial gauges, determine the elevation of a point near the top of the test pile/shaft (on plan datum) by survey level at each load and unload interval during the load test. Unless approved otherwise by the Engineer, level survey precision is 0.001 foot. Alternately, the surveyor may

read an engineer's 50 scale attached near the pile/shaft head. Determine the first elevation before applying the first load increment; make intermediate readings immediately before a load increment or an unload decrement, and after the final unload decrement that completely removes the load. Make a final reading at the time of the last recovery reading or as directed by the Engineer.

For over-water test sites, when shown in the plans or directed by the Engineer, the Contractor shall drive an H pile through a 36 inch casing to provide a stable support for the level and to protect it against wave action interfering with level measurements. Provide a suitable movable jig for the surveyor to stand. Use a jig that has a minimum of three legs, has a work platform providing at least 4 feet width of work area around the casing, and is approved by the Engineer before use. The described work platform may be supported by the protective casing when approved by the Engineer.

455-2.4 Load Test Instrumentation:

(1) General: The intent of the load test instrumentation is to measure the test load on top of the pile/shaft and, when provided in the Contract Documents, its distribution between side friction and end bearing to provide evaluation of the preliminary design calculations and settlement estimates and to provide information for final pile/shaft length design. Ensure that the instrumentation is as described in the Contract Documents.

When requested by the Engineer, provide assistance during installation of any instrumentation supplied by the Department. Supply 110 V, 60 Hz, 30 A of AC electric power in accordance with the National Electric Code to each test pile/shaft site during the installation of the instrumentation, during the load testing, and during any instrumented redrives ordered by the Engineer.

Place all of the internal instrumentation on the rebar cage before installation in the test shaft. Construct the rebar cage at least two days before it is required for construction of the test shaft. Provide assistance during installation of instrumentation supplied by the Department, including help to string, place, and tie the instrumentation and any assistance needed in moving or repositioning the cage to facilitate installation. Place the rebar cage in one segment complete with its instrumentation. The Engineer may require multiple lift points and/or a suitable "stiffleg" (length of H pile or other suitable section) to get the cage in a vertical position without causing damage to the instrumentation. Successfully demonstrate the lifting and handling procedures before the installing instrumentation.

(2) Hydraulic Jack and Load Cell: Provide hydraulic jack(s) of adequate size to deliver the required test load to the pile/shaft unless shown otherwise in the plans. Before load testing begins, furnish a certificate from a reputable testing laboratory showing a calibration of gauge readings for all stages of jack loading and unloading for jacks provided. Ensure that the jack has been calibrated within the preceding six months unless approved otherwise. Recalibrate the jack after completing load testing if so directed by the Engineer. Ensure that the accuracy of the gauge is within 5% of the true load.

Provide an adequate load cell approved by the Engineer that has been calibrated within the preceding six months. Provide an approved electrical readout device for the load cell. Before beginning load testing, furnish a

certificate from a reputable testing laboratory showing a calibration of readings for all stages of loading and unloading for load cells furnished by the Contractor. Ensure that the accuracy of the load cell is within 1% of the true load.

If the Department supplies the Contractor with the jack and/or load cell, have the equipment calibrated and include the cost in the cost for static load test.

(3) Telltales: When shown in the Contract Documents, provide telltales that consist of an unstressed steel rod placed, with appropriate clearance and greased for reducing friction and corrosion, inside a constant-diameter pipe that rests on a flat plate attached to the end of the pipe at a point of interest shown in the plans. Construct telltales in accordance with details shown in the Contract Documents. Install dial gauges reading to 0.001 inch with 1 inch minimum travel as directed by the Engineer to measure the movement of the telltale with respect to the top of the pile/shaft.

(4) Embedded Strain Gauges: When shown in the Contract Documents, provide strain gauges which shall be placed in the test shaft to measure the distribution of the load. Ensure that the type, number, and location of the strain gauges are as shown in the plans or as directed by the Engineer. Use strain gauges that are waterproof and have suitable shielded cable that is unspliced within the shaft.

455-2.5 Support Facilities: Furnish adequate facilities for making load and settlement readings 24 hours per day. Provide such facilities for the instrumented area, and include lighting and shelter from rain, wind, and direct sunlight.

455-2.6 Load Test Personnel Furnished by the Contractor: Provide a certified welder, together with necessary cutting and welding equipment, to assist with the load test setup and to make any necessary adjustments during the load test. Provide personnel to operate the jack, generators, and lighting equipment, and also provide one person with transportation to assist as required during load test setup and conducting of the load tests. Provide qualified personnel, as determined by Specialty Engineer or testing lab, required to read the dial gauges, take level measurements, and conduct the load test, except when the Contract Documents show that the Department will provide these personnel.

455-2.7 Cooperation by the Contractor: Cooperate with the Department, and ensure that the Department has access to all facilities necessary for observation of the conduct and the results of the test.

455-2.8 Required Reports: Submit a preliminary static load test report to the Engineer within five days after completing the load test. When the Contract Documents do not require internal instrumentation, submit the final report within ten days after completing the load test. Furnish the final report of test results for internally instrumented shafts within 30 days after completing the load test. Include in the report of the load test the following information:

(1) A tabulation of the time of, and the amount of, the load and settlement readings, and the load and recovery readings taken during the loading and unloading of the pile/shaft.

(2) A graphic representation of the test results, during loading and unloading of pile/shaft top movement as measured by the average of the dial gauge readings, from wireline readings and from level readings.

(3) A graphic representation of the test results, when using telltales, showing pile/shaft compression and pile/shaft tip movement.

(4) The estimated failure and safe loads according to the criteria described herein.

(5) Remarks concerning any unusual occurrences during the loading of the pile/shaft.

(6) The names of those making the required observations of the results of the load test, the weather conditions prevailing during the load test, and the effect of weather conditions on the load test.

(7) All supporting data including jack and load cell calibrations and certificates and other equipment requiring calibration.

(8) When the Contract Document requires internal instrumentation of the pile/shaft, furnish all of the data taken during the load test together with instrument calibration certifications. In addition, provide a report showing an analysis of the results of axial load and lateral load tests in which soil resistance along and against the pile/shaft is reported as a function of deflection.

Provide the necessary report(s) prepared by the Specialty Engineer responsible for collection and interpretation of the data, except when the Contract Documents show that the Department will provide a Geotechnical Engineer.

455-2.9 Disposition of Loading Material: After completing all load tests, clean, remove all rust and debris from Department equipment, repaint all areas having damage to the paint in accordance with Section 560, and return all load test equipment supplied by the Department to its designated storage area. Repair any structural damage to Department owned equipment to the satisfaction of the Engineer. Notify the Department at least ten working days in advance so that arrangements can be made to unload the equipment. Remove all equipment and materials, which remains the Contractor's property, from the site. Clean up and restore the site to the satisfaction of the Engineer.

455-2.10 Disposition of Tested Piles/Shafts: After completing testing, cut off the tested piles/shafts, which are not to be incorporated into the final structure, and any reaction piles/shafts at an elevation 24 inches below the finished ground surface. Take ownership of the cut-offs and provide areas for their disposal.

B. PILING

455-3 Description.

Furnish and install concrete, steel, or wood piling including driving, jetting, preformed pile holes, cutting off, splicing, dynamic load testing, and static load testing of piling.

455-4 Classification.

The Department classifies piling as follows:

(1) Treated timber piling.

(2) Prestressed concrete piling.

(3) Steel piling.

(4) Test piling.

(5) Sheet piling.

(a) Concrete sheet piling.

(b) Steel sheet piling.

(6) Fiberglass Structurally Reinforced Composite Piles (see Section 973 for material requirements).

455-5 General Requirements.

455-5.1 Site Preparation:

455-5.1.1 Predrilling of Pile Holes: Predrilled pile holes are either starter holes to the depth described in this section or holes drilled through embankment/fill material down to the natural ground surface. When using low displacement steel piling such as structural shapes, drive them through the compacted fill without the necessity of drilling holes through the fill except when the requirements for predrilling are shown in the plans. When using concrete or other high displacement piles, drill pile holes through fill, new or existing, to at least the elevation of the natural ground surface. Use the range of drill diameters listed below for square concrete piles.

12 inch square piles..... 15 to 17 inches
14 inch square piles..... 18 to 20 inches
18 inch square piles..... 22 to 26 inches
20 inch square piles..... 24 to 29 inches
24 inch square piles..... 30 to 34 inches
30 inch square piles..... 36 to 43 inches

For other pile sizes, use the diameter of the drills shown in the plans or approved by the Engineer. Accurately drill the pile holes with the hole centered over the plan location of the piling. Maintain the location and vertical alignment within the tolerances allowed for the piling.

For predrilled holes required through rock or other hard (i.e. debris, obstructions, etc.) materials that may damage the pile during installation, predrill hole diameters approximately 2 inches larger than the largest dimension across the pile cross-section. Fill the annular space around the piles as described in 455-5.9.1 with clean A-3 sand or sand meeting the requirements of 902-3.3.

In the setting of permanent and test piling, the Contractor may initially pre-drill holes to a depth up to 10 feet or 20% of the pile length whichever is greater, except that, where installing piles in compacted fill, pre-drill the holes to the elevation of the natural ground surface. With prior written authorization from the Engineer, the Contractor may pre-drill holes to greater depths to minimize the effects of vibrations on existing structures adjacent to the work and/or for other reasons the Contractor proposes. Perform such work the Engineer allows but does not require at no expense to the Department. When the Engineer requires such work, the Department will pay for such work as Preformed Pile Holes as described in 455-5.9.

455-5.1.2 Underwater Driving: Underwater driving is defined as any driving through water which is above the pile head at the time of driving.

When conducting underwater driving, provide a diver equipped with voice communications to aid in placing the hammer back on the pile for required cushion changes or for subsequent re-driving, to attach or recover

instrumentation the Engineer is using, to inspect the condition of the pile, or for other assistance as required.

Select one of the following methods for underwater driving:

(a) Accomplish underwater driving using conventional driving equipment and piling longer than authorized so that the piling will extend above the water surface during final driving. When choosing this option, furnish a pile hammer that satisfies the requirements of this Section for use with the longer pile.

(b) Accomplish underwater driving using an underwater hammer that meets the requirements of this Section and is approved by the Engineer. When choosing this option, provide at least one pile longer than authorized at each pile group, extending above the water surface at final driving. At each group location, drive the longer pile first. The Engineer will evaluate the adequacy of the underwater driving system. The Engineer may use the pile tip elevation of the longer pile that the Contractor has driven and the Engineer has accepted, to evaluate the acceptability of the piles driven with the underwater hammer.

(c) Accomplish underwater driving using conventional driving equipment with a suitable approved pile follower. When choosing this option, provide at least one pile longer than required at each pile group, extending above the water surface at final driving. At each group location, drive the full length pile first without using the follower. The Engineer will evaluate the adequacy of the follower used for underwater driving. The Engineer may choose to perform a dynamic load test on the first pile the Contractor drives with the follower in each group. The Engineer may use the pile tip elevation of the longer pile, that the Contractor has driven and the Engineer has accepted, to evaluate the acceptability of the piles driven with the follower.

Prior to use, submit details of the follower for the Engineer's evaluation and approval along with the information required in 455-10. Include the weight, cross-section details, stiffness, type of materials, and dimensions of the follower.

455-5.2 Pile Hammers: All equipment is subject to satisfactory field performance. Use a variable energy hammer to drive concrete piles. Hammers will be rated based on the theoretical energy of the ram at impact. Supply driving equipment which provides the required resistance at a blow count ranging from 3 blows per inch (36 blows per foot) to 10 blows per inch (120 blows per foot) at the end of initial drive, unless approved otherwise by the Engineer after satisfactory field trial. When the Engineer determines the stroke height or bounce chamber pressure readings do not adequately determine the energy of the hammer, provide and maintain a device to measure the velocity of the ram at impact. Determine the actual hammer energy in the field so that it is consistent with the hammer energy used for each bearing capacity determination. When requested, furnish to the Engineer all technical specifications and operating instructions related to hammer equipment.

455-5.2.1 Air/steam: Variable energy air/steam hammers shall be capable of providing at least two ram stroke lengths. The short ram stroke length shall be approximately half of the full stroke for hammers with strokes up to 4 feet and no more than 2 feet for hammers with maximum strokes lengths over

4 feet. Operate and maintain air/steam hammers within the manufacturer's specified ranges. Use a plant and equipment for steam and air hammers with sufficient capacity to maintain, under working conditions, the hammer, volume and pressure specified by the manufacturer. Equip the plant and equipment with accurate pressure gauges which are easily accessible to the Engineer. The Engineer will not accept final bearing on piles the Contractor drives with air/steam hammers unless the Contractor operates the hammers within 10% of the manufacturer's rated speed in blows per minute, unless otherwise authorized by the Engineer.

455-5.2.2 Diesel: Variable energy diesel hammers shall have at least three fuel settings that will produce reduced strokes. Operate and maintain diesel hammers within the manufacturer's specified ranges. Determine the rated energy of diesel hammers using measured ram stroke length multiplied by the weight of the ram for open end hammers and by methods recommended by the manufacturer for closed end hammers.

Provide the Engineer with a chart from the hammer manufacturer equating stroke and blows per minute for the open-end diesel hammer to be used. Also provide and maintain in working order for the Engineer's use an approved device to automatically determine and display ram stroke for open-end diesel hammers.

Equip closed-end (double acting) diesel hammers with a bounce chamber pressure gauge, in good working order, mounted near ground level so the Engineer can easily read. Also, provide the Engineer with a chart, calibrated to actual hammer performance within 30 days prior to initial use, equating bounce chamber pressure to either equivalent energy or stroke for the closed-end diesel hammer to be used.

455-5.2.3 Hydraulic: Variable energy hydraulic hammers shall have at least three hydraulic control settings that provide for predictable stroke control. The shortest stroke shall be a maximum of 2 feet for the driving of concrete piles. The remaining strokes shall be full stroke and approximately halfway between minimum and maximum stroke.

Determine the hammer energy according to the manufacturer's recommendations. When pressure measuring equipment is required to determine hammer energy, calibrate the pressure gauges before use.

455-5.2.4 Vibratory: Vibratory hammers of sufficient capacity (force and amplitude) may be used to drive steel sheet piles and, with approval of the Engineer, to drive steel bearing piles a sufficient distance to get the impact hammer on the pile (to stick the pile). The Engineer will determine the allowable depth of driving using the vibratory hammer based on site conditions. However, in all cases, use a power impact hammer for the last 15 feet or more of the final driving of steel bearing piles for bearing determinations after all piles in the bent/pier have been driven with a vibratory hammer. Do not use vibrating hammers to install concrete piles, or to install support or reaction piles for a load test.

455-5.3 Cushions and Pile Helmet:

455-5.3.1 Capblock: Provide a capblock (also called the hammer cushion) as recommended by the hammer manufacturer. Use commercially

manufactured capblocks constructed of durable manmade materials with uniform known properties. Do not use wood chips, wood blocks, rope, or other material which permit excessive loss of hammer energy. Do not use capblocks constructed of asbestos materials. Obtain the Engineer's approval for all proposed capblock materials and proposed thickness for use. Maintain capblocks in good condition, and change them when charred, melted, or otherwise significantly deteriorated. The Engineer will inspect the capblock before driving begins and weekly or at appropriate intervals determined by the Engineer based on field trial. Replace or repair any hammer cushion which loses more than 25% of its original thickness, in accordance with the manufacturer's instructions, before permitting further driving.

455-5.3.2 Pile Cushion: Provide a pile cushion that is adequate to protect the pile from being overstressed in compression and tension during driving. Use a pile cushion sized so that it will fully fill the lateral dimensions of the pile helmet minus one inch. Determine the thickness based upon the hammer-pile-soil system. For driving concrete piles, use a pile cushion made from pine plywood or oak lumber. Alternative materials may be used with the approval of the Engineer. Obtain the Engineer's approval for all pile cushions. Do not use materials previously soaked, saturated or treated with oil. Maintain pile cushions in good condition and change when charred, splintered, excessively compressed, or otherwise deteriorated to the point it will not protect the pile against overstressing in tension and/or compression. Protect cushions from the weather, and keep them dry. Do not soak the cushions in any liquid. Replace the pile cushion if, during the driving of any pile, the cushion is either compressed more than one-half the original thickness or begins to burn. Provide a new cushion for each pile unless approved otherwise by the Engineer after satisfactory field trial.

Reuse pile cushions in good condition to perform all set-checks and redrives. Use the same cushion to perform the set-check or redrive as was used during the initial driving, unless this cushion is unacceptable due to deterioration, in which case use a similar cushion.

455-5.3.3 Pile Helmet: Provide a pile helmet suitable for the type and size of piling being driven. Use a pile helmet deep enough to adequately contain the required thickness of pile cushion and to assist in maintaining pile-hammer alignment. Use a pile helmet that fits loosely over the pile head and is at least 1 inch larger than the pile dimensions. Use a pile helmet designed so that it will not restrain the pile from rotating.

455-5.4 Leads: Provide pile leads constructed in a manner which offers freedom of movement to the hammer and that have the strength and rigidity to hold the hammer and pile in the correct position and alignment during driving. When using followers, use leads that are long enough and suitable to maintain position and alignment of the hammer, follower, and pile throughout driving.

455-5.5 Followers: Use followers only for underwater driving. Obtain the Engineer's approval for the type of follower, when used, and the method of connection to the leads and pile. Use followers constructed of steel with an adequate cross-section to withstand driving stresses. When driving concrete piles, ensure that the cross-sectional area of the follower is at least 18% of the cross-sectional area of the pile. When driving steel piles, ensure that the cross-sectional

area of the follower is greater than or equal to the cross-sectional area of the pile. Provide a pile helmet at the lower end of the follower sized according to the requirements of 455-5.3.3. Use followers constructed that maintain the alignment of the pile, follower, and hammer and still allow the pile to be driven within the allowable tolerances. Use followers designed with guides adapted to the leads that maintain the hammer, follower, and the piles in alignment.

Use information from driving full length piles described in 455-5.1.2 compared to driving piles with the follower and/or dynamic load tests described in 455-5.13 to evaluate the adequacy of the follower and to establish the blow count criteria when using the follower.

455-5.6 Templates and Ground Elevations: Provide a fixed template, adequate to maintain the pile in proper position and alignment during driving with swinging leads or with semi-fixed leads. Where practical, place the template so that the pile can be driven to cut-off elevation before removing the template. Ensure that templates do not restrict the vertical movement of the pile.

Supply a stable reference close to the pile, which is satisfactory in the opinion of the Engineer, for determination of the pile penetration. At the time of driving piles, furnish the Engineer with elevations of the original ground and template at each pile or pile group location. Note the highest and lowest elevation at each required location and the ground elevation at all piles.

455-5.7 Water Jets: Use jet pumps, supply lines, and jet pipes that provide adequate pressure and volume of water to freely erode the soil. Do not perform jetting without prior approval by the Engineer or unless allowed by the plans.

Do not perform jetting in the embankment or for end bents. Where conditions warrant, with approval by the Engineer, perform jetting on the holes first, place the pile therein, then drive the pile to secure the last few feet of penetration. Only use one jet for pre-jetting or jetting through piles constructed with a center jet-hole. Use two jets when using external jets. When jetting and driving, position the jets slightly behind the advancing pile tip (approximately 3 feet or as approved by the Engineer). When using water jets in the driving, determine the pile bearing only from the results of driving after withdrawing the jets, except where using jets to continuously eliminate soil resistance through the scour zone, ensure that they remain in place as directed by the Engineer and operating during pile bearing determination. Where practical, perform jetting on all piles in a pile group before driving begins. When large pile groups or pile spacing and batter make this impractical, or when the plans specify a jet-drive sequence, set check a sufficient number of previously driven piles in a pile group to confirm their capacity after completing all jetting.

455-5.8 Penetration Requirements: Measure the penetration of piles from the elevation of natural ground, scour elevation shown in the plans, or the bottom of excavation, whichever is lower. When the Contract Documents show a minimum pile tip elevation or a minimum depth of penetration, drive the tip of the pile to this minimum elevation or this minimum penetration depth. In all such cases, the Engineer will accept the bearing of a pile only if the Contractor achieves the required bearing when the tip of the pile is at or below the specified minimum tip elevation or depth of penetration and below the bottom of the preformed or predrilled pile hole.

When the plans do not show a minimum depth of penetration, scour elevation, or minimum tip elevation, ensure that the required penetration is at least 10 feet into firm bearing material or at least 20 feet into soft material unless otherwise permitted by the Engineer. If a scour elevation is shown in the plans, achieve these penetrations below the scour elevation. The Engineer may accept a penetration between 15 and 20 feet when there is an accumulation of five consecutive feet or more of firm bearing material. Firm bearing material is any material offering a driving resistance greater than or equal to 30 tons/ft^2 of gross pile area as determined by the Wave Equation (455-5.11.2). Soft material is any material offering less than these resistances. The gross pile area is the actual pile tip cross-sectional area for solid concrete piles, the product of the width and depth for H piles, and the area within the outside perimeter for pipe piles and voided concrete piles.

Do not drive piles beyond practical refusal (20 blows per inch). To meet the requirements in this Subarticle, provide penetration aids, such as jetting or preformed pile holes, when piles cannot be driven to the required penetration without reaching practical refusal.

If the Contractor encounters unforeseeable, isolated obstructions that the Contractor cannot practically penetrate by driving, jetting, or preformed pile holes, and the Contractor must remove the pile to obtain the required pile penetration, the Department will pay the costs for such removal as Unforeseeable Work.

455-5.9 Preformed Pile Holes:

455-5.9.1 Description: Preformed Pile Holes serve as a penetration aid when all other pile installation methods fail to produce the desired penetration and when authorized by the Engineer to minimize the effects of vibrations on adjacent structures. Preformed Pile Holes are necessary when the presence of rock or strong strata of soils will not permit the installation of piles to the desired penetration by driving or a combination of jetting and driving, when determined necessary by the Engineer, or when authorized by the Engineer to minimize the effects of vibrations on adjacent existing structures. The Engineer may require preformed holes for any type of pile. Drive all piles installed in Preformed Pile Holes to determine that the bearing requirements have been met.

For preformed holes which are required through material that caves during driving to the extent that the preformed hole does not serve its intended purpose, case the hole from the surface through caving material. After installing the pile to the bottom of the preformed hole, remove the casings unless shown otherwise in the plans. Determine bearing of the pile after removing the casing unless shown otherwise in the plans. Fill all voids between the pile and soil remaining after driving through preformed holes with clean A-3 sand or sand meeting the requirements of 902-3.3, after the pile has achieved the required minimum tip elevation, unless grouting of preformed pile holes is shown in the plans. If pile driving is interrupted during sand placement, drive the pile at least 20 additional blows after filling all of the voids between the pile and soil with sand at no additional compensation.

455-5.9.2 Provisions for Use of Preformed Pile Holes: The Department generally anticipates the necessity for Preformed Pile Holes and includes

directions in the Contract Documents. The Department will pay for Preformed Piles Holes when the Contractor establishes that the required results cannot be obtained when driving the load bearing piles with specified driving equipment, or if jetting is allowed, while jetting the piles and then driving or while jetting the piles during driving.

455-5.9.3 Conditions Under Which Payment Will Be Made: The Department will make payment for Preformed Pile Holes shown in the plans, required by the Engineer or where the Contractor demonstrates that such work is necessary to achieve the required penetration of the pile. The Department considers, but does not limit to, the following conditions as reasons for Preformed Pile Holes:

(a) Inability to drive piles to the required penetration with driving and jetting equipment.

(b) To penetrate a hard layer or layers of rock or strong stratum that the Engineer considers not sufficiently thick to support the structure.

(c) To obtain greater penetration into dense (strong) material and into dense material containing holes, cavities or unstable soft layers.

(d) To obtain penetration into a stratum in which it is desired to found the structure.

(e) To minimize the effects of vibrations or heave on adjacent existing structures.

(f) To minimize the effects of ground heave on adjacent piles.

455-5.9.4 Construction Methods: Construct Preformed Pile Holes by drilling, or driving and withdrawing a suitable punch or chisel at the locations of the piles. Construct a hole that is equal to or slightly greater than the largest pile dimension for the entire length of the hole and of sufficient depth to obtain the required penetration. Carefully form the preformed hole by using a drill or punch guided by a template or other suitable device, and do not exceed the minimum dimensions necessary to achieve the required penetration of the pile. When the plans call for grouting the Preformed Pile Holes, provide the minimum dimension of the pile hole that is 2 inches larger than the largest pile dimension. Construct the holes at the plan position of the pile and the tolerances in location, and ensure the hole is straight and that the batter is the same as specified for the pile. Loose material may remain in the preformed pile hole if the conditions in 455-5.9.3 are satisfied.

455-5.9.5 Grouting of Pile Holes: Grout Preformed Pile Holes for bearing piles, when the plans require grouting after driving. Clean the Preformed Pile Holes, and fill them with cement grout as shown in the plans. Use grout that has a minimum compressive strength of 3,000 psi at 28 days or as specified. Pump the grout through three or more grout pipes initially placed at the bottom of the preformed hole. The Contractor may raise the grout pipes when necessary to prevent clogging and to complete the grouting operations. Maintain the grout pipes below the surface of the previously placed grout. Continue grouting until the grout reaches the ground surface all around the pile. Provide divers to monitor grouting operations when the water depth is such that it is impractical to monitor from the ground surface. When grouting is shown in the plans, include the cost in the price for piles. In the event that the Engineer determines the

Contractor must grout and the required grouting is not shown in the plans, the Department will pay for the grouting work as Unforeseeable Work.

455-5.10 Bearing Requirements:

455-5.10.1 General: Drive piles to provide the bearing capacities required for carrying the loads shown in the plans. For all types of bearing piles, consider the driving resistance as determined by the methods described herein sufficient for carrying the specified loads as the minimum bearing which is accepted for any type of piles. Determine pile bearing using the method described herein or as shown in the plans.

The Engineer may accept a driven pile when the pile has achieved minimum penetration; the blow count is generally increasing and the minimum required bearing capacity obtained for 24 inches of consecutive driving. At his discretion, the Engineer may also accept a driven pile when the minimum penetration is achieved and driving has reached practical refusal in firm material.

455-5.10.2 Blow Count Criteria: The Engineer will determine the number of blows required to provide the required bearing according to the methods described herein. Determine the pile bearing by computing the penetration per blow with less than 1/4 inch rebound averaged through 12 inches each of penetration. When it is considered necessary by the Engineer, determine the average penetration per blow by averaging the penetration per blow through the last 10 to 20 blows of the hammer.

455-5.10.3 Practical Refusal: Practical refusal is defined as 20 blows per inch with the hammer operating at the highest setting or setting determined by the Engineer and less than 1/4 inch rebound per blow. Stop driving as soon as the Engineer determines that the pile has reached practical refusal. The Engineer will generally make this determination within 2 inches of driving. However, the Engineer will in no case approve the continuation of driving at practical refusal for more than 12 inches. When the required pile penetration cannot be achieved by driving without exceeding practical refusal, use other penetration aids such as jetting or Preformed Pile Holes.

455-5.10.4 Set-checks and Pile Redrive:

(a) Set-checks: In the event that the Contractor has driven the pile to approximately 12 inches above cut-off without reaching the required resistance, the Engineer may require the Contractor to interrupt driving up to two hours prior to performing a set-check. Provide an engineer's level or other suitable equipment for elevation determinations to determine accurate pile penetration during the set-checks. There will be no separate payment for an initial set-check. In the event the result of an initial set-check is not satisfactory, the Engineer may direct additional set-checks. For each additional set-check ordered by the Engineer within two working days from the end of original driving, the Contractor will be paid an additional Set Check. The Engineer may accept the pile as driven when a set-check shows that the Contractor has achieved the minimum required pile bearing and has met all other requirements of this Section.

(b) Pile Redrive: Pile Redrive consists of redriving the pile after two working days from original driving to determine time effects, to reestablish pile

capacity due to pile heave, or for other reasons determined by the Engineer. Redrive piles as directed by the Engineer.

(c) Uninstrumented Set-Checks and Uninstrumented Pile Redrive: The Engineer may consider the pile to have sufficient bearing resistance when the specified set-check criteria is met through the last 10 to 20 blows of the hammer at the specified minimum stroke and the total penetration is less than six inches with less than 1/4 inch rebound per blow. When the total penetration during a set-check or redrive is greater than six inches or pile rebound exceeds 1/4 inch per blow, the Engineer may consider the pile to have sufficient bearing resistance when the specified blow count criteria is achieved in accordance with 455-5.10.1.

(d)Instrumented Set-Checks and Instrumented Pile Redrive: When considered necessary by the Engineer, dynamic load tests will be used to determine whether the pile bearing is sufficient. The Engineer may consider the pile to have sufficient bearing resistance when dynamic measurements demonstrate the static pile resistance during at least one hammer blow exceeds the required pile resistance, the average static pile resistance during the next five hammer blows exceeds 95% of the required pile resistance and the static pile resistance during all subsequent blows exceeds 90% of the required pile resistance.

455-5.10.5 Pile Heave: Pile heave is the upward movement of a pile from its originally driven elevation. Drive the piles in an approved sequence to minimize the effects of heave and lateral displacement of the ground. Monitor piles previously driven in a pile group for possible heave during the driving of the remaining piles. When required by the Engineer, take elevation measurements to determine the magnitude of the movement of piles and the ground surface resulting from the driving process. Redrive all piles that have heaved 1/4 inch or more unless the Engineer determines that the heave is not detrimental to pile capacity. The Department will pay for all work in conjunction with redriving piles due to pile heave under the Pile Redrive item.

455-5.10.6 Piles with Insufficient Bearing: In the case that the Engineer determines that the safe bearing capacity of any pile is less than the required bearing capacity, the Contractor may splice the pile and continue driving or may extract the pile and drive a pile of greater length, or, if so ordered by the Engineer, drive additional piles until reducing the required bearing per pile to the determined bearing capacity of the piles already driven.

455-5.11 Methods to Determine Pile Capacity:

455-5.11.1 General: Dynamic load test will be used to determine pile capacity for all structures or projects unless shown otherwise in the Contract Documents. When necessary, the Engineer may require static load tests to confirm pile capacities. When the Contract Documents do not include items for static load tests, the Engineer will consider all required static load testing Unforeseeable Work. When considered necessary by the Engineer, adjust the blow count criteria to match the resistance determined from static load tests.

455-5.11.2 Wave Equation:

(a) General: Use Wave Equation Analysis for Piles (WEAP) programs to evaluate the suitability of the proposed driving system (including the

hammer, follower, capblock and pile cushions) as well as to estimate the driving resistance, in blows per 12 inches or blows per inch, to achieve the pile bearing requirements and to evaluate pile driving stresses.

The Engineer may modify the scour resistance shown in the plans if the dynamic load test is used to determine the actual soil resistance through the scour zone. Also, the Engineer may make modifications in scour resistance when the Contractor proposes drilling and/or jetting to reduce the soil resistance in the scour zone.

Use Wave Equation Analyses to show the hammer is capable of driving to a resistance equal to at least 2.0 times the factored design load plus the scour and down drag resistance (if applicable) shown in the Contract Documents, without overstressing the piling in compression or tension and without reaching practical refusal (20 blows per inch). Ensure that the hammer provided also meets the requirements described in 455-5.2.

(b) Required Equipment For Driving: Hammer approval is solely based on satisfactory field trial including PDA, CAPWAP and Wave Equation Analysis. Supply a hammer system that meets the requirements described in the specifications based on the above analysis. Obtain approval from the Engineer for the pile driving system based on satisfactory field performance.

In the event piles require different hammer sizes, the Contractor may elect to drive with more than one size hammer or with a variable energy hammer, provided the hammer is properly sized and cushioned, will not damage the pile, and will develop the required resistance.

(c) Maximum Allowed Pile Stresses:

(1) General: The maximum allowed driving stresses for concrete, steel, and timber piles are given below. In the event Wave Equation analyses show that the hammer will overstress the pile, modify the driving system or method of operation as required to prevent overstressing the pile. In such cases provide additional cushioning or make other appropriate agreed upon changes. For penetration of weak soils by concrete piles, use thick cushions and/or reduced stroke to control tension stresses during driving.

(2) Concrete Piles: Use the wave equation to evaluate the proposed pile cushioning. Use the following equations to determine the maximum allowed pile stresses as predicted by the wave equation, and measured during driving when driving prestressed concrete piling:

$$s_{apc} = 0.7\ f'_c - 0.75\ f_{pe} \qquad (1)$$

$$s_{apt} = 6.5\ (f'_c)^{0.5} + 1.05\ f_{pe} \qquad \text{(2a) for piles less than 50 feet long}$$

$$s_{apt} = 3.25\ (f'_c)^{0.5} + 1.05\ f_{pe} \qquad \text{(2b) for piles 50 feet long and greater}$$

$$s_{apt} = 500 \qquad \text{(2c) within 20 feet of a mechanical splice}$$

where:

s_{apc}= maximum allowed pile compressive stress, psi

s_{apt}= maximum allowed pile tensile stress, psi

f'_c= specified minimum compressive strength of concrete, psi

f_{pe}= effective prestress (after all losses) at the time of driving, psi, taken as 0.8 times the initial prestress force (f_{pe}= 0 for dowel spliced piles).

(3) Steel Piles: Ensure the maximum allowed pile compression and tensile stresses as predicted by the Wave Equation, and/or measured during driving are no greater than 0.9 times the yield strength (0.9 f_y) of the steel.

(4) Timber Piles: Ensure the maximum allowed pile compression and tensile stresses as predicted by the wave equation, and/or measured during driving are no greater than 3.6 ksi for Southern Pine and Pacific Coast Douglas Fir and 0.9 of the ultimate parallel to the grain strength for piles of other wood.

455-5.11.3 Temporary Piles: Submit for the Engineers approval, a Wave Equation analysis signed and sealed by a Specialty Engineer which establishes the driving criteria for temporary piles. The required driving resistance is equal to the design (service) load multiplied by the appropriate factor of safety plus the scour and down drag resistance shown in the plans (no safety factor is required) or the ultimate bearing capacity shown in the plans, whichever is higher:

The factor of safety applied to the design (service) load is:

2.0 ..... when static load tests are required.

2.5 ..... when the Pile Driving Analyzer ..... and Wave Equation Analysis are required.

3.0 ..... when only the Wave Equation Analysis is required.

455-5.11.4 Dynamic Load Tests: Dynamic load testing consists of predicting pile capacity from blows of the hammers during drive and/or redrive of an instrumented pile.

455-5.11.5 Static Load Tests: Static load testing consists of applying a static load to the pile to determine its capacity. Use The Modified Quick Test Procedure in accordance with 455-2.2.1.

455-5.11.6 Fender Pile Installation: For piles used in fender systems, regardless of type or size of pile, either drive them full length or jet the piles to within 2 feet of cutoff and drive to cutoff elevation to seat the pile. The Engineer will not require a specific driving resistance unless noted in the plans. Use methods and equipment for installation that do not damage the piles. If the method or equipment used causes damage to the pile, modify the methods or equipment at no expense to the Department.

455-5.12 Test Piles:

455-5.12.1 Description: Drive piles of the same cross-section and type as the permanent piles shown in the plans, in order to determine any or all of the following:

(a) the installation criteria for the piles.

(b) the nature of the soil.

(c) the lengths of permanent piles required for the work.

(d) the driving resistance characteristics of the various soil strata.

(e) the amount of work necessary to obtain minimum required pile penetration.

(f) the ability of the driving system to do the work.

(g) the need for point protection.

Because test piles are exploratory in nature, drive them harder (within the limits of practical refusal), deeper, and to a greater bearing resistance than required for the permanent piling. Except for test piles which are to be statically (or Statnamically) load tested, drive test piles their full length or to practical refusal. Build up test piles which have been driven their full length and have developed only minimal required bearing, and proceed with further driving.

As a minimum, unless otherwise directed by the Engineer, do not cease driving of test piles until obtaining the required bearing capacity continuously, where the blow count is increasing, for 10 feet unless reaching practical refusal first. For test piles which are to be statically (or Statnamically) load tested, ignore this minimum and drive these piles as anticipated for the production piles.

When test piles attain practical refusal prior to attaining minimum penetration, perform all work necessary to attain minimum penetration and the required bearing. Where practical, use water jets to break the pile loose for further driving. Where jetting is impractical, extract the pile and install a Preformed Pile Hole through which driving will continue. The Department will consider the work of extracting the pile to be Unforeseeable Work.

When driving test piles other than low displacement steel test piles, have preforming equipment available at the site and water jets as specified in 455-5.7 when jetting is allowed, ready for use, before the test pile driving begins.

The Engineer may elect to interrupt pile driving up to four times on each test pile, two times for up to two hours and two additional times during the next working day of initial driving to determine time effects during the driving of test piles at no additional cost to the Department.

If additional set-checks are determined necessary by the Engineer within two working days following the end of initial driving, each set-check will be paid as an additional set-check. If set-checks are determined necessary by the Engineer after two working days from the end of initial driving, each set-check will be paid for as Pile Redrive.

Install instruments on test piles when dynamic load tests are included in the plans or when directed by the Engineer.

455-5.12.2 Location of Test Piles: Drive all test piles in the position of permanent piles at the designated locations. Ensure that all test piles designated to be statically load tested are plumb. In the event that all the piles are battered at a static load test site, the Engineer will designate an out-of-position location for driving a plumb pile for the static load test.

455-5.12.3 Equipment for Driving: Use the same hammer and equipment for driving test piles as for driving the permanent piles. Also use the same equipment to redrive piles.

455-5.13 Dynamic Load Tests: The Engineer will take dynamic measurements during the driving of piles designated in the plans or authorized by the Engineer as Dynamic Load Test Piles. Install instruments on test piles and

selected permanent piles for dynamic load testing. All test piles will have dynamic load tests. The Engineer will perform Dynamic Load Tests to evaluate any or all of the following:

1. Evaluate suitability of Contractor's driving equipment, including hammer, capblock, pile cushion, and any proposed follower.
2. Determine pile capacity.
3. Determine pile stresses.
4. Determine energy transfer to pile.
5. Determine distribution of soil resistance.
6. Evaluate soil variables including quake and damping.
7. Evaluate hammer-pile-soil system for Wave Equation analyses.
8. Evaluate pile installation problems.
9. Other.

Attach instruments (strain transducers to measure force and accelerometers to measure acceleration) with screws to the pile for dynamic load testing.

Make each pile to be dynamically tested available to drill holes for attaching instrumentation and for wave speed measurements. Support the pile with timber blocks placed at appropriate intervals. Ensure that the pile is in a horizontal position and does not contact adjacent piles. Provide a sufficient clear distance at the sides of the pile for drilling the holes. The Engineer will furnish the equipment, materials, and labor necessary for drilling holes and taking the wave speed measurements. If the Engineer directs dynamic load testing of piles already driven, provide the Engineer safe access to the top of the piles for drilling the attachment holes. After placing the leads provide the Engineer reasonable means of access to the piles to attach the instruments and for removal of the instruments after completing the pile driving.

The Engineer will monitor the stresses in the piles with the dynamic test equipment during driving to ensure the Contractor does not exceed the maximum allowed stresses. If necessary, add additional cushioning, replace the cushions, or reduce the hammer stroke to maintain stresses below the maximum allowable. If dynamic test equipment measurements indicate non-axial driving, immediately realign the driving system. If the cushion is compressed to the point that a change in alignment of the hammer will not correct the problem, add cushioning or change the cushion as directed by the Engineer.

Drive the pile to the required penetration and resistance or as directed by the Engineer. Dynamic load testing of a pile may average up to two hours longer than for driving an uninstrumented pile.

When directed by the Engineer, perform instrumented redrives. Do not use a cold diesel hammer for a redrive unless in the opinion of the Engineer it is impractical to do otherwise. Generally, warm up the hammer by driving another pile or applying at least 20 blows to a previously driven pile or to timber mats placed on the ground.

455-5.14 Pile Lengths:

455-5.14.1 Test Pile Length: Provide the length of test piles shown in the plans or as directed by the Engineer.

455-5.14.2 Production Pile Length: When shown in the plans, the lengths are based on information available during design and are approximate only. The Engineer will determine final pile lengths in the field which may vary significantly from the lengths or quantities shown in the plans.

455-5.14.3 Authorized Pile Lengths: The authorized pile lengths are the lengths determined by the Engineer based on all information available before the driving of the permanent piles, including, but not limited to, information gained from the driving of test piles, dynamic load testing, static load testing, supplemental soil testing, etc. When authorized by the Department, soil freeze information obtained during set checks and pile redrives may be used to determine authorized pile lengths for sites with extreme soil conditions. The Contractor may elect to provide piling with lengths longer than authorized to suit his method of installation or schedule. When the Contractor elects to provide longer than authorized pile lengths, the Department will pay for the furnished length as either the originally authorized length or the length between cut-off elevation and the final accepted pile tip elevation, whichever is the longer length.

Within five working days after driving all the test piles, completing all load tests, completing all redrives, and receiving all test reports, the Engineer will furnish the Contractor an itemized list of authorized pile lengths. Use these lengths for furnishing the permanent piling for the structure. If the Contractor is willing to start his pile driving operations in zones consisting of at least four test piles designated by the Engineer, and if the Contractor so requests in writing at the beginning of the test pile program, the Department will furnish pile lengths for these designated phases within five working days after driving all the test piles, completing all load tests, completing all redrives, and receiving all test reports for those designated zones. The Engineer will furnish the driving criteria for piles within three working days of furnishing pile lengths.

On multiple phase projects, the Engineer will not furnish pile lengths on subsequent phases until completing the piling on initial phases.

455-5.15 Allowable Driving Tolerances:

455-5.15.1 General: Meet the tolerances described in this Subarticle to the piles that are free standing without lateral restraint (after the template is removed). After the piles are driven, do not move the piles laterally to force them to be within the specified tolerances. The Contractor may move battered piles laterally to overcome the dead load deflections caused by the pile's weight. When this is necessary, submit calculations signed and sealed by a Specialty Engineer to the Engineer that verify the amount of dead load deflection prior to moving any piles.

455-5.15.2 Position: Ensure that the final position of the pile head at cut-off elevation is no more than 3 inches laterally in the X or Y coordinate from the plan position indicated in the plans.

455-5.15.3 Axial Alignment: Ensure that the axial alignment of the driven piles does not deviate by more than 1/4 in/ft from the vertical or batter line indicated in the plans.

455-5.15.4 Elevation: Ensure that the final elevation of the pile head is no more than 1 1/2 inches above, or more than 4 inches below, the elevation

shown in the plans. Do not embed the pile less than 6 inches below the elevation shown in the plans unless a minimum penetration requirement is shown.

For fender piles, cut off piles at the elevation shown on the plans to a tolerance of +0.0"/-2.0" using sawing or other means as approved by the Engineer to provide a smooth level cut.

455-5.15.5 Deviation From Above Tolerances: When the Contractor has failed to meet the above tolerances, the Contractor may request design changes in the pile caps or footings to incorporate piles driven out of tolerance. Bear the expense of redesign and Unforeseeable Work resulting from approved design changes to incorporate piles driven out of tolerance. Ensure the Contractor's Engineer of Record performs any redesign and signs and seals the redesign drawings and computations. Do not begin any proposed redesign until it has been reviewed for acceptability and approved by the Engineer.

455-5.16 Disposition of Pile Cut-offs, Test Piles, and Load Test Materials:

455-5.16.1 Pile Cut-offs:

(a) Steel Piling: Unless shown otherwise in the plans, the Department will retain ownership of cut-off sections, or portions of cut-off sections, and unused piling 20 feet long or longer that are not damaged. Deliver them to the Department's nearest maintenance yard. Ensure that sections of piles delivered to the maintenance yard are straight and undamaged. Cut off the damaged portions prior to delivery. Take ownership of cut-off sections less than 20 feet long. Remove them from the job, and dispose of them.

(b) Other Pile Types: Upon completion of all work under the Contract in connection with piling, unless shown otherwise in the plan, take ownership of any unused cut-off lengths remaining, and remove them from the right-of-way. Provide areas for their disposal.

455-5.16.2 Test Piles: Where so directed by the plans or the Engineer, cut off, or build-up as necessary, test piles, and leave them in place as permanent piles. Extract and replace test piles driven in permanent position and found not suitable for use due to actions of the Contractor at no expense to the Department. Pull, or cut off at an elevation 2 feet below the ground surface or bottom of proposed excavation, test piles driven out of permanent position, and dispose of the removed portion of the test pile.

When test piles are required to be driven in permanent pile positions, the Contractor may elect to drive the test pile out of position, with the approval of the Engineer, provided that a replacement pile is furnished and driven by the Contractor at no expense to the Department in the position that was to be occupied by the test pile. Under this option, the Department will pay for the test pile in the same manner as if it were in permanent position.

Unless otherwise directed in the plans or by the Engineer, retain ownership of test piles that are pulled or cut off and provide areas for their disposal.

455-6 Timber Piling.

455-6.1 Description: Drive timber piles constructed of round timber of the kind and dimensions specified in the plans at the locations and to the elevations shown in the plans, or as directed by the Engineer.

455-6.2 Materials: Meet the timber piling requirements of Section 953. Treat the piles according to the applicable provisions of Section 955. Treat all cuts and drilled holes in accordance with 470-3.

455-6.3 Preparation for Driving:

455-6.3.1 Caps: Protect the heads of timber piles during driving, using a cap of approved type, that will distribute the hammer blow over the entire cross-section of the pile. When necessary, cut the head of the pile square before beginning pile driving.

455-6.3.2 Collars: Provide collars or bands to protect piles against splitting and brooming at no expense to the Department.

455-6.3.3 Shoes: Provide piles shod with metal shoes, of a design satisfactory to the Engineer, at no expense to the Department. Shape pile tips to receive the shoe and install according to the manufacturer's directions.

455-6.4 Storage and Handling: Store and handle piles in the manner necessary to avoid damage to the piling. Take special care to avoid breaking the surface of treated piles. Do not use cant dogs, hooks, or pike holes when handling and storing the piling.

455-6.5 Cutting Off: Saw off the tops of all timber piles at the elevation indicated in the plans. Saw off piles which support timber caps to the exact plane of the superimposed structure so that they exactly fit it. Withdraw and replace broken, split, or misplaced piles.

455-6.6 Build-ups: The Engineer will not permit splices or build-ups for timber piles. Extract piles driven below plan elevation and drive a longer pile.

455-6.7 Pile Heads:

455-6.7.1 Piles with Timber Caps: On piles wider than the timber caps, dress off to a slope of 45 degrees the part of the pile head projecting beyond the sides of the cap. Coat the cut surface with the required preservative over which place a sheet of copper, of a weight of 10 oz/ft^2 or greater, meeting the requirements of ASTM B 370. Provide a cover that measures at least 4 inches more in each dimension greater than the diameter of the pile. Bend the cover down over the pile and fasten the edges with large head copper nails or three wraps of No. 12 copper wire.

455-6.7.2 Fender and Bulkhead Piles: First paint the heads of fender piles and of bulkhead piles with preservative and then cover with copper as provided above for piles supporting timber caps.

455-7 Prestressed Concrete Piling.

455-7.1 Description: Provide prestressed concrete piles that are manufactured, cured, and driven in accordance with the requirements of the Contract Documents. Provide piles full length without splices when transported by barge or the pile length is less than or equal to 120 feet. When piles are transported by truck and the pile length exceeds 120 feet but is less than the maximum length for a three point pick-up according to Index 20600, and splicing

is desired, provide minimal splices. Include the cost of the splices in the cost of the pile.

455-7.2 Manufacture: Fabricate piles in accordance with Section 450.

455-7.3 Storage and Handling:

455-7.3.1 Time of Driving Piles: Drive prestressed concrete piles at any time after the concrete has been cured in accordance with Section 450, and the concrete compressive strength is equal to or greater than the specified 28 day compressive strength.

455-7.3.2 Storage: Support piles on adequate dunnage both in the prestress yard and at the job site in accordance with the locations shown in the Standard Indexes to minimize undue bending stresses or creating a sweep or camber in the pile.

455-7.3.3 Handling: Handle and store piles in the manner necessary to eliminate the danger of fracture by impact or of undue bending stresses in handling or transporting the piles from the forms and into the leads. In general, lift concrete piles by means of a suitable bridge or slings attached to the pile at the locations shown in the Standard Indexes. Construct slings used to handle piles of a fabric material or braided wire rope constructed of six or more wire ropes which will not mar the corners or the surface finish of the piles. Do not use chains to handle piles. During transport, support concrete piles at the lifting locations shown in the Standard Indexes or fully support them throughout 80% or more of their length. In handling piles for use in salty or brackish water, exercise special care to avoid damaging the surface and corners of the pile. If an alternate transportation support arrangement is desired, submit calculations, signed and sealed by the Specialty Engineer, for approval by the Engineer prior to transporting the pile. Calculations must show that the pile can be transported without exceeding the bending moments calculated using the support locations shown in the plans.

455-7.4 Cracked Piles: The Engineer will reject any pile that becomes cracked in handling to the point that a transverse or longitudinal crack extends through the pile, shows failure of the concrete as indicated by spalling of concrete on the main body of the pile adjacent to the crack, or which in the opinion of the Engineer will not withstand driving stresses. The Engineer will not reject any pile for the occasional minor surface hairline cracking caused by shrinkage or tensile stress in the concrete from handling.

Do not drive piling with irreparable damage, which is defined as any cracks that extend through the pile cross-sectional area that are, or will be, below ground or water level at the end of driving. Such cracks are normally evidenced by emitting concrete dust during their opening and closing with each hammer blow. Remove and replace broken piles or piles cracked to the extent described above at no expense to the Department. The Engineer will accept cracks less than 0.005 inch which do not extend through the pile. Using approved methods, cut off and splice or build-up to cut-off elevation piles with cracks greater than 0.005 inch at the pile head or above ground or water level, and piles with cracks above ground or water level which extend through the cross-sectional area of the pile. The Engineer, at his discretion, may require correction of pile damage or pile cracks by cutting down the concrete to the plane of sound concrete below the

crack and rebuilding it to cut-off elevation, or the Engineer may reject the pile. Extract and replace rejected piles that cannot be repaired, at no expense to the Department.

Take appropriate steps to prevent the occurrence of cracking, whether due to handling or driving. When cracking occurs during driving take immediate steps to prevent additional cracking by using thicker cushions or reducing the ram stroke length. Revise handling and transporting equipment and procedures as necessary to prevent cracking during handling and transportation.

455-7.5 Preparation for Transportation: Cut any strands protruding beyond the ends of the pile flush with the surface of the concrete using an abrasive cutting blade before transporting the piles from the casting yard.

Cut the metal handling devices cast into the concrete back to a minimum depth of 1 inch and patch with an approved epoxy mortar, mixed, applied and cured in accordance with the manufacturer's recommendations before transporting the piles from the casting yard.

455-7.6 Method of Driving: Unless otherwise directed, drive piles by a hammer or by means of a combination of water jets and hammer when jetting is allowed. When using jets in combination with a hammer, withdraw the jets and drive the pile by the hammer alone, to secure final penetration and to rigidly fix the tip end of the pile. Keep jets in place if they are being used to continuously eliminate the soil resistance in the scour zone.

455-7.7 Extensions and Build-ups Used to Increase Production Lengths:

455-7.7.1 General: Where splices and build-ups for concrete piles are necessary, construct such splices and build-ups in accordance with Standard Index 20601. The Contractor may construct build-ups less than 2 feet in length in accordance with 455-11.9. When splicing a prestressed precast section onto the original pile and, after driving, the length of spliced section below cut-off elevation is 4 feet or less, remove the pile concrete to the cut-off elevation and leave the dowels in place to be incorporated into the cap as directed by the Engineer. The Contractor may cut the length of dowels which becomes exposed to a length of 48 inches from the plane of pile-splice.

These requirements are not applicable to specially designed piling. Make splices for special pile designs as shown in the plans.

455-7.7.2 Extensions to be Driven or Those 21 feet or Longer: Construct extensions to be driven or extensions 21 feet or longer in length in accordance with the details shown in the plans and in a manner including the requirements, sequences, and procedures outlined below:

(a) Cast a splice section in accordance with Section 450 with the dowel steel in the correct position and alignment.

(b) Drill dowel holes using an approved steel template that will position and align the drill bit during drilling. Drill holes a minimum of 2 inches deeper than the length of the dowel to be inserted.

(c) Clean the drilled dowel holes by inserting a high pressure air hose to the bottom of the hole and blowing the hole clean from the bottom upward. Eliminate any oil, dust, water, and other deleterious materials from the holes and the concrete surfaces to be joined.

(d) Place forms around joints between the pile sections.

(e) Mix the adhesive components in accordance with the manufacturer's directions. Do not mix sand or any other filler material with the epoxy components unless it is prepackaged by the manufacturer for this specific purpose. Use adhesives meeting the requirements of Section 926 for Type B Epoxy Compounds.

(f) After ensuring that all concrete surfaces are dry, fill the dowel holes with the adhesive material.

(g) Insert the dowels of the spliced section into the adhesive filled holes of the bottom section and position the spliced section so that the axes of the two sections are in concentric alignment and the ends of the abutting sections are spaced 1/2 inch apart. The Contractor may use small steel spacers of the required thickness provided they have 3 inches or more of cover after completing the splice. Fill the space between the abutting sections completely with the adhesive.

(h) Secure the spliced sections in alignment until the adhesive is cured in accordance with the manufacturer's directions for the time appropriate with the prevailing ambient temperatures. Do not utilize the crane to secure the pile extension during the adhesive cure time. Utilize alignment braces to maintain the proper pile alignment during the epoxy cure time.

(i) After curing is completed, remove alignment braces and forms and clean and dress the spliced area to match the pile dimensions.

455-7.7.3 Precast Reinforced Build-ups: Construct Precast Reinforced Build-ups in accordance with the requirements of this Subarticle, Section 346, and Section 400. Provide the same material for the form surfaces for precast build-ups as was used to form the prestressed piles. Use concrete of the same mix as used in the prestressed pile and dimension the cross-section the same as piling being built up. Install build-ups as specified in 455-7.7.2(b) through 455-7.7.2(i). Apply to the build-ups the same surface treatment or sealant applied to the prestressed piles. The Department will make payment for authorized build-ups at the respective Contract unit prices per foot for Prestressed Concrete Piling.

455-7.8 Pre-Planned Splices: Splices shall be made by the doweled splice method contained in the Standard Indexes or may be made using proprietary splices which are listed on the Department's QPL. Splice test piles in the same manner as the production piles. Include in the pile installation plan, the chosen method of splicing and the approximate locations of the splice. Generally, place the splice at approximately the midpoint between the estimated pile tip and the ground surface, considering scour if applicable. Stagger the splice location between adjacent piles by a minimum of 10 feet. Obtain the Engineer's approval prior to constructing any pile sections. Construct piles which are to be spliced using the doweled splice with preformed dowel holes in the bottom section and embedded dowels in the upper section.

When the electing to use dowel splices, assist the Engineer in performing a dynamic load test on each dowel spliced pile to verify the splicing integrity at the end of driving. Replace any damaged pile splices in accordance with 455-11.2.7. Provide the Engineer 48 hours advance notification prior to driving piles with epoxy-bonded dowel splices.

Mechanical pile splices shall be capable of developing the following capacities in the pile section unless shown otherwise in the plans and capable of being installed without damage to the pile or splice:

a) Compressive strength = (Pile Cross sectional area) x (28 day concrete strength)
b) Tensile Strength = (Pile Cross sectional area) x 900 psi

Pile Size (inches)	Bending Strength (kip-feet)
18	245
20	325
24	600
30	950

455-7.9 Pile Cut-offs: After the completion of driving, cut piles off which extend above the cut-off elevation with an abrasive saw. Make the cut the depth necessary to cleanly cut through the prestressed strands. Take ownership and dispose of cut-off sections not used elsewhere as allowed by this Section.

455-8 Steel Piling.

455-8.1 Description: Furnish, splice, drive, and cut off structural steel shapes to form bearing piles. Include in this work the installation of bracing members of structural steel by bolting or welding, construction of splices and the filling of pipe piles with the specified materials.

455-8.2 Material: For the material in steel piles, pile bracing, scabs, wedges, and splices, meet the requirements of Section 962.

455-8.3 Pile Splices: Order and use the full authorized pile length where practicable. Do not splice to obtain authorized lengths less than 40 feet except when shown in the plans. When approved by the Engineer, perform splicing to obtain authorized lengths between 40 and 60 feet. The Engineer will permit splicing to obtain authorized lengths in excess of 60 feet.

Where the pile length authorized is not sufficient to obtain the required bearing value or penetration, order an additional length of pile and splice it to the original length.

Make all splices in accordance with details shown in the plans and in compliance with the general requirements of AWS D1.1 or American Petroleum Institute Specification 5L (API 5L). Payment for pile splicing will be limited as specified in 455-11.9.

455-8.4 Welding: Make all welded connections to steel piles by electric arc welding, in accordance with details shown in the plans and in compliance with the general requirements of AWS D1.5. Electroslag welding is not permitted. Welds will be inspected by visual methods.

455-8.5 Pile Heads and Tips: Cut off all piles at the elevation shown in the plans. If using a cutting torch, make the surface as smooth as practical.

Where foundation material is so dense that the Contractor cannot drive the pile to the required penetration and firmly seat it without danger of crumpling the tip, reinforce the tips with approved cast steel point protectors as shown in the plans or required by the Engineer. Construct point protectors in one piece of cast

steel meeting the requirements of ASTM A 27, Grade 65-35 heat treated to provide full bearing for the piles. Attach points by welding according to the recommendations of the manufacturer.

455-8.6 Pile Bent Bracing Members: Place structural steel sway and cross bracing, and all other steel tie bracing, on steel pile bents and bolt or weld in place as indicated in the plans. Where piles are not driven into position in exact alignment as shown in the plans, the Engineer may require the use of fills and shims between the bracing and the flanges of the pile. Furnish and place all fills and shims required to square and line up faces of flanges for cross bracing at no additional expense to the Department.

455-8.7 Coating: Coat exposed parts of steel piling, wedging, bracing, and splices in accordance with the provisions for coating structural steel as specified in Section 560.

455-8.8 Storage and Handling: While handling or transporting the piles from the point of origin and into the leads, store and handle in the manner necessary to avoid damage due to bending stresses. In general, lift steel piles by means of a suitable bridge or a sling attached to the pile at appropriate points to prevent damage. Lift the pile from the horizontal position in a manner that will prevent damage due to bending of the flanges and/or web.

455-8.9 Filling Pipe Piles: When required by the plans, fill pipe piles with the specified materials. Use clean concrete sands and concrete meeting the requirements of Section 346. Place concrete in pipes containing water using methods in accordance with 455-15.9 with modified tremie and pump line sizes. Concrete may be placed directly into pipes which are dry. Construct and place reinforcement cages in accordance with 455-16. Reinforcement cages may be installed before concrete placement or after concrete placement is completed if proper alignment and position is obtainable.

455-9 Sheet Piling.

455-9.1 Description: Leave permanent piling in place as part of the finished work and generally remove temporary piling after each construction phase.

455-9.2 Materials: Meet the following requirements:

Concrete	Section 346
Bar Reinforcement	Section 931
Prestressing Reinforcement	Section 933
Steel Sheet Piles*	Section 962

*For temporary steel sheet piles meet the requirements specified in the plans.

455-9.3 Steel Sheet Piling: Drive steel sheet piling and cut off true to line and grade. Install steel sheet piling with a suitable hammer. Remove and replace any section damaged during handling and installation at no additional expense to the Department.

455-9.3.1 Method of Installation: Where rock or strong material is encountered such that the sheet piles cannot be set to grade by driving, remove the strong material by other acceptable means, such as excavation and backfilling or by punching. When the plans do not indicate the existence of rock or strong

material, work of removing, drilling or punching the strong material or rock will be paid for as Unforeseeable Work.

455-9.4 Concrete Sheet Piling:

455-9.4.1 Description: Ensure that Concrete Sheet Piling is of prestressed concrete construction and manufactured, cured, and installed in accordance with the requirements of the Contract Documents. Use these piles in bulkheads and abutments and at other locations as shown in the plans.

455-9.4.2 Manufacture of Piles: Ensure that the piles are fabricated in accordance with Section 450.

455-9.4.3 Method of Installation: Jet concrete sheet piling to grade where practical. The Engineer will require a minimum of two jets. Provide water at the nozzles of sufficient volume and pressure to freely erode material adjacent to the piles. Where encountering rock or strong material, such that the sheet piles cannot be set to grade by jetting, remove the strong materials by other acceptable means, such as excavation and backfilling, drilling or by punching with a suitable punch. When the plans do not indicate the existence of rock or strong material and the piles cannot be set by jetting, the Department will pay for the work of removing, drilling or punching the strong material or rock as Unforeseeable Work.

455-9.4.4 Grouting and Caulking: Concrete sheet piles are generally detailed to have tongues and grooves on their lower ends, and double grooves on their upper ends. Where so detailed, after installation, clean the grooves of all sand, mud, or debris, and fully grout the grooves. Use approved plastic bags (sheaths) which will meet the shape and length of the groove to be grouted to contain the plastic grout within the double grooves. Provide grout composed of one part cement and two parts sand. The Contractor may use clean local sand or beach sand in this grout. In lieu of sand-cement grout, the Contractor may use concrete meeting the requirements of Section 347, using small gravel or crushed stone coarse aggregate. Deposit the grout through a grout pipe placed within a watertight plastic sheath (bag) extending the full depth of the double grooves and which, when filled, completely fills the slot formed by the double grooves.

455-9.5 Storage and Handling: Handle and store all sheet piles in a manner to prevent damage. Handle long sheet piles with fabric slings or braided wire rope constructed of six or more wire ropes placed at appropriate lift points to prevent damage due to excessive bending.

455-10 Pile Installation Plan.

455-10.1 General: Complete the Pile Driving Installation Plan form provided by the Engineer. Return the Pile Driving Installation Plan information to the Engineer at the preconstruction conference or no later than 30 days before driving the first pile. Ensure the Pile Driving Installation Plan information includes the following:

1. List and size of proposed equipment including cranes, barges, driving equipment, jetting equipment, compressors, and preformed pile hole equipment. Include manufacturer’s data sheets on hammers.

2. Methods to determine hammer energy in the field for determination of pile capacity. Include in the submittal necessary charts and recent calibrations for any pressure measuring equipment.

3. Detailed drawings of any proposed followers.

4. Detailed drawings of templates.

5. Details of proposed load test equipment and procedures, including recent calibrations of jacks and required load cells.

6. Sequence of driving of piles for each different configuration of pile layout.

7. Proposed schedule for test pile program and production pile driving.

8. Details of proposed features and procedures for protection of existing structures.

9. Required shop drawings for piles, cofferdams, etc.

10. Methods and equipment proposed to prevent displacement of piles during placement and compaction of fill within 15 feet of the piles.

11. Methods to prevent deflection of battered piles due to their own weight and to maintain their as-driven position until casting of the pile cap is complete.

12. Proposed pile splice locations and details of any proprietary splices anticipated to be used.

455-10.2 Acceptance of Equipment and Procedures: All equipment and procedures are subject to satisfactory field performance. Make any required changes that may result from unsatisfactory field performance. The Engineer will give final acceptance after the Contractor makes necessary modifications. Do not make any changes in the driving system after acceptance without authorization of the Engineer. A hammer repaired on site or removed from the site and returned is considered to have its performance altered (efficiency increased or decreased), which is considered a change in the driving system and is subject to a Dynamic Load Test in accordance with 455-5.13 at no additional compensation.

455-11 Method of Measurement (All Piling).

455-11.1 Treated Timber Piling: The quantity to be paid for will be the length, in feet, furnished, placed, and accepted according to the authorized lengths list, including any additions and excluding any deletions thereto, as approved by the Engineer.

455-11.2 Prestressed Concrete Piling:

455-11.2.1 General: The quantity to be paid for will be the length, in feet, of Prestressed Concrete Piling furnished, driven and accepted according to the authorized lengths list, including any additions and excluding any deletions thereto, as approved by the Engineer.

455-11.2.2 Furnished Length: The furnished length of precast concrete piles will be considered as the overall length from head to tip. Final pay length will be based on the casting length as authorized in accordance with 455-5.14.3 subject to provisions of 455-11.2.3 through 455-11.2.10, 455-11.9, 455-11.10 and 455-11.14.

455-11.2.3 Build-ups: The lengths of pile build-ups authorized by the Engineer, measured from the plane of cutback or the joint between the sections, to head of build-up, will be included in the quantities of Piling.

455-11.2.4 Piles Requiring Cut-offs: No deduction from the length, in feet, of Piling will be made if cut-offs are required after the pile has been driven to satisfactory bearing.

455-11.2.5 Piles Driven Below Cut-off Elevation: Where a pile is driven below cut-off elevation and satisfactory bearing is obtained so that no further driving is required, the length of pile will be measured from cut-off elevation to tip of the pile.

455-11.2.6 Driving of Splice: If a pile is driven below cut-off and satisfactory bearing is not obtained, and additional driving is required after construction of a satisfactory splice, an additional 10 feet of piling will be paid for the additional driving. This compensation for driving of splice, however, will not be allowed for test piles that are spliced and redriven.

455-11.2.7 Replacing Piles: In the event a pile is broken or otherwise damaged by the Contractor to the extent that the damage is irreparable, in the opinion of the Engineer, the Contractor shall extract and replace the pile at no additional expense to the Department. In the event that a pile is mislocated by the Contractor, the Contractor shall extract and replace the pile at no expense to the Department except when a design change proposed by the Contractor is approved by the Department as provided in 455-5.15.5.

In the event that a pile is driven below cut-off without obtaining the required bearing, and the Engineer elects to have the pile pulled and a longer pile substituted, it will be paid for as Unforeseeable Work. In the event a pile is damaged or mislocated, and the damage or mislocation is determined to be the Department's responsibility, the Engineer may elect to have the pile extracted, and it will be paid for as Unforeseeable Work. If the extracted pile is undamaged and driven elsewhere the pile will be paid for at 30% of the Contract unit price for Piling. When the Department determines that it is responsible for damaged or mislocated pile, and a replacement pile is required, compensation will be made under the item for Piling, for both the original pile and replacement pile.

The Contractor may substitute a longer pile in lieu of splicing and building-up a pile. In this event, the Contractor will be paid for the original authorized length of the pile, plus any additional length furnished by the Contractor up to the authorized length of the build-up, as Piling. The Contractor will be paid 30 feet of piling as full compensation for extracting the original pile.

455-11.2.8 Underwater Driving: When the Contractor selects one of the optional underwater driving methods, payment will be made by selecting the applicable method from the following:

(a) Using a pile longer than the authorized length: Payment for piling will be made only for the authorized length at that location unless the length of pile from cut-off elevation to the final tip elevation is greater than the authorized length, in which case payment for piling will be made from cut-off elevation to final tip elevation. No payment will be made for pile splice, when this option is selected, unless the pile is physically spliced and the splice is driven below cut-off elevation to achieve bearing. When making and driving a pile splice below

cut-off elevation to achieve bearing, the length to be paid for piling will be the length between cut-off elevation and final pile tip elevation.

(b) Using an underwater hammer: Payment for piling and pile splices will be in accordance with 455-11.2.1 through 455-11.2.7 and 455-11.2.10. The Contractor shall furnish additional lengths required to provide the full length confirmation pile at no expense to the Department. Payment for piling for the full length confirmation pile will be the authorized length of the pile, unless the length driven below cut-off elevation is greater than the authorized length, in which case the length to be paid for will be the length between cut-off elevation and the final tip elevation. Splices in confirmation piles will be paid for only when the splice is driven below cut-off elevation.

(c) Using a pile follower: When a pile follower is used with a conventional pile driving system, the method of payment will be the same as shown above in 455-11.2.10(b).

455-11.2.9 Set-Checks/Test Piles: As described in 455-5.12.1, there will be no separate payment for the initial four set-checks performed within one working day of initial driving. For each additional set-check performed within two working days of initial driving, an additional quantity of 10 feet piling will be paid.

455-11.2.10 Set-Check/Production Piles: As described in 455-5.10.4(a), there will be no separate payment for one initial set-check. For each additional set-check performed within two working days from the end of initial driving, an additional quantity of 10 feet of piling will be paid.

455-11.3 Steel Piling:

455-11.3.1 General: The quantity to be paid for will be the length, in feet, of Steel Piling furnished, spliced, driven and accepted, up to the authorized length, including any additions and excluding any deletions thereto as approved by the Engineer.

455-11.3.2 Point Protectors: The quantity to be paid for will be each for the total of point protectors authorized, furnished, and properly installed.

455-11.4 Test Piles: The quantity to be paid for of test piles of various types, will be the length, in feet, of Test Piling furnished, driven and accepted, according to the authorized length list, and any additions or deletions thereof as approved by the Engineer.

Where a test pile is left in place as a permanent pile, it will be paid for only as Test Piles. Any extensions necessary to continue driving the pile for test purposes, as authorized by the Engineer, will be paid for as Test Piles. Other build-ups made only to incorporate the pile into the structure as a permanent pile will be included in the quantities of regular Piling and will not be paid for as Test Piling.

455-11.5 Dynamic Load Tests: Payment will be based on the number of dynamic load tests as shown in the plans or authorized by the Engineer, completed and accepted in accordance with the Contract Documents. No separate payment will be made for dynamic load tests used to evaluate the Contractor's driving equipment. This will generally be done on the first test pile or production pile driven on a project with each combination of proposed hammer and pile size and/or a separate pile to evaluate any proposed followers, or piles driven to

evaluate proposed changes in the driving system. No payment will be made for dynamic load tests used to evaluate the integrity of a pre-planned epoxy-bonded dowel splice. Include all costs associated with dynamically testing production piles with epoxy-bonded dowel splices in the Pay Item 455-34.

Payment for Dynamic Load Tests will include all costs related to dynamic testing as described in 455-5.13 including the initial instrumented drive, and up to two instrumented set-checks that day. In the event the Engineer requires an instrumented set check or redrive of a pile after the day of initial driving, 1/2 the payment for a Dynamic Load Test will be added to the payment for the set check or redrive.

455-11.6 Steel Sheet Piling: The quantity to be paid for will be the plan quantity area, in square feet, measured from top of pile elevation to the bottom of pile elevation and beginning and end wall limits as shown in the plans with no allowance for variable depth surface profiles. Sheet piling used in cofferdams and to incorporate the Contractor's specific means and methods, and not ordered by the Engineer, will be paid for as required in Section 125.

455-11.7 Concrete Sheet Piling: The quantity to be paid for will be the product of the number of such piles satisfactorily completed, in place, times their lengths in feet as shown in the plans or authorized by the Engineer. This quantity will be based upon piles 2 1/2 feet wide.

When the Engineer approves, the Contractor may furnish the concrete sheet piling in widths wider than shown in the plans; then the number of piles shall be the actual number of units completed times the width used divided by the width in the plans.

455-11.8 Fiberglass Structurally Reinforced Composite Piles: The quantity of fiberglass structurally reinforced composite piles to be paid will be the length in feet furnished and driven to the authorized lengths, as approved by the Engineer.

455-11.9 Pile Splices: Authorized splices in concrete piling, steel piling and test piling, which are made for the purpose of obtaining authorized pile lengths longer than shown as the maximum length in the Standard Indexes, for obtaining greater lengths than originally authorized by the Engineer, to incorporate test piling in the finished structure, for further driving of test piling, or for splices shown in the plans, will be paid for as described in 455-12.13.

For concrete piles, where the head of the pile to be spliced is not more than 2 feet below the elevation of cut-off, the Contractor, if he so elects, may cast the pile build-up with the cap, under the following conditions:

(a) Reinforcing steel and pile dimensions will generally conform in every respect to a standard splice.

(b) 9 feet of piling, will be paid for as compensation for drilling and grouting the dowels and reinforcing steel and concrete used for-build up and all other costs for which provision has not otherwise been made.

455-11.10 Pile Redrive: The quantity to be paid for will be the number of redrives, each, authorized by the Engineer. Pile Redrive is defined in 455-5.10.4(b). Payment for any pile redrive ordered by the Engineer will consist of 20 feet of additional piling. The size of the pile redriven will be the same size as the furnished item for payment.

Pile Redrive will be paid under any of the following conditions:

(a) When the Engineer directs the Contractor to redrive a pile to determine its capacity as described in 455-5.10.4.

(b) When the Engineer orders the Contractor to redrive piles to reestablish their capacity as the result of pile heave as described in 455-5.10.5.

455-11.11 Pile Extraction: Piles authorized to be extracted by the Engineer and successfully extracted as provided in 455-11.2.7 will be paid for as described in 455-11.2.7. No payment for extraction will be made for piles shown in the plans to be extracted or piling damaged or mislocated by the Contractor that are ordered to be extracted by the Engineer.

455-11.12 Protection of Existing Structures: The quantity to be paid for will be at the Contract lump sum price. When the Contract Documents do not include an item for protection of existing structures, the cost of settlement monitoring as required by these Specifications will be included in the cost of the piling items; however, work in addition to settlement monitoring will be paid for as Unforeseeable Work when such additional work is ordered by the Engineer.

455-11.13 Static Load Tests: The quantity to be paid for will be the number of static load tests of the designated tonnages, each, as shown in the plans or authorized by the Engineer, actually applied to piles, completed and accepted in accordance with the plans and these Specifications.

455-11.14 Preformed Pile Holes: The quantity to be paid for will be 30% of one foot of piling for each foot of completed Preformed Pile Holes from existing ground or the bottom of any required excavation, whichever is lower, to the bottom of preformed hole acceptably provided, complete for the installation of the bearing piles, regardless of the type of pile installed therein. Only those holes authorized to be paid for, as provided in 455-5.9.3, will be included in the measurement for payment. The Engineer will authorize payment for Preformed Pile Holes only when the pile has been placed in proper position and has achieved the required penetration.

455-12 Basis of Payment (All Piling).

455-12.1 Treated Timber Piling: Price and payment will be full compensation for furnishing all materials, including collars, metal shoes, copper cover sheets, preservatives and tar, and for wrapping pile clusters with wire cable, where so shown in the plans.

455-12.2 Prestressed Concrete Piling: Price and payment will be full compensation for the cost of furnishing and placing all reinforcing steel, predrilled holes, furnishing the material for and wrapping pile clusters with wire cable where so shown in the plans and grouting of preformed pile holes when shown in the plans. Payment will be made in two increments: 70% of the unit price for Prestressed Concrete Piling for each foot fabricated and accepted as stockpiled materials, and 30% of the unit price for Prestressed Concrete Piling for the entire authorized length upon completion of driving.

455-12.3 Steel Piling: Price and payment will be full compensation for all labor, equipment, and materials required for furnishing and installing Steel Piling, including welding and painting as specified and the cost of predrilling pile holes described in 455-5.1.1. The cost of any sand or concrete fill and reinforcing

steel in pipe piles will be included in the price for Steel Piling. Payment will be made in two increments: 70% of the unit price for Steel Piling for each foot (meter) fabricated and accepted as stockpiled materials and 30% of the unit price for Steel Piling for the entire authorized length upon completion of driving.

Bracing and other metal parts attached to or forming a part of piling or bracing and not otherwise classified, will be measured and paid for as provided in Section 460.

455-12.4 Test Piles: Price and payment will be full compensation for all incidentals necessary to complete all the work of this item except splices, build-ups, pile extractions and preformed pile holes authorized by the Engineer and paid for under other pay items or payment methods. The cost of all additional work not listed above necessary to ensure required penetration and attain required bearing of the test piles will be included in the price bid per foot of Test Pile, including driving and all other related costs. Payment will be made in two increments: 70% of the unit price for Test Piles for each foot fabricated and accepted as stockpiled materials, and 30% of the unit price for Test Piles for the entire authorized length upon completion of driving.

455-12.5 Dynamic Load Tests:

455-12.5.1 Dynamic Load Tests/ Test Piles: No separate payment will be made for dynamic load tests on test piles. Anticipate all test piles will require dynamic load tests, and include all costs associated with dynamic load tests in the pay items for test piles.

455-12.5.2 Dynamic Load Tests/ Production Piles: Price and payment will be full compensation for all labor, equipment, and materials required to assist the Engineer in performing this work. Payment for each dynamic load test on a production pile authorized by the Engineer will be made as 20 feet of additional piling.

455-12.6 Steel Sheet Piling:

455-12.6.1 Permanent Sheet Piling: Price and payment will be full compensation for all labor, equipment, and materials required for furnishing and installing steel sheet piling including preformed holes and coating, but will not include furnishing and placing anchors when an anchored wall system is designed and detailed in the plans. In such cases, furnishing and installing anchors will be paid for separately.

455-12.6.2 Temporary Sheet Piling: For critical temporary steel sheet pile walls, walls which are necessary to maintain the safety of the traveling public or structural integrity of nearby structures, roadways and utilities during construction, that are detailed in the plans, price and payment will be full compensation for all labor, equipment, and materials required for furnishing and installing steel sheet piling including preformed holes when shown in the plans, and including wales, anchor bars, dead men, soil anchors, proof tests, creep tests, and other incidental items when an anchored wall system is required. Removal of the sheet piling, anchors, and incidentals will be included in the cost per square foot for Steel Sheet Piling (Critical Temporary). When the temporary steel sheet pile walls are not detailed in the plans, the cost of furnishing and installation shall be incidental to cost of other related items and no separate payment shall be made. If the wall is not shown in the plans, but deemed to be critical as

determined by the Engineer, then a design shall be furnished by the Department and paid for separately under Steel Sheet Piling (Critical Temporary).

455-12.7 Concrete Sheet Piling: Price and payment will be full compensation for furnishing all materials, including reinforcing steel, grouting, plastic filter fabric, preformed holes and installation.

455-12.8 Fiberglass Structurally Reinforced Composite Piles: Price and payment will be full compensation for all labor, equipment and materials required to furnish and install the piles to the elevation shown in the plans. No separate payment will be made for pile cut-offs.

455-12.9 Preformed Pile Holes: There will be no separate pay item for Preformed Pile Holes. Payment will be made as the unit price for Piling of the applicable pile type (excluding sheet pile) for 30% of each foot of hole which is preformed when authorized by the Engineer. Price and payment will be full compensation for all labor, equipment, casings and materials required to perform this work.

455-12.10 Protection of Existing Structures: Price and payment will be full compensation for all labor, equipment, and materials required to perform this work.

455-12.11 Point Protectors: Price and payment will be full compensation for all labor, equipment, and materials required to perform this work.

455-12.12 Static Load Tests: Price and payment will be full compensation for all labor, equipment, and materials required to perform this work.

455-12.13 Pile Splices: The quantity of this item will be determined as provided in 455-11.9. Payment for each Steel Pile Splice authorized by the Engineer will be made as 20 feet of additional steel piling. Payment for each Concrete Pile Splice authorized and approved by the Engineer will be made as 30 feet of additional prestressed concrete piling.

455-12.14 Pile Cut-Off: There will be no separate pay item for pile cut-off. Anticipate all piles will require cutting-off, and include all costs associated with pile cut-off in the pay items for piling.

455-12.15 Payment Items: Payment will be made under:

Item No. 455- 2-	Treated Timber Piling - per foot.
Item No. 455- 14-	Concrete Sheet Piling - per foot.
Item No. 455- 18-	Protection of Existing Structures - lump sum.
Item No. 455- 34-	Prestressed Concrete Piling - per foot.
Item No. 455- 35-	Steel Piling - per foot.
Item No. 455- 36-	Concrete Cylinder Piling - per foot.
Item No. 455- 37-	Fiberglass Structurally Reinforced Composite Piles-per foot.
Item No. 455-119-	Test Loads- each.
Item No. 455-120-	Point Protection - each.
Item No. 455-133-	Steel Sheet Piling - per square foot.
Item No. 455-143-	Test Piles (Prestressed Concrete) - per foot.
Item No. 455-144-	Test Piles (Steel) - per foot.

Item No. 455-145- Test Piles (Concrete Cylinder) - per foot.

C. DRILLED SHAFTS

455-13 Description.

Construct drilled shaft foundations consisting of reinforced, or unreinforced when indicated in the plans, concrete drilled shafts with or without bell footings.

455-14 Materials.

455-14.1 Concrete: For all concrete materials, meet the requirements of Section 346. Use concrete that is specified in the plans.

455-14.2 Reinforcing Steel: Meet the reinforcing steel requirements of Section 415. Ensure that reinforcing steel is in accordance with the sizes, spacing, dimensions, and the details shown in the plans.

455-15 Construction Methods and Equipment.

455-15.1 General Requirements:

455-15.1.1 Templates: Provide a fixed template, adequate to maintain shaft position and alignment during all excavation and concreting operations, when drilling from a barge. Do not use floating templates (attached to a barge). The Engineer will not require a template for shafts drilled on land provided the Contractor demonstrates satisfactorily to the Engineer that shaft position and alignment can be properly maintained. The Engineer will require a fixed template, adequate to maintain shaft position and alignment during all excavation and concreting operations, for shafts drilled on land when the Contractor fails to demonstrate satisfactorily that he can properly maintain shaft position and alignment without use of a template.

455-15.1.2 Drilled Shaft Installation Plan: At the preconstruction conference submit a drilled shaft installation plan for review by the Engineer. Final approval will be subject to satisfactory performance. Include in this plan the following details:

1. Name and experience record of drilled shaft superintendent or foreman in responsible charge of drilled shaft operations. Ensure the drilled shaft superintendent or foreman in responsible charge of the drilled shaft operations has a minimum of one year of experience of installing drilled shafts of the size and depth shown in the plans and a minimum of three years experience in the construction of drilled shafts using the following methods:

   a. Mineral slurry,

   b. Casings up to the length shown in the plans,

   c. Shaft drilling operations on water under conditions as shown in the plans.

2. List and size of proposed equipment, including cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, slurry pumps, core sampling equipment, tremies or concrete pumps, casings, etc.

3. Details of sequence of construction operations and sequence of shaft construction in bents or shaft groups.

4. Details of shaft excavation methods and drilling log procedures.

5. Details of slurry, including proposed methods to mix, circulate, desand, test methods, and proposed testing laboratory to document test results.

6. Details of proposed methods to clean shaft after initial excavation.

7. Details of shaft reinforcement, including methods to ensure centering/required cover, cage integrity during placement, placement procedures, cage support, and tie downs.

8. Details of concrete placement, including elapsed concrete placement times and proposed operational procedures for concrete tremie or pump, including initial placement, raising during placement, and overfilling of the shaft concrete. Provide provisions to ensure proper final shaft cutoff elevation.

9. Details of casing removal when removal is required, including minimum concrete head in casing during removal.

10. Required submittals, including shop drawing and concrete design mixes.

11. Details of any required load tests, including equipment and procedures, and recent calibrations for any jacks or load cells.

12. Details of any required cross-hole-sonic logging (CSL) tubes, test equipment, procedures and proposed CSL Specialty Engineer to perform, log, analyze, and report the test results.

13. Methods and equipment proposed to prevent displacement of casing and/or shafts during placement and compaction of fill.

14. Details of environmental control procedures used to prevent loss of slurry or concrete into waterways or other protected areas.

15. Proposed schedule for test shaft installation, load tests and production shaft installation.

16. Other information shown in the plans or requested by the Engineer.

17. For drilled shafts for miscellaneous structures constructed using polymer slurry, identify the polymer slurry meeting the requirements of 455-15.8.2, the pH and viscosity ranges recommended by the manufacturer for the materials to be excavated and a description of the mixing method to be used. Submit the Material Safety Data Sheets (MSDS) for the product, and certifications that the polymer slurry and components meet the requirements of 455-15.8.2. Submit the contact information for the manufacturer's representative available for immediate contact during shaft construction and the representative's schedule of availability.

The Engineer will evaluate the drilled shaft installation plan for conformance with the Contract Documents. Within 20 days after receipt of the plan, the Engineer will notify the Contractor of any additional information required and/or changes that may be necessary in the opinion of the Engineer to satisfy the Contract Documents. The Engineer will reject any part of the plan that is unacceptable. Submit changes agreed upon for reevaluation. The Engineer will notify the Contractor within seven days after receipt of proposed changes of their acceptance or rejection. All equipment and procedures are subject to trial and satisfactory performance in the field.

Acceptance by the Engineer does not relieve the Contractor of the responsibility to perform the work in accordance with the Contract Documents. The Installation Plan is for the Contractor to explain the approach to the work and allow the Engineer an opportunity to comment on the equipment and procedures chosen before field operations begin. The Engineers acceptance is not a guarantee that the chosen methods and equipment are capable of obtaining the required results, this responsibility lies with the Contractor.

455-15.1.3 General Methods & Equipment: Perform the excavations required for the shafts and bell footings, through whatever materials encountered, to the dimensions and elevations shown in the Contract Documents, using methods and equipment suitable for the intended purpose and the materials encountered. Provide equipment capable of constructing shafts supporting bridges to a depth equal to the deepest shaft shown in the plans plus 15 foot or plus three times the shaft diameter, whichever is greater, except when the plans require equipment capable of constructing shafts to a deeper depth. Provide equipment capable of constructing shafts supporting non-bridge structures, including mast arms, signals, signs and light supports to a depth equal to the deepest shaft shown in the plans plus 5 feet.

Construct drilled shafts according to the Contract Documents using generally either the dry method, wet method, casing method, or permanent casing method as necessary to produce sound, durable concrete foundation shafts free of defects. Use the permanent casing method only when required by the plans or authorized by the Engineer. When the plans describe a particular method of construction, use this method except when permitted otherwise by the Engineer after field trial. When the plans do not describe a particular method, propose a method on the basis of its suitability to the site conditions and submit it for approval by the Engineer.

Set a suitable temporary removable surface casing to at least 1-1/2 shaft diameters below the ground surface to prevent caving of the surface soils and to aid in maintaining shaft position and alignment except as noted in 455-15.8.3. The Engineer may require predrilling with slurry and/or overreaming to the outside diameter of the casing to install the surface casing at some sites.

455-15.2 Dry Construction Method: Use the dry construction method only at sites where the ground water table and soil conditions, generally stiff to hard clays or rock above the water table, make it feasible to construct the shaft in a relatively dry excavation and where the sides and bottom of the shaft are stable and may be visually inspected by the Engineer prior to placing the concrete.

In applying the dry construction method, drill the shaft excavation, remove accumulated seepage water and loose material from the excavation and place the shaft concrete in a relatively dry excavation.

Use the dry construction method only when shaft excavations, as demonstrated in a test hole, have 12 inches or less of seepage water accumulated over a four hour period, the sides and bottom remain stable without detrimental caving, sloughing, or swelling for a four hour period, and the loose material and water can be satisfactorily removed prior to inspection and prior to placing concrete. Use the wet construction method or the casing construction method for shafts that do not meet the requirements for the dry construction method.

455-15.3 Wet Construction Method: Use the wet construction method at all sites where it is impractical to provide a dry excavation for placement of the shaft concrete.

The wet construction method consists of drilling the shaft excavation below the water table, keeping the shaft filled with fluid (mineral slurry, natural slurry or water), desanding and cleaning the mineral slurry and final cleaning of the excavation by means of a bailing bucket, air lift, submersible pump or other approved devices and placing the shaft concrete (with a tremie or concrete pump extending to the shaft bottom) which displaces the water or slurry during concreting of the shaft excavation. Provide temporary surface casings from at least one foot above the ground surface to at least 1-1/2 shaft diameters below the ground surface to aid shaft alignment and position, to prevent sloughing of the top of the shaft, to provide for additional slurry head inside the shaft and to facilitate overpouring of the shaft during concreting.

Where drilled shafts are located in open water areas, construct the shafts by the wet method using exterior casings extending from above the water elevation into the ground to protect the shaft concrete from water action during placement and curing of the concrete. Install the exterior casing in a manner that will produce a positive seal at the bottom of the casing so that there is no intrusion or extrusion of water or other materials into or from the shaft excavation.

Expandable or split casings that are removable are not permitted for use below the water surface.

455-15.4 Temporary Casing Construction Method: Use the temporary casing method at all sites where it is inappropriate to use the dry or wet construction methods without the use of temporary casings other than surface casings. In this method, the casing is advanced prior to excavation. When a formation is reached that is nearly impervious, seal in the nearly impervious formation. Proceed with drilling as with the wet method to the projected depth. Proceed with the placement of the concrete as with the dry method except withdraw the casing after placing the concrete. In the event seepage conditions prevent use of the dry method, complete the excavation and concrete placement using wet methods.

Where drilling through materials having a tendency to cave, advance the excavation by drilling in a mineral slurry. In the event that a caving layer or layers are encountered that cannot be controlled by slurry, install temporary removable casing through such caving layer or layers. The Engineer may require overreaming to the outside diameter of the casing. Take whatever steps are required to prevent caving during shaft excavation including installation of deeper casings. If electing to remove a casing and replace it with a longer casing through caving soils, backfill the excavation. The Contractor may use soil previously excavated or soil from the site to backfill the excavation. The Contractor may use other approved methods which will control the size of the excavation and protect the integrity of the foundation soils to excavate through caving layers.

Before withdrawing the casing, ensure that the level of fresh concrete is at such a level that the fluid trapped behind the casing is displaced upward. As

the casing is withdrawn, maintain the level of concrete within the casing so that fluid trapped behind the casing is displaced upward out of the shaft excavation without mixing with or displacing the shaft concrete.

The Contractor may use the casing method, when approved by the Engineer, to construct shafts through weak caving soils that do not contribute significant shaft shear resistance. In this case, place a temporary casing through the weak caving soils before beginning excavation. Conduct excavation using the dry construction method where appropriate for site conditions and the wet construction method where the dry construction method is not appropriate. Withdraw the temporary casing during the concreting operations unless the Engineer approves otherwise.

455-15.5 Permanent Casing Construction Method: Use the permanent casing method when required by the plans. In this method, place a casing to the prescribed depth before beginning excavation. If the Contractor cannot attain full penetration, the Engineer may direct the Contractor to excavate through the casing and advance the casing until reaching the desired penetration. In some cases the Engineer may require the Contractor to over ream the outside diameter of the casing before placing the casing.

Cut the casing off at the prescribed elevation upon reaching the proper construction sequence and leave the remainder of the casing in place.

455-15.6 Excavations: When pilot holes and/or load tests are performed, the Engineer will use the pilot hole and/or load test results to determine the authorized tip elevations and/or the authorized installation criteria of the drilled shafts. Drilled shaft construction shall not begin until pilot hole and/or load test reports are approved by the Engineer. Shaft tip elevations based on pilot hole results and/or load tests may vary from the Tip Elevations presented in the plans. Extend drilled shaft excavations deeper by extra depth excavation when the Engineer determines the material encountered while drilling the shaft excavation is unsuitable and/or is not the same as anticipated in the design of the drilled shaft. In the absence of suitable strength tests or load tests to evaluate materials excavated, construct the shafts no higher than the Tip Elevations shown in the plans.

455-15.6.1 Pilot Hole: When pilot holes are shown in the plans core a pilot hole, prior to shaft excavation, in accordance with ASTM D 2113 Standard Practice for Diamond Core Drilling for Site Excavation and the Department's Soils & Foundations Handbook using a double or triple wall core barrel through part or all of the shaft, to a depth of 3 times the diameter of the drilled shaft below the tip elevation shown in the plans, as directed by the Engineer. The Engineer may require the Contractor to cut any core to a total depth below the bottom of the drilled shaft excavation of up to 5 times the diameter of the drilled shaft.

455-15.6.2 Cores: Take cores when shown in the plans or directed by the Engineer to determine the character of the material directly below the shaft excavation. Provide equipment to retrieve the core from a depth of 5 times the diameter of the drilled shaft below the bottom of the drilled shaft excavation in accordance with ASTM D 2113 Standard Practice for Diamond Core Drilling for Site Excavation. Cut the cores with an approved core barrel to a minimum depth

of 3 times the diameter of the drilled shaft below the bottom of the drilled shaft excavation after completing the shaft excavation, as directed by the Engineer. The Engineer may require the Contractor to cut any core to a total depth below the bottom of the drilled shaft excavation of up to 5 times the diameter of the drilled shaft.

For cores or pilot holes, use only a double or triple wall core barrel designed:

(a) to cut a core sample from 4 to 6 inches in diameter, at least 5 feet in length, and,

(b) so that the sample of material cored can be removed from the shaft excavation and the core barrel in an undisturbed state, and

The Engineer will inspect the cores and determine the depth of required excavation. When considered necessary by the Engineer, take additional cores. Place the core samples in suitable containers, identified by shaft location, elevation from and to, and job number, and deliver to the Department within 48 hours after cutting. When called for in the plans, substitute Standard Penetration Tests (SPT) for coring. In such cases, supply these tests at no additional cost per foot to the Department above that bid for core (shaft excavation).

Provide areas for the disposal of unsuitable materials and excess materials as defined in 120-5 that are removed from shaft excavations, and dispose of them in a manner meeting all requirements pertaining to pollution.

When shown in the plans, excavate bells to form a bearing area of the size and shape shown. Bell outlines varying from those shown in the plans are permissible provided the bottom bearing area equals or exceeds that specified. If the diameter of the bell exceeds three times the shaft diameter, drill the excavation deeper as directed and form a new bell footing. Excavate bells by mechanical methods.

Furnish the additional drilled shaft concrete over the theoretical amount required to complete filling any excavations for bells and shafts which are larger than required by the plans or authorized by the Engineer, at no expense to the Department.

455-15.7 Casings: Ensure that casings are metal, or concrete when indicated in the plans, of ample strength to withstand handling and driving stresses and the pressure of concrete and of the surrounding earth materials, and that they are smooth and water tight. Ensure that the inside diameter of casing is not less than the specified size of shaft except as provided below. The Department will not allow extra compensation for concrete required to fill an oversize casing or oversize excavation.

The Engineer will allow the Contractor to supply casing with an outside diameter equal to the specified shaft diameter (O.D. casing) provided he supplies additional shaft length at the shaft tip. Determine the additional length of shaft required by the following relationship:

$$Additional\ Length = \frac{(D_1 - D_2)\,L}{D_2}$$

where:

D_1= casing inside diameter specified = shaft diameter specified

D_2= casing inside diameter provided (D_2 = D_1 minus twice the wall thickness).

L= authorized shaft length below ground for temporary casing methods or below casing for permanent casing methods.

Bear all costs relating to this additional length including but not limited to the cost of extra excavation, extra concrete, and extra reinforcing steel.

Remove all casings from shaft excavations except those used for the Permanent Casing Method. Ensure that the portion of casings installed under the Permanent Casing Method of construction below the shaft cut-off elevation remains in position as a permanent part of the Drilled Shaft. The Contractor may leave casings if in the opinion of the Engineer the casings will not adversely affect the shaft capacity in place. When casings that are to be removed become bound in the shaft excavation and cannot be practically removed, drill the shaft excavation deeper as directed by the Engineer to compensate for loss of capacity due to the presence of the casing. The Department will not compensate for the casing remaining. The Department will pay for the additional length of shaft under Item No. 455-88 and the additional excavation under Item No. 455-125.

If temporary casing is advanced deeper than the Minimum Top of Rock Socket Elevation shown in the plans or actual top of rock elevation if deeper, withdraw the casing from the rock socket and over ream the shaft. If the temporary casing cannot be withdrawn from the rock socket before final cleaning, extend the length of rock socket below the authorized tip elevation one-half of the distance between the Minimum Top of Rock Socket Elevation or actual elevation if deeper, and the temporary casing tip elevation.

When the shaft extends above ground or through a body of water, the Contractor may form the portion exposed above ground or through a body of water, with removable casing except when the Permanent Casing Method is specified (see 455-23.10). When approved, the Contractor may form drilled shafts extending through a body of water with permanent or removable casings. However, for permanent casings, remove the portion of metal casings between an elevation 2 feet below the lowest water elevation or 2 feet below ground whichever is higher and the top of shaft elevation after the concrete is cured. Dismantle casings removed to expose the concrete as required above in a manner which will not damage the drilled shaft concrete. Dismantle removable casings in accordance with the provisions of 455-17.5.

Generally when removal of the temporary casing is required, do not start the removal until completing all concrete placement in the shaft. The Engineer will permit movement of the casing by rotating, exerting downward pressure, and tapping it to facilitate extraction, or extraction with a vibratory hammer. Extract casing at a slow, uniform rate with the pull in line with the axis of the shaft. Withdraw temporary casings while the concrete remains fluid.

When conditions warrant, the Contractor may pull the casing in partial stages. Maintain a sufficient head of concrete above the bottom of the casing to overcome the hydrostatic pressure of water outside the casing. At all times maintain the elevation of the concrete in the casing high enough to displace the

drilling slurry between the outside of the casing and the edge of the hole while removing the casing.

The Contractor may use special casing systems in open water areas, when approved, which are designed to permit removal after the concrete has hardened. Design special casings so that no damage occurs to the drilled shaft concrete during their removal.

455-15.8 Slurry and Fluid in Excavation at Time of Concrete Placement:

455-15.8.1 Mineral Slurry: When mineral slurry is used in an excavation, use only processed attapulgite or bentonite clays. Use mineral slurry having a mineral grain size such that it will remain in suspension and having sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. Use a percentage and specific gravity of the material to make the suspension sufficient to maintain the stability of the excavation and to allow proper placement of concrete. Ensure that the material used to make the slurry is not detrimental to concrete or surrounding ground strata. During construction, maintain the level of the slurry at a height sufficient to prevent caving of the hole. In the event of a sudden significant loss of slurry such that the slurry level cannot practically be maintained by adding slurry to the hole, backfill the excavation and delay the construction of that foundation until an alternate construction procedure has been approved.

Thoroughly premix the mineral slurry with clean fresh water prior to introduction into the shaft excavation. Ensure that the percentage of mineral admixture used to make the suspension is such as to maintain the stability of the shaft excavation. The Engineer will require adequate water and/or slurry tanks when necessary to perform the work in accordance with these Specifications. The Engineer will not allow excavated pits on projects requiring slurry tanks without the written permission of the Engineer. Take the steps necessary to prevent the slurry from "setting up" in the shaft, including but not limited to agitation, circulation, and/or adjusting the composition and properties of the slurry. Provide suitable offsite disposal areas and dispose of all waste slurry in a manner meeting all requirements pertaining to pollution.

Provide a qualified professional soil testing laboratory approved by the Engineer to perform control tests using suitable apparatus on the mineral slurry mixture to determine the following parameters:

(a) Freshly mixed mineral slurry: Measure the density of the freshly mixed mineral slurry regularly as a check on the quality of the suspension being formed using a measuring device calibrated to read within ±0.5 lb/ft^3.

(b) Mineral slurry supplied to the drilled shaft excavation: Perform the following tests on the mineral slurry supplied to the shaft excavation and ensure that the results are within the ranges stated in the table below:

Item to be measured	Range of Results at 68ºF	Test Method
Density	64 to 73 lb/ft^3 (in fresh water environment) 66 to 75 lb/ft^3 (in salt water environment)	Mud density balance: FM 8-RP13B-1

Item to be measured	Range of Results at 68ºF	Test Method
Viscosity	28 to 40 seconds	Marsh Cone Method: FM 8-RP13B-2
pH	8 to 11	Electric pH meter or pH indicator paper strips: FM 8-RP13B-4
Sand Content	4% or less	FM 8-RP13B-3

The Contractor may adjust the limits in the above table when field conditions warrant as successfully demonstrated in a Test Hole or with other methods approved by the Engineer. The Engineer must approve all changes in writing before the Contractor can continue to use them.

Perform tests to determine density, viscosity, and pH value to establish a consistent working pattern, taking into account the mixing process and blending of freshly mixed mineral slurry and previously used mineral slurry. Perform a minimum of four sets of tests to determine density, viscosity, and pH value during the first 8 hours mineral slurry is in use.

When the results show consistent behavior, discontinue the tests for pH value, and only carry out tests to determine density and viscosity during each four hours mineral slurry is in use. If the consistent working pattern changes, reintroduce the additional tests for pH value for the time required to establish consistency of the test values within the required parameters.

(c) Furnish reports of all mineral slurry tests required above, signed and sealed by a Specialty Engineer, representing the soil testing laboratory to the Department on completion of each drilled shaft.

(d) The Department may perform comparison tests as determined necessary during the mineral slurry operations.

During construction, maintain the level of mineral slurry in the shaft excavation within the excavation and at a level not less than 4 feet above the highest expected piezometric water pressure along the depth of a shaft.

At any time the wet construction method of stabilizing excavations fails, in the opinion of the Engineer, to produce the desired final result, discontinue this method of construction, and propose modifications in procedure or alternate means of construction for approval.

455-15.8.2 Polymer Slurry For Shafts For Miscellaneous Structures:

Materials manufactured expressly for use as polymer slurry for drilled shafts may be used as slurry for drilled shaft excavations up to 60 inches in diameter installed to support mast arms, cantilever signs, overhead truss signs, high mast light poles or other miscellaneous structures. A representative of the manufacturer must be on-site or available for immediate contact to assist and guide the construction of the first three drilled shafts at no additional cost to the Department. This representative must also be available for on-site assistance or immediate contact if problems are encountered during the construction of the remaining drilled shafts as determined by the Engineer. The Engineer will not allow polymer slurries during construction of drilled shafts for bridge foundations. Use polymer slurry only if the soils below the casing are not

classified as organic, and the pH of the fluid in the hole can be maintained in accordance with the manufacturer's published recommendations. Submit the Material Safety Data Sheets (MSDS) for the product, the manufacturer's published mixing procedures, and the manufacturer's published range of values for pH and viscosity of the mixed slurry. Certify that the polymer slurry and components meet the following requirements:

a. The polymer slurries to be used on the project and their waste products are classified as non-hazardous as defined by Resource Conservation and Recovery Act (RCRA) Subpart C rules, Table 1 of 40 CFR 261.24 Toxicity Characteristic.

b. Pull out tests demonstrate the bond between the bar reinforcement and the concrete is not materially affected by exposure to the slurry under typical construction conditions, over the typical range of slurry viscosities to be used.

c. The slurry does not have a detrimental effect on the strength or quality of the concrete as a result of continuous contact with the concrete, and when 10% of the concrete mix water is replaced by slurry, over the typical range of slurry viscosities to be used.

d. Load tests demonstrate the bond between the concrete and the soil is not materially affected by exposure to the slurry under typical construction conditions, over the typical range of slurry viscosities to be used for the project.

e. The method of disposal meets the approval of all federal, state and local regulatory authorities.

Perform the following tests on the polymer slurry in the shaft excavation and ensure that the results are maintained within the ranges stated in the table below:

Mixed Polymer Slurry Properties		
Item to be measured	Range of Results at 68ºF	Test Method
Density	62 to 64 lb/ft^3 (fresh water) 64 to 66 lb/ft^3 (salt water)	Mud density balance: FM 8-RP13B-1
Viscosity	Range Published By The Manufacturer for Materials Excavated	Marsh Cone Method: FM 8-RP13B-2
pH	Range Published By The Manufacturer for Materials Excavated	Electric pH meter or pH indicator paper strips: FM 8-RP13B-4
Sand Content	0.5% or less	FM 8-RP13B-3

During construction, maintain the level of the slurry at a height sufficient to prevent caving of the hole. At any time the wet construction method of stabilizing excavations fails, in the opinion of the Engineer, to produce the desired final result, discontinue this method of construction, and propose modifications in procedure or alternate means of construction for approval.

455-15.8.3 Exceptions for Drilled Shafts for Miscellaneous Structures: For drilled shafts up to 60 inches in diameter installed to support mast arms, cantilever signs, overhead truss signs, high mast light poles or other miscellaneous structures:

a. Provide temporary surface casings from at least one foot above the ground surface to at least five feet below the ground surface to aid shaft alignment and position, to prevent sloughing of the top of the shaft, to provide for additional slurry head inside the shaft and to facilitate overpouring of the shaft during concreting.

b. Fill the excavation with premixed mineral slurry meeting the requirements of 455-15.8.1 or polymer slurry meeting the requirements of 455-15.8.2 before the drill advances to the bottom of the temporary casing. Do not attempt to excavate the shaft excavation using plain water or "natural" slurry. Polymer slurry may be mixed in the field in accordance with the manufacturer's published procedures.

455-15.8.4 Fluid In Excavation At Time Of Concrete Placement: When any fluid is present in any drilled shaft excavation, including shafts to support miscellaneous structures, the applicable test methods and reporting requirements described in 455-15.8.1 apply to tests of fluid in the shaft prior to placing the concrete.

Take samples of the fluid in the shaft from the base of the shaft and at intervals not exceeding 10 feet up the shaft, using an approved sampling tool. Take whatever action is necessary prior to placing the concrete to bring the fluid within the specification and reporting requirements, outlined in the tables in 455-15.8.1, except as follows:

The Engineer will not require tests for pH or viscosity when slurry has not been introduced into the shaft excavation.

When using polymer slurry to support the excavation for drilled shafts installed to support mast arms, cantilever signs, overhead truss signs, high mast light poles or other miscellaneous structures, take whatever action is necessary prior to placing the concrete to bring the properties of the fluid within the ranges in 455-15.8.2.

When using slurry, engage an approved soil testing laboratory to provide a CTQP qualified drilled shaft inspector, or provide an experienced person approved by the Engineer to perform slurry testing. The Department may also perform comparison tests. Provide equipment for such comparison tests when requested by the Engineer.

455-15.9 Tremies and Pumps:

455-15.9.1 General: The requirements of the applicable provisions of Section 400 will apply when using a tremie or a pump to place drilled shaft concrete.

455-15.9.2 Dry Excavations: Ensure that the tremie for depositing concrete in a dry drilled shaft excavation consists of a tube of solid construction, a tube constructed of sections which can be added and removed, or a tube of other approved design. The Contractor may pass concrete through a hopper at the top of the tube or through side openings as the tremie is retrieved during concrete placement. Support the tremie so that the free fall of the concrete is less than

5 feet at all times. If the free falling concrete causes the shaft excavation to cave or slough, control the movement of concrete by reducing the height of free fall of the concrete and/or reducing the rate of flow of concrete into the excavation.

455-15.9.3 Wet Excavations: Construct the tremie or pump line used to deposit concrete beneath the surface of water so that it is water-tight and will readily discharge concrete. Construct the discharge end of the tremie or pump line to prevent water intrusion and permit the free flow of concrete during placement operations. Ensure that the tremie or pump line has sufficient length and weight to rest on the shaft bottom before starting concrete placement. Ensure that the discharge end of the tremie or pump line is embedded at least 10 feet into the concrete at all times during placement operations after 10 feet of concrete has been placed. Ensure that the free fall of concrete into the hopper is less than 5 feet at all times. Support the tremie so that it can be raised to increase the discharge of concrete and lowered to reduce the discharge of concrete. The Engineer will not allow rapid raising or lowering of the tremie to increase the discharge of the concrete. Maintain a continuous flow of concrete and a positive pressure differential of the concrete in the tremie or pump line at all times to prevent water or slurry intrusion into the shaft concrete.

455-15.10 Excavation and Drilling Equipment:

455-15.10.1 General: All shaft excavation is Unclassified Shaft Excavation. The Engineer will require Drilled Shaft Sidewall Overreaming when inspections show it to be necessary. These terms are defined in 455-15.10.2, 455-15.10.3, and 455-15.10.4, respectively.

Use excavation and drilling equipment having adequate capacity, including power, torque, and crowd (downthrust), and excavation and overreaming tools of adequate design, size, and strength to perform the work shown in the plans or described herein. When the material encountered cannot be drilled using conventional earth augers and/or under reaming tools, provide special drilling equipment, including but not limited to rock augers, core barrels, rock tools, air tools, blasting materials, and other equipment as necessary to continue the shaft excavation to the size and depth required. In the event blasting is necessary, obtain all necessary permits. The Contractor is responsible for the effects of blasting on already completed work and adjacent structures. The Engineer must approve all blasting.

455-15.10.2 Unclassified Shaft Excavation: Unclassified Shaft Excavation is defined as all processes required to excavate a drilled shaft of the dimensions shown in the Contract Documents to the depth indicated in the plans plus 15 feet or plus 3 shaft diameters, whichever is deeper, completed and accepted. Include in the work all shaft excavation, whether the material encountered is soil, rock, weathered rock, stone, natural or man-made obstructions, or materials of other descriptions.

455-15.10.3 Unclassified Extra Depth Excavation: Unclassified Extra Depth Excavation is defined as all processes required to excavate a drilled shaft of plan dimensions which is deeper than the limits defined as Unclassified Shaft Excavation.

455-15.10.4 Drilled Shaft Sidewall Overreaming: Drilled Shaft Sidewall Overreaming is defined as the unclassified excavation required to

roughen its surface or to enlarge the drilled shaft diameter due to softening of the sidewalls or to remove excessive buildup of slurry cake when slurry is used. Increase the shaft radius a minimum of 1/2 inch and a maximum of 3 inches by overreaming. The Contractor may accomplish overreaming with a grooving tool, overreaming bucket, or other approved equipment.

Meet the limit for depth of sidewall overreaming into the shaft sidewall material and the elevation limits between which sidewall overreaming is required.

455-15.11 Inspection of Excavations:

455-15.11.1 Dimensions and Alignment: Provide equipment for checking the dimensions and alignment of each permanent shaft excavation. Determine the dimensions and alignment of the shaft excavation under the observation and direction of the Department. Generally check the alignment and dimensions by any of the following methods as necessary:

(a) Check the dimensions and alignment of dry shaft excavations using reference stakes and a plumb bob.

(b) Check the dimensions and alignment of casing when inserted in the excavation.

(c) Insert a casing in shaft excavations temporarily for alignment and dimension checks.

(d) Insert a rigid rod or pipe assembly with several 90-degree offsets equal to the shaft diameter into the shaft excavation for alignment and dimension checks.

Insert any casing, rod or pipe assembly, or other device used to check dimensions and alignment into the excavation to full depth.

455-15.11.2 Depth: Generally reference the depth of the shaft during drilling to appropriate marks on the Kelly bar or other suitable methods. Measure final shaft depths with a suitable weighted tape or other approved methods after final cleaning.

455-15.11.3 Shaft Inspection Device: The Engineer, when shown in the plans, will furnish and use an inspection device comprised of a television camera sealed inside a water-tight jacket to inspect the bottoms of the shafts. The Engineer may also use a sidewall sampler attached to the inspection device to sample the sides of the shafts. Cooperate with the Engineer in using this inspection device, including placing the inspection device in position for inspection and removing it after the inspection. Furnish 110 V single phase current (minimum 30A service), 220 V single phase current (minimum 15A service), and a 150 psi compressor (8 cfm minimum) to operate the device. Include all cost related to the inspection device in the cost of drilled shaft items.

Provide the projected drilled shaft construction schedule to the Engineer at the preconstruction conference so that the inspection device may be scheduled. Include in the bid the cost of transporting the inspection device from its storage location to the job site and back.

Assume responsibility for the device from the time it leaves its storage area until the time it is returned. During this time, insure the device against loss or damage for the replacement cost thereof (the greater of $400,000

or the amount shown in the plans) or for the full insurable value if replacement cost insurance is not available.

Return the device in good working condition to its proper location within 30 days after completing the drilled shafts. Notify the Department at least ten working days before returning the inspection device.

455-15.11.4 Shaft Cleanliness Requirements: Adjust cleaning operations so a minimum of 50% of the bottom of each shaft will have less than 1/2 inch of sediment at the time of placement of the concrete. Ensure the maximum depth of sedimentary deposits or any other debris at any place on the bottom of the shaft excavation does not exceed 1 1/2 inches. The Engineer will determine shaft cleanliness by visual inspection for dry shafts, using divers or an inspection device or other methods the Engineer deems appropriate for wet shafts.

When using slurry, meet the requirements of 455-15.8 at the time of concrete placement.

455-15.11.4.1 Exceptions for Shafts for Miscellaneous Structures: Ensure the depth of sedimentary deposits or other debris does not exceed 1 inch over the bottom of the shaft when installing drilled shafts up to 60 inches in diameter installed to support mast arms, cantilever signs, overhead truss signs, high mast light poles or other miscellaneous structures.

455-15.11.5 Time of Excavation: Any unclassified excavation work lasting more than 36 hours (measured from the beginning of excavation for all methods except the Permanent Casing Method, which begins at the time excavation begins below the casing) before placement of the concrete may require overreaming the sidewalls to the depth of softening or removing excessive slurry cake buildup as indicated by samples taken by the sidewall sampler or other test methods employed by the Engineer. Ensure that the minimum depth of overreaming the shaft sidewall is 1/2 inch and the maximum depth is 3 inches. Provide any overreaming required at no expense to the Department when exceeding the 36 hour limit unless the time limit is exceeded solely to accomplish excavating deeper than the elevation shown in the plans as ordered by the Engineer. The Department will pay the Contractor for authorized overreaming resulting from softening or excessive filtercake buildup which is indicated by sidewall samples or other test methods employed by the Engineer during the initial 36 hour time period. The Department will pay the Contractor for authorized overreaming when sidewall samples indicate softening or excessive filter cake buildup in shaft excavations which exceed the 36 hour time limit in order to accomplish excavating deeper than the elevation shown in the plans as ordered by the Engineer.

When using mineral slurry, adjust excavation operations so that the maximum time that slurry is in contact with the bottom 5 feet of the shaft (from time of drilling to concreting) does not exceed 12 hours. If exceeding the 12 hour time limit, overream the bottom 5 feet of shaft at no additional expense to the Department prior to performing other operations in the shaft.

455-15.11.5.1 Excavation Time for Shafts for Miscellaneous Structures: For drilled shafts up to 60 inches in diameter installed to support mast arms, cantilever signs, overhead truss signs, high mast light poles or other

miscellaneous structures, all references to a 36 hour time limit is changed to a 12 hour time limit.

455-16 Reinforcing Steel Construction and Placement.

455-16.1 Cage Construction and Placement: Completely assemble and place as a unit the cage of reinforcing steel, consisting of longitudinal bars, ties, and cage stiffener bars, immediately after the Engineer inspects and accepts the shaft excavation and immediately prior to placing concrete. Tie all intersections of drilled shaft reinforcing steel with cross ties or "figure 8" ties. Use double strand ties or ties with larger tie wire when necessary. The Engineer will give final approval of the cage construction and placement subject to satisfactory performance in the field.

455-16.2 Splicing Cage: If the bottom of the constructed shaft elevation is lower than the bottom of the shaft elevation in the plans, extend a minimum of one half of the longitudinal bars required in the upper portion of the shaft the additional length. Continue the tie bars for the extra depth, spaced on 2 foot centers, and extend the stiffener bars to the final depth. The Contractor may lap splice these bars or use unspliced bars of the proper length. Do not weld bars to the planned reinforcing steel unless shown in the Contract Documents.

455-16.3 Support, Alignment, and Tolerance: Tie and support the reinforcing steel in the shaft so that the reinforcing steel will remain within allowable tolerances as specified in 455-20 and Section 415.

Use concrete wheels or other approved noncorrosive spacing devices near the bottom, within 3 feet of the top, and intervals not exceeding 15 feet along the shaft to ensure concentric spacing for the entire length of the cage. Do not use block or wire type spacers. Use a minimum of one spacer per 30 inches of circumference of cage with a minimum of three at each level. Provide spacers at the bottom of the drilled shaft reinforcing cage to maintain the specified distance between the bottom of the cage and the bottom of the shaft. Use a minimum of one spacer per 30 inches of cage circumference with a minimum of three spacers. Use spacers constructed of approved material equal in quality and durability to the concrete specified for the shaft. The Engineer will approve spacers subject to satisfactory performance in the field.

Check the elevation of the top of the steel cage before and after placing the concrete. If the rebar cage is not maintained within the specified tolerances, correct it as directed by the Engineer. Do not construct additional shafts until modifying the rebar cage support in a manner satisfactory to the Engineer.

455-16.4 Cross-Hole Sonic Logging (CSL) Tubes: Install CSL access tubes full length in all drilled shafts from the tip of shaft to a point high enough above top of shaft to allow cross-hole-sonic-logging testing, but not less than 30 inches above the top of the drilled shaft, ground surface or water surface, whichever is higher. Equally space tubes around circumference of drilled shaft. Securely tie access tubes to the inside of the reinforcing cage and align tubes to be parallel to the vertical axis of the center of the cage. Access tubes must be Schedule 40 steel with a minimum inside diameter of 1.5 inches. Couple tubes as required with threaded couplers, such that inside of tube remains flush. Seal the bottom and top of the tubes with threaded caps. The tubes, joints and bottom caps shall be

watertight. Seal the top of the tubes with lubricated, threaded caps sufficient to prevent the intrusion of foreign materials. Stiffen the cage sufficiently to prevent damage or misalignment of access tubes during the lifting and installation of the cage. Repair or replace any unserviceable tube prior to concreting. Exercise care in removing the caps from the top of the tubes after installation so as not to apply excess torque, hammering or other stress which could break the bond between the tubes and the concrete.

Provide the following number (rounded up to the next whole number of tubes) and configuration of crosshole sonic logging access tubes in each drilled shaft based on the diameter of the shaft.

Shaft Diameter	Number of Tubes Required	Configuration around the inside of Circular Reinforcing Cage
36 to 48 inches	4	90 degrees apart
Greater than 48 inches	1 tube per foot of Shaft Diameter	360 degrees divided by the Number of Tubes

Insert simulated or mock probes in each cross-hole-sonic access tube prior to concreting to ensure the serviceability of the tube. Fill access tubes with clean potable water and recap prior to concreting. Repair or replace any leaking, misaligned or damaged tubes as in a manner acceptable to the Engineer prior to concreting.

455-17 Concrete Placement.

455-17.1 General: Place concrete in accordance with the applicable portions of Sections 346 and 400, 455-15.2, 455-15.3, 455-15.4, 455-15.5, 455-15.8, 455-15.9, and the requirements herein.

Place concrete as soon as possible after completing all excavation, cleaning the shaft excavation, inspecting and finding it satisfactory, and immediately after placing reinforcing steel. Continuously place concrete in the shaft to the top elevation of the shaft. Continue placing concrete after the shaft is full until good quality concrete is evident at the top of the shaft. Place concrete through a tremie or concrete pump using approved methods.

If the pressure head is lost during concrete placement for any reason, the Engineer may direct the Contractor to perform integrity testing at no expense to the Department.

Immediately after concreting, check the water levels in the CSL access tubes and refill as necessary. If tubes become unserviceable, core new holes in the drilled shaft as directed by the Engineer.

455-17.2 Placement Time Requirements: The elapsed time for placing drilled shaft concrete includes the concrete mixing and transit time, the concrete placement time, the time required to remove any temporary casing that causes or could cause the concrete to flow into the space previously occupied by the casing, and the time to insert any required column steel, bolts, weldments, etc. Maintain a minimum slump of 5 inches throughout the elapsed time. Use

materials to produce and maintain the required slump through the elapsed time that meets the class of concrete specified. Provide slump loss tests that demonstrate to the Engineer that the concrete will maintain a 5 inch or greater slump for the anticipated elapsed time before beginning drilled shaft construction.

455-17.3 Forms: When the top of shaft elevation is above ground, form the portion of the shaft above ground with a removable form or another approved method to the dimensions shown in the plans.

When the shaft extends above the ground through a body of water, the Contractor may form the portion through the water with removable forms except when the Permanent Casing Method is specified.

When approved, the Contractor may form the portion through the water with permanent forms, provided the forms are removed from 2 feet below the lowest water elevation to the top of shaft elevation.

455-17.4 Riser Blocks: The Contractor may cast a riser block of equal diameter as the column and of a maximum height of 6 inches at the top of the completed shaft. When this option is chosen, extend any dowel steel above the top of shaft an additional 6 inches.

455-17.5 Curing: Cure the top surface in accordance with the applicable provisions of Section 400, and construct any construction joint area as shown in the plans. Protect portions of drilled shafts exposed to a body of water from the action of water by leaving the forms in place for a minimum of seven days after casting the concrete. The Contractor may remove forms prior to seven days provided the concrete strength has reached 2,500 psi or greater as evidenced by cylinder breaks.

455-17.6 Non-Destructive Testing of Drilled Shaft Integrity:

455-17.6.1 Cross-Hole Sonic Logging (CSL) Tests: Perform all CSL testing in accordance with ASTM D 6760. Test all drilled shafts in bridge bents or piers considered nonredundant in the plans, using CSL. For all other drilled shafts, perform CSL testing only on drilled shafts selected by the Engineer. The minimum number of shafts tested is the number of shafts indicated in the plans. The Engineer may increase the number shafts tested as deemed necessary.

Engage a qualified Specialty Engineer to perform the CSL testing. The qualified CSL Specialty Engineer must have a minimum three years experience of CSL testing and have a Florida Licensed Professional Engineer supervising the collection and interpretation of data. The Contractor shall provide all necessary assistance to the CSL Specialty Engineer to satisfactorily perform the testing.

When a shaft contains four tubes, test every possible tube combination. For shafts with five or more tubes, test all pairs of adjacent tubes around the perimeter, and one-half of the remaining number of tube combinations, as chosen by the Engineer.

After acceptance of production shafts by the Engineer, remove all water from the access tubes or core holes and fill the tubes or core holes with a structural non-shrink grout approved by the Engineer.

If the Contractor determines at any time during the non-destructive testing and evaluation of the drilled shaft that the drilled shaft should be replaced, no further testing or evaluation of that shaft is required.

455-17.6.1.1 Equipment: Furnish Cross-Hole-Sonic logging test equipment as follows:

(1) Include ultrasonic transmitter and receiver probes for 1.5 inch or 2.0 inch I.D. pipe, as appropriate, which produce measurements with consistent signal strength and arrival time in uniform, good quality concrete with all tube spacings on the project.

(2) Include a microprocessor based data acquisition system for display, storage, and transfer of data. Graphically display First pulse Arrival Time (FAT) during data acquisition.

(3) Electronically measure and record the relative position (depth) of the probes in the tubes with each CSL signal.

(4) Print the CSL logs for report presentation.

(5) Provide report quality plots of CSL measurements that identify each individual test.

(6) Electronically store each CSL log in digital format, with shaft identification, date, time and test details, including the transmitter and receiver gain.

455-17.6.1.2 Procedure: Perform Cross-hole sonic logging between 72 hours and 25 calendar days of shaft concrete placement and after the concrete compressive strength exceeds 3,000 psi. Furnish information regarding the shaft, tube lengths and depths, construction dates, and other pertinent shaft installation observations and details to the Department at the time of testing. Verify access tube lengths and their condition in the presence of the Department, at least 24 hours prior to CSL testing. If the access tubes do not provide access over the full length of the shaft, repair the existing tube(s) or core additional hole(s), as directed by the Engineer, at no additional cost to the Department.

Pull the probes simultaneously, starting from the bottoms of the tubes, over an electronic depth measuring device. Perform the CSL tests with the source and receiver probes in the same horizontal plane. Continuously record CSL signals at depth intervals of 2.5 inches or less from the bottom of the tubes to the top of each shaft. Remove all slack from the cables prior to pulling to provide accurate depth measurements in the CSL records.

Report any anomalies indicated by longer pulse arrival times and significantly lower amplitude/energy signals to the Engineer and conduct further tests as required to evaluate the extent of possible defects. Conduct offset CSL measurements between all tube pair combinations in any drilled shafts with 30% or greater in velocity reduction. Record offset measurements with source and receiver vertically offset in the tubes. These measurements add four measurements per tube combination to the horizontal measurements described in this section. Offset measurements are described by the angle (in degrees) and direction the signal travels between the probes with respect to the horizontal plane: +45, +22.5 (source below receiver), and -45, -22.5 (source above receiver). Record offset measurements from the point where the higher probe is at least 5 feet below the velocity reduction to the point where the lower probe is

at least 5 feet above the velocity reduction. Provide offset CSL logs and 3-D tomographic analysis of all CSL data at no additional cost to the Department in the event 30% or greater in velocity reductions are detected.

455-17.6.1.3 Required Reports: Present the CSL testing and analysis results to the Engineer in a report. Include CSL logs with analyses of first pulse arrival time (FAT) versus depth and pulse energy/amplitude versus depth. Present a CSL log for each tube pair tested with any defect zones identified on the logs and discussed in the test report as appropriate. When offset measurements are required, perform 3-D tomographic analysis using all offset data, and include color coded 3-D tomographic images in the report.

455-17.6.1.4 Evaluation of CSL Test Results: The Engineer will evaluate the observations during drilled shaft construction and CSL test results to determine whether or not the drilled shaft construction is acceptable. Drilled shafts with velocity reduction exceeding 30% are not acceptable without an engineering analysis.

455-17.6.1.5 Coring and/or Repair of Drilled Shafts: If the Engineer determines a drilled shaft is unacceptable based on the CSL tests and tomographic analyses, or observes problems during drilled shaft construction, core the shaft to allow further evaluation and repair, or replace the shaft. If coring to allow further evaluation of the shaft and repair is chosen, one or more core samples shall be taken from each unacceptable shaft for full depth of the shaft or to the depth directed by the Engineer. The Engineer will determine the number, location, and diameter of the cores based on the results of 3-D tomographic analysis of offset and horizontal CSL data. Keep an accurate log of cores. Properly mark and place the cores in a crate showing the shaft depth at each interval of core recovery. Transport the cores, along with five copies of the coring log to the Engineer. Perform strength testing by an AASHTO certified lab on portions of the cores that exhibit questionable concrete as determined by the Engineer. If the drilled shaft offset CSL testing, 3-D tomographic analyses and coring indicate the shaft is defective, propose remedial measures for approval by the Engineer. Such improvement may consist of, but is not limited to correcting defective portions of the shaft, providing straddle shafts to compensate for capacity loss, or providing a replacement shaft. Repair all detected defects and conduct post repair integrity testing using horizontal and offset CSL testing and 3-D tomographic imaging as described in this Section. Engage a Specialty Engineer to perform gamma-gamma density logging to verify the integrity of the shaft outside the reinforcing cage in the same locations offset CSL data was/is required. Submit all results to the Engineer within five days of test completion for approval. Perform all work described in this Section at no additional cost to the Department, and with no increase in contract time.

455-18 Test Holes.

The Engineer will use the construction of test holes to determine if the methods and equipment used by the Contractor are sufficient to produce a shaft excavation meeting the requirements of the Contract Documents. During test hole excavations, the Engineer will evaluate the ability to control dimensions and alignment of excavations within tolerances; to seal the casing into impervious

materials; to control the size of the excavation under caving conditions by the use of mineral slurry or by other means; to properly clean the completed shaft excavation; to construct excavations in open water areas; to establish elevations for belling; to determine the elevation of ground water; to place reinforcing steel and concrete meeting the requirements of these Specifications within the prescribed time frame; and to execute any other necessary construction operation. Revise the methods and equipment as necessary at any time during the construction of the test hole when unable to satisfactorily carry out any of the necessary operations described above or when unable to control the dimensions and alignment of the shaft excavation within tolerances.

Drill test holes out of permanent position at the location shown in the plans or as directed by the Engineer. Ensure the diameter and depth of the test hole or holes are the same diameter and maximum depth as the production drilled shafts. Reinforce the test hole unless otherwise directed in the Contract Documents. Fill the test hole with concrete in the same manner production drilled shafts will be constructed. Backfill test holes which are not filled with concrete with suitable soil in a manner satisfactory to the Engineer. Leave concreted test holes in place, except remove the top of the shaft to a depth of 2 feet below the ground line. Use the same procedure for shafts constructed in water. Restore the disturbed areas at the sites of test holes drilled out of position as nearly as practical to their original condition. When the Contractor fails to demonstrate to the Engineer the adequacy of his methods or equipment, and alterations are required, make appropriate modifications and provide additional test holes at no expense to the Department. Include the cost of all test holes in the cost of the Drilled Shafts. Make no changes in methods or equipment after initial approval without the consent of the Engineer.

A separate test hole is not required for drilled shafts installed under mast arms, cantilever signs, overhead truss signs, high mast light poles or other miscellaneous structures. The first production shaft will serve as a test hole for determining acceptability of the installation method.

455-19 Test Bells.

Ream the bells at specified test holes to establish the feasibility of belling in a specific soil strata. Use the diameter and shape of the test bell shown in the plans or as approved in writing.

455-20 Construction Tolerances.

Meet the following construction tolerances for drilled shafts:

(a) Ensure that the top of the drilled shaft is no more than 3 inches laterally in the X or Y coordinate from the position indicated in the plans.

(b) Ensure that the vertical alignment of the shaft excavation does not vary from the alignment shown in the plans by more than 1/4 in/ft of depth.

(c) After placing all the concrete, ensure that the top of the reinforcing steel cage is no more than 6 inches above and no more than 3 inches below plan position.

(d) Ensure that the reinforcing cage is concentric with the shaft within a tolerance of 1 1/2 inches. Ensure that concrete cover is a minimum of 6 inches unless shown otherwise in the plans.

(e) All casing diameters shown in the plans refer to I.D. (inside diameter) dimensions. However, the Contractor may use casing with an outside diameter equal to the specified shaft diameter if the extra length described in 455-15.7 is provided. In this case, ensure that the I.D. of the casing is not less than the specified shaft diameter less 1 inch. When approved, the Contractor may elect to provide a casing larger in diameter than shown in the plans to facilitate meeting this requirement. When casing is not used, ensure that the minimum diameter of the drilled shaft is 1 inch less than the specified shaft diameter. When conditions are such that a series of telescoping casings are used, provide the casing sized to maintain the minimum shaft diameters listed above.

(f) Excavate the bearing area of bells to the plan bearing area as a minimum. Ensure that the diameter of the bells does not exceed three times the specified shaft diameter. The Contractor may vary all other plan dimensions shown for the bells, when approved, to accommodate his equipment.

(g) Ensure that the top elevation of the drilled shaft concrete has a tolerance of +1 and -3 inches from the top of shaft elevation shown in the plans.

(h) The dimensions of casings are subject to American Petroleum Institute tolerances applicable to regular steel pipe.

(i) Use excavation equipment and methods designed so that the completed shaft excavation will have a flat bottom. Ensure that the cutting edges of excavation equipment are normal to the vertical axis of the equipment within a tolerance of ±3/8 in/ft of diameter.

455-21 Drilled Shaft Excavations Constructed out of Tolerance.

Do not construct drilled shaft excavations in such a manner that the concrete shaft cannot be completed within the required tolerances. The Contractor may make corrections to an unacceptable drilled shaft excavation by any combination of the following methods:

(a) Overdrilling the shaft excavation to a larger diameter to permit accurate placement of the reinforcing steel cage with the required minimum concrete cover.

(b) Increasing the number and/or size of the steel reinforcement bars.

(c) Enlargement of the bearing area of the bell excavation within tolerance allowed.

When the tolerances are not met, the Contractor may request design changes in the caps or footings to incorporate shafts installed out of tolerance. The Contractor shall bear the costs of redesign and Unforeseeable Work resulting from approved design changes to incorporate shafts installed out of tolerance. The Contractor's Engineer of Record will perform any redesign and will sign and seal the redesign drawings and computations. Do not begin any proposed redesign until it has been reviewed for acceptability and approved by the Engineer.

Backfill any out of tolerance shafts in an approved manner when directed by the Engineer until the redesign is complete and approved. Furnish additional

materials and work necessary, including engineering analysis and redesign, to effect corrections of out of tolerance drilled shaft excavations at no expense to the Department.

455-22 Load Tests.

When the plans include load testing, perform all load tests in accordance with 455-2 or as shown in the Contract Documents.

455-23 Method of Measurement.

455-23.1 Drilled Shafts: The quantity to be paid for will be the length, in feet, of the reinforced concrete drilled shaft of the diameter shown in the plans, completed and accepted. The length will be determined as the difference between the top of shaft elevation as shown in the plans and the final bottom of shaft elevation as authorized and accepted. When the Contractor elects to provide outside diameter (O.D.) sized casing rather than inside diameter (I.D.) sized casing as allowed in 455-15.7, the pay quantity measured as described above will be multiplied by a factor (F) determined as follows:

$$F = \frac{2D_2 - D_1}{D_2}$$

where:

F= factor to adjust pay quantities to compensate for smaller shafts.

D_1= casing inside diameter specified = shaft diameter specified.

D_2= casing inside diameter provided ($D_2 = D_1$ minus twice the wall thickness).

455-23.2 Drilled Shafts (Unreinforced): The quantity to be paid for will be the length, in feet, of unreinforced concrete drilled shaft of the diameters shown in the plans, completed and accepted. The length will be determined as the difference between the top of shaft elevation as shown in the plans and the final bottom of shaft elevation as authorized and accepted. When the Contractor elects to use O.D. casing, the quantity as determined above will be multiplied by the factor “F” determined as described in 455-23.1.

455-23.3 Unclassified Shaft Excavation: The quantity to be paid for will be the length, in feet, of unclassified shaft excavation of the diameter shown in the plans, completed and accepted, measured along the centerline of the shaft from the ground surface elevation after any required excavation per 455-1.2 to the plan bottom of shaft elevation authorized and accepted plus up to 15 feet or 3 shaft diameters, whichever is deeper, of additional excavation as authorized by the Engineer. When drilled shafts are constructed through fills placed by the Contractor, the original ground surface before the fill was placed will be used to determine the quantity of unclassified shaft excavation. When the Contractor elects to use O.D. casing, the quantity as determined above will be multiplied by the factor “F” determined as described in 455-23.1.

455-23.4 Unclassified Extra Depth Excavation: When excavation is required by the Engineer to extend more than 15 feet or 3 shaft diameters,

whichever is deeper, below the bottom of the shaft elevation shown in the plans, the work will be considered as Unforeseeable Work.

455-23.5 Drilled Shaft Sidewall Overreaming: The quantity to be paid for will be the length, in feet, of drilled shaft sidewall overreaming authorized, completed and accepted, measured between the elevation limits authorized by the Engineer. When the Contractor elects to use O.D. casing, the quantity as determined above will be multiplied by the factor "F" determined as described in 455-23.1.

455-23.6 Bell Footings: The quantity to be paid for will be the number of bells of the diameter and shape shown in the plans, completed and accepted.

455-23.7 Test Holes: The cost of all test holes will be included in the cost of Drilled Shafts.

455-23.8 Test Bells: The quantity to be paid for will be the number of test bells, completed and accepted.

455-23.9 Core (Shaft Excavation): The quantity to be paid for will be the length, in feet, measured from the bottom of shaft elevation to the bottom of the core-hole, for each authorized core drilled below the shaft excavation, completed and accepted. When the Engineer authorizes pilot holes extending through part or all of the shaft, prior to excavation, to some depth below the shaft bottom, the quantity paid as Core (Shaft Excavation) will be the length in feet, measured from the top elevation to the bottom elevation authorized by the Engineer, completed and accepted. When SPT tests are substituted for coring or pilot holes as provided in 455-15.6, the quantity will be determined as described above in this Section.

455-23.10 Casings: The quantity to be paid for will be the length, in feet, of each size casing as directed and authorized to be used. The length will be measured along the casing from the top of the shaft elevation or the top of casing whichever is lower to the bottom of the casing at each shaft location where casing is authorized and used, except as described below when the top of casing elevation is shown in the plans. Casing will be paid for only when the Permanent Casing Method is specified, when the plans show a casing that becomes a permanent part of the shaft, or when the Engineer directs the Contractor to leave a casing in place which then becomes a permanent part of the shaft. No payment will be made for casings which become bound or fouled during shaft construction and cannot be practically removed. The Contractor shall include the cost of all temporary removable casings for methods of construction other than that of the Permanent Casing Method in the bid price for Unclassified Shaft Excavation item.

When the Permanent Casing Method and the top of casing elevation are specified, the casing will be continuous from top to bottom. Authorization for temporary casing will not be given unless the Contractor demonstrates that he can maintain alignment of the temporary upper casing with the lower casing to be left in place during excavation and concreting operations. When artesian conditions are or may be encountered, the Contractor shall also demonstrate that he can maintain a positive water-tight seal between the two casings during excavation and concreting operations.

When the top of casing elevation is shown in the Contract Documents, payment will be from the elevation shown in the plans or from the actual top of casing elevation, whichever is lower, to the bottom of the casing. When the Contractor elects to use an approved special temporary casing system in open water locations, the length to be paid for will be measured as a single casing as provided above.

455-23.11 Protection of Existing Structures: The quantity to be paid for will be at the lump sum price.

455-23.12 Load Tests: The quantity to be paid for will be the number and type of load tests conducted.

455-23.13 Instrumentation and Data Collection: The quantity to be paid for will be at the lump sum price.

455-23.14 Cross-Hole Sonic Logging: The quantity of the cross-hole sonic logging test set-ups to be paid for will be the number of drilled shafts accepted based on cross-hole sonic logging tests.

455-24 Basis of Payment.

455-24.1 Drilled Shafts: Price and payment will be full compensation for all drilled shafts, including the cost of concrete, reinforcing steel and cross-hole sonic logging tubes, including all labor, materials, equipment, and incidentals necessary to complete the drilled shaft. The cost of the reinforcing steel, including lap lengths, to accommodate shaft lengths longer than shown in the plans is included in the cost of Drilled Shafts. Costs associated with repairing defects found in the drilled shaft shall be included in the cost of the drilled shaft.

455-24.2 Drilled Shafts (Unreinforced): Price and payment will be full compensation for all drilled shafts (unreinforced), including the cost of concrete and all labor, equipment, materials, and incidentals necessary to complete the drilled shaft.

455-24.3 Unclassified Shaft Excavation: Price and payment will be full compensation for the shaft excavation (except for the additional costs included under the associated pay items for casing); removal from the site and disposal of excavated materials; restoring the site as required; cleaning and inspecting shaft excavations; using slurry as necessary; using drilling equipment; blasting procedures, special tools and special drilling equipment to excavate the shaft to the depth indicated in the plans; and furnishing all other labor, materials, and equipment necessary to complete the work in an acceptable manner.

455-24.4 Bell Footings: Price and payment will be full compensation for forming and excavating the bell beyond the diameter of the drilled shaft, furnishing and casting additional concrete necessary to fill the bell outside the shaft together with any extra reinforcing steel required, removing excavated materials from the site, and all other expenses necessary to complete the work.

455-24.5 Test Holes: No separate payment will be made for Test Hole. All cost of Test Holes will be included in the cost of Drilled Shafts.

455-24.6 Test Bells: Price and payment will be full compensation for forming the test bell, providing inspection facilities, backfilling the bell when the test hole is drilled out of position, and all other expenses necessary to complete the work.

455-24.7 Core (Shaft Excavation): Price and payment will be full compensation for drilling and classifying the cores/pilot hole, delivering them to the Department, furnishing drilled shaft concrete to fill the core/pilot hole, and all other expenses necessary to complete the work. When SPT tests are substituted for cores/pilot holes as provided in 455-15.6, they will be paid for at the price per foot for coring.

455-24.8 Casings: Price and payment will be full compensation for additional costs necessary for furnishing and placing the casing in the shaft excavation above the costs attributable to the work paid for under associated pay items for Unclassified Shaft Excavation.

455-24.9 Protection of Existing Structures: Price and payment will include all cost of work shown in the plans or described herein for protection of existing structures. When the Contract Documents do not include an item for protection of existing structures, the cost of settlement monitoring as required by these Specifications will be included in the cost of Unclassified Shaft Excavation; however, work in addition to settlement monitoring will be paid for as Unforeseeable Work when such additional work is ordered by the Engineer.

455-24.10 Load Tests: Price and payment will include all costs related to the performance of the load test.

455-24.11 Instrumentation and Data Collection: Price and payment will include all labor, equipment, and materials incidental to the instrumentation and data collection, and, when required, the load test report.

455-24.12 Cross-Hole Sonic Logging: Price and payment will include all costs related to the performance of the CSL testing and incidentals to the cross-hole sonic test set-up.

455-24.13 Payment Items: Payment will be made under:

Item No. 455- 18-	Protection of Existing Structures - lump sum.
Item No. 455- 88-	Drilled Shaft - per foot.
Item No. 455- 90-	Bell Footings - each.
Item No. 455- 92-	Test Bells - each.
Item No. 455-107-	Casing - per foot.
Item No. 455-111-	Core (Shaft Excavation) - per foot.
Item No. 455-119-	Test Loads - each.
Item No. 455-122-	Unclassified Shaft Excavation - per foot.
Item No. 455-129-	Instrumentation and Data Collection - lump sum.
Item No. 455-142-	Cross-Hole Sonic Logging - each.

D. SPREAD FOOTINGS

455-25 Description.

Construct reinforced concrete spread footing foundations, including dewatering when necessary, excavating to the required limits, compacting the underlying soil as required, and constructing seals when required.

455-26 General Requirements.

Meet the following requirements for all spread footings:

1. Perform excavations, including the removal of all material, of whatever nature, necessary for the construction of spread footings. As used herein, the term "soil" shall constitute any material, whether soil, rock, or other materials.

2. Slope excavations as required, or support them with sheeting, and shore them if necessary, to provide a safe excavation that is adequate for construction purposes and that will adequately protect any existing adjacent structures.

3. Ensure that the foundation soils are firm, stable, and, in the opinion of the Engineer, meet or exceed the design bearing and compressibility requirements before constructing the footings or any required seals. The Department may elect to use any type of test(s) to evaluate the foundation soils that is appropriate in the opinion of the Engineer. Cooperate with the Engineer in the evaluation of the foundation soils, and assist the Engineer as necessary to provide access to the site.

4. The elevation of the bottom of footings or seals and/or the depth of over-excavation shown in the plans is approximate and the Engineer may order, in writing, such changes as may be necessary to secure a satisfactory foundation.

5. Place all spread footing concrete in the dry.

455-27 Protection of Existing Structures.

Protect existing structures in accordance with 455-1.1. Also, if not otherwise provided in the plans, evaluate the need for, design, and provide all reasonable precautionary features to prevent damage, including, but not limited to, the installation of sheet piling, shoring as necessary, maintenance of the water table beneath such structures as nearly as practical to existing conditions, and monitoring and controlling vibrations from construction activities including driving of sheeting or from blasting.

455-28 Dewatering.

The Contractor is responsible for the design, installation, and operation of an adequate dewatering system to dewater excavations for spread footings. Use a well point or well system. Submit a dewatering plan to the Engineer for his records before beginning construction.

Use well points or wells where the piezometric water level is above an elevation 3 feet below the bottom of the excavation. Maintain the water table 3 feet or more below the maximum depth of excavation. Provide continuous dewatering until completing construction of the footing and backfill the excavation at least 3 feet above the piezometric water table elevation. Continue dewatering until the Engineer considers conditions safe to discontinue dewatering. In the event of a dewatering failure, assist the Engineer as required in determining the effects of such a failure on the foundation soils, and take whatever corrective measures are required at no additional expense to the Department. When the Engineer approves the discontinuing of dewatering, decrease the rate of pumping, allowing the water level to rise slowly. Use a rate,

in feet per hour, that the water table is allowed to rise equal to the total number of feet the water table was lowered, divided by ten hours or a rate of 1 ft/hr, whichever is less.

Install one piezometer well approximately every 15 feet of footing perimeter. Provide a minimum of two and a maximum of six piezometers at locations within 2 feet from the outside of the footing perimeter. Install piezometer wells to a depth at least 10 feet below the bottom of footing elevation or as directed by the Engineer. Measure water elevation in the piezometer wells prior to excavation and at 12-hour intervals between excavation and discontinuation of dewatering. Maintain the piezometers in working condition throughout the dewatering process, and repair or replace them when damaged at no expense to the Department.

455-29 Excavations.

455-29.1 Dry Excavations: Dry excavations are excavations that can be completed without the need to lower the piezometric water level. Perform dry excavations when the piezometric water level at the time of construction is and, in the opinion of the Engineer, will remain at least 3 feet below the bottom of the authorized excavation or over-excavation. Demonstrate to the Engineer that a stable excavation can be made without dewatering. Make adequate provisions to divert surface runoff and to collect and remove any water entering the excavation.

Excavate to the bottom of footing, to the over-excavation limits shown in the plans, or as directed by the Engineer. Save any suitable materials for backfill. Provide areas for the disposal of all unsuitable materials, and dispose of them in a satisfactory method. Compact the foundation soils below the footing as shown in the plans or described herein before constructing the footing.

455-29.2 Dewatered Excavations: Dewatered excavations are excavations made after first lowering the piezometric water level with wellpoints or wells. Perform dewatering as described in 455-28. Excavate in the dry after lowering of the water table.

When dewatering is required, the Contractor may excavate within 3 feet of the ground water table before dewatering begins if the dewatering system is operating and the Contractor has demonstrated that the water level has been lowered to and maintained at acceptable limits. Where large excavations require stage lowering of the water table (additional wellpoint systems installed at lower elevations), the Contractor may continue excavating as long as the water elevation is maintained at least 3 feet below the excavation.

Ensure that surface runoff is diverted from the excavation. Compact the foundation soils as shown in the plans or as described herein before constructing the footing.

455-29.3 Wet Excavations: Wet excavations are excavations made below the existing water table without prior dewatering. When the plans show a cofferdam and seal, perform the excavation in the wet. Maintain the water level during excavation at or above the water level outside the cofferdam.

Place the seal directly upon the foundation soils or rock when using wet excavations. Do not compact foundation soils for wet excavations. Ensure that

the foundation soils or rock are disturbed as little as practical. Remove all materials that are determined by the Engineer to be loose or disturbed before placing the seal concrete.

455-30 Fill or Backfill.

Only use fill or backfill, including over-excavations below the footing that is clean cohesionless material, free of rubble, debris, or rocks that would prevent uniform placement and compaction. For backfill materials, use A-1, A-2, or A-3 materials, materials as shown in the plans, or materials approved by the Engineer.

455-31 Compaction and Density Requirements.

Compact the bottom of the excavation with suitable equipment. Compact the soil beneath footing excavation (whether dug to the bottom of footing or over-excavated) to a density not less than 95% of the maximum density as determined by AASHTO T 180 for a minimum depth of 2 feet below the bottom of the excavation or to the depth shown in the plans before backfilling begins. Perform at least one density determination at each footing excavation at a depth of one to 2 feet below the bottom of the excavation. Compact the backfill in footing excavations which have been over-excavated in 12 inch maximum loose lifts to a density not less than 95% of the maximum density as determined by AASHTO T 180 to the bottom of footing elevation. Perform at least one density determination in each lift of backfill at each footing excavation.

For compaction, use an approved heavy vibratory roller with a static drum weight of at least 4 tons. Compact each lift to the required density. Also, compact the final lift below the footing with a suitable sled vibratory compactor to remove any upper disturbance caused by the drum roller. When conditions require use of smaller compaction equipment, obtain the Engineer's approval for the equipment, and reduce the lift thickness to achieve the required density.

Perform backfilling to the original ground surface, finished grade, or subgrade as required by the plans in the immediate vicinity by approved mechanical compactors weighing less than 1,000 pounds. The Contractor may compact backfill located more than 15 feet away from the exterior periphery of the footing with heavier compactors. Do not place backfill on the footing until the Engineer has given permission and until the concrete is at least seven days old.

455-32 Forming.

Form spread footings if it can not be demonstrated that the natural soil or rock is strong enough to prevent caving during construction. For forms, meet the applicable requirements of 400-5. When forms are not required, meet the requirements of 400-5.4.4.

455-33 Materials.

455-33.1 Concrete: Meet the requirements of Section 346.

455-33.2 Reinforcing Steel: Meet the requirements of Section 415. For spread footing reinforcing steel, use Grade 60.

455-34 Reinforcing Steel Placement.

Place and fasten reinforcing steel for footings according to the applicable provisions of 415-5.

455-35 Concrete Placement.

455-35.1 Placement: Place all footing concrete in the dry and according to the applicable provisions of Section 400. Do not construct joints in footings.

455-35.2 Finish: After placing and consolidating the concrete, strike-off the top surface to the grades shown in the Contract Documents, leaving the surface smooth and free of undesirable cavities and other defects. Do not provide a special finish unless the footing will be visible after construction, in which case, meet the applicable provisions of Section 400.

455-35.3 Curing: Provide continuous-moisture-curing for footings. For cover materials, use clean sand, sawdust, or other materials meeting the approval of the Engineer. Continuously wet the cover materials for a period of 72 hours.

455-36 Method of Measurement.

455-36.1 Protection of Existing Structures: The quantity to be paid for, when included in the Contract Documents, will be at the Contract lump sum price.

455-36.2 Dewatering: The quantity to be paid for will be at the Contract unit price for each footing excavation, only at locations authorized by the Engineer and acceptably dewatered.

455-36.3 Excavation: No separate payment will be made for backfill or will separate payment be made for excavation above bottom of footing elevation. The cost of this work will be included in the Contract unit price for Concrete (Substructure). For footings with excavation (over-excavation) below the bottom of the footing elevation shown in the plans, the cost of this excavation, backfilling, and compaction will be included in the Contract unit price for Excavation for Structures. The pay quantity will be the volume in cubic yards bounded by vertical planes 12 inches outside of the limits of the footing and parallel thereto and extending from the bottom of the footing elevation to the authorized bottom of over-excavation or within the pay limits shown in the plans.

455-36.4 Reinforcing Steel: The quantity to be paid for will be the total weight, in pounds , determined as described in Section 415.

455-36.5 Concrete: The quantity to be paid for will be the volume of the classes shown in the plans, in cubic yards, determined as described in Section 400.

455-37 Basis of Payment.

455-37.1 Protection of Existing Structures: When separate payment for Protection of Existing Structures is provided, price and payment will be full compensation for all work necessary to evaluate the need for, design of, and to provide the necessary features to protect existing structures, including all cost of work shown in the plans or described herein for protection of existing structures.

When a separate payment for Protection of Existing Structures is not provided, the cost of this work will be included in the Contract unit prices for Excavation for Structures and/or for Concrete (Substructure).

455-37.2 Dewatering: Price and payment will be full compensation for all work related to the successful dewatering of footings, including installing, maintaining, and monitoring piezometer wells. Dewatering will be considered Unforeseeable Work when the Engineer determines that dewatering is required and the plans do not include a Dewatering item.

455-37.3 Excavation: Price and payment will be full compensation for all work related to over-excavating below the bottom of footing elevation, backfill, and compaction as specified.

455-37.4 Reinforcing Steel: Price and payment will be full compensation for all work required to furnish and place the steel as shown in the plans and as specified herein.

455-37.5 Concrete: Price and payment will be full compensation for all work required to construct footings and seals as shown in the plans and described herein.

No separate payment will be made for sheeting and shoring required for excavation and footing construction except when a separate pay item for sheeting and shoring is included in the plans. The cost of all work not specifically mentioned in the other footing items will be included in the price per cubic yard for substructure Concrete.

455-37.6 Payment Items: Payment will be made under:

Item No. 125- 1-	Excavation For Structures - per cubic yard.
Item No. 400- 2-	Class II Concrete - per cubic yard.
Item No. 400- 3-	Class III Concrete - per cubic yard.
Item No. 400- 4-	Class IV Concrete - per cubic yard.
Item No. 400- 91-	Dewatering For Spread Footings - each.
Item No. 415- 1-	Reinforcing Steel - per pound.
Item No. 455- 18-	Protection of Existing Structures - lump sum.

E. STRUCTURES (OTHER THAN BRIDGE) FOUNDATIONS-AUGER CAST PILES

455-38 Description.

Furnish and install auger cast piles used for structural support, other than bridge foundations.

455-39 General Requirements.

455-39.1 Contractor's Operations: Submit an Auger Cast Pile Installation Plan in accordance with 455-47. Prior to the start of production piles, demonstrate to the satisfaction of the Engineer, the dependability of the equipment, techniques, and source of materials by construction of a demonstration pile.

455-39.2 Protection of Existing Structures: Protect existing structures in accordance with 455-1.1.

455-40 Materials.

Meet the following material requirements:

(1) Portland Cement (Types I, II, III, IP, and IS) ..... Section 921
(2) Fly Ash, Slag and other Pozzolanic Materials for Portland Cement Concrete ..... Section 929
(3) Fine Aggregate (Sand)* ..... Section 902
(4) Admixtures ..... Section 924
(5) Water ..... Section 923
(6) Fluidifier ..... ASTM C 937

* The Contractor may use any clean sand with 100% passing 3/8 inch sieve and not more than 10% passing the 200 mesh sieve. The Engineer will only permit Silica Sand except as provided in 902-5.2.3.

455-41 Grout Mix Proportions.

Use a grout mix consisting of a mixture of Portland cement, fly ash, retarder, sand and water proportioned and mixed to produce a mortar capable of maintaining the solids in suspension without appreciable water gain and which may be pumped without difficulty and fill open voids in the adjacent soils. The grout mix may also include a fluidifier if desired. Proportion these materials to produce a hardened grout of the required strength shown on the plans.

455-42 Mixing and Pumping Cement Grout.

Meet the following requirements:

1. Only use pumping equipment approved by the Engineer in the preparation and handling of the grout. Before using the mixers, remove all oil or other rust inhibitors from the mixing drums, stirring mechanisms, and other portions of the equipment in contact with the grout.

2. Accurately measure all materials by volume or weight as they are fed to the mixer. Place the materials in the mixer in the following order: 1) water, 2) fluidifier, 3) other solids in order of increasing particle sizes. The fluidifier may be added at the option of the Contractor.

3. Use a quantity of water and mixing time that will produce a homogenous grout having a consistency of 21 seconds minimum, when tested with a flow cone in accordance with ASTM C 939 (3/4 inch diameter outlet), with a frequency at the discretion of the Engineer. Mix the grout at least one minute. If agitated continuously, the grout may be held in the mixer or agitator for a period not exceeding 2.5 hours at grout temperatures below 70ºF; two hours for temperatures from 70 to 100ºF. Do not place grout when its temperature exceeds 100ºF. If there is a lapse in the operation of grout injection, recirculate the grout through the pump, or through the mixer drum or agitator.

4. Use mixers capable of combining components of the cement grout into a thoroughly mixed and uniform mass, free from balls or lumps of cementitious material and capable of discharging the concrete with a satisfactory degree of uniformity. The Engineer's approval of grout mixers and all other equipment will

be conditioned on proper performance during construction of the demonstration pile and subsequent production work.

5. Use a screen no larger than 3/4 inch mesh between the mixer and pump to remove large particles which might clog the injection system.

6. Use a positive displacement piston type grout pump capable of developing displacing pressures at the pump up to 350 psi.

7. Use a grout pump/system equipped with a pressure gauge to accurately monitor the pressure of the grout flow. Test and calibrate the equipment during construction of the demonstration pile to demonstrate flow rate measurement accuracy of ±3% over the range of grouting pressures anticipated during this work. Provide a pump stroke counter in good working condition on the grout pump. Also calibrate the equipment any time the Engineer suspects that the grout pump performance has changed.

455-43 Testing Cement Grout.

The Engineer will cast four 4"x8" cylinders in accordance with ASTM C 31 for each LOT, considered to be 50 yd^3 of cement grout placed, or one day of pile placement. The Department will test two cylinders at seven days and two cylinders at 28 days, in accordance with ASTM C 39. The minimum required strength for the LOT will be specified on the plans. When a cement grout acceptance strength test falls more than 10% or 500 psi below the specified minimum strength, whichever is less deviation from the specified minimum strength, perform one of the following:

(a) Remove and replace the cement grout represented by the LOT in question at no additional cost to the Department, or

(b) Submit a structural analysis performed by the Contractor's Engineer of Record. If the results of the analysis, approved by the Department, indicate adequate strength to serve the intended purpose with adequate durability, the concrete may remain in place. Otherwise, remove and replace the LOT of concrete in question at no additional cost to the Department.

All low strength cement grout accepted by the Engineer will be subject to reduced payment as follows: \$0.80/yd^3 for each 10 psi of strength test value below the specified minimum strength.

Reduction in pay will be applied to the entire length of all piles containing low strength cement grout, in any quantity. The quantity of cement grout affected by the price reduction may exceed the quantity of cement grout contained in the LOT. The dollar reduction will be equated to an equivalent length of pile not to exceed the total pile length constructed utilizing the subject LOT based on the following formula:

PLR = RC/UC

Where: PLR = Equivalent Pile Length Reduction in feet
RC = Total Reduction in payment, dollars
UC = Unit Cost of pile, dollars /foot

455-44 Pile Installation.

Meet the following requirements:

1. Locate the piles as shown on the drawings.

2. Should soft, compressible muck, organics, clay or other unsuitable materials (non A-1, A-3, A-2-4 or limestone materials) be encountered, remove the unsuitable material to a maximum depth of 5 feet and a maximum diameter about the pile centerline, not to exceed 1/2 of the distance to the adjacent pile. Backfill with clean granular backfill materials (A-1, A-3, A-2-4), placed and compacted in maximum 12 inch lifts to at least 95% of maximum dry density as determined by AASHTO T 180. Complete this work to the Engineer's satisfaction prior to auger cast pile construction. Should more than 5 feet or excessive quantities of unsuitable material be encountered, immediately advise the Engineer and proceed with the work as directed by the Engineer.

3. Provide continuous auger flighting from the auger head to the top of auger with no gaps or other breaks, uniform in diameter throughout its length, and of the diameter specified for the piles less a maximum of 3%. Provide augers with a distance between flights of approximately half the diameter of the auger.

4. Use augers with the grout injection hole located at the bottom of the auger head below the bar containing the cutting teeth, and with pile auger leads containing a bottom guide.

5. Construct piles of the length and diameter shown on the drawings.

6. Clearly mark the auger leads to facilitate monitoring of the incremental drilling and grout placement. Provide individual foot marks with 5 foot increments highlighted and clearly visible. Provide a clear reference mark on the moving auger assembly to facilitate accurately monitoring the vertical movement of the auger.

7. Place piles by rotating a continuous flight hollow shaft auger into the ground at a continuous rate that prevents removal of excess soil. Stop advancement after reaching the predetermined depth.

8. Should auger penetration to the required depth prove difficult due to hard materials/refusal, the pile location may be predrilled, upon approval of the Engineer, through the obstruction using appropriate drilling equipment, to a diameter no larger than 1/2 the prescribed finish diameter of the auger cast pile. Commence auger cast pile construction immediately upon predrilling to minimize ground loss and soil relaxation. Should non-drillable material be encountered preventing placement to the depth required, immediately advise the Engineer and proceed with the work as directed by the Engineer. Refusal is defined as the depth where the penetration of the standard auger equipment is less than 12 inches/minute.

9. Plug the hole in the bottom of the auger while being advanced into the ground. Remove the plug by the grout or with the reinforcing bar.

10. Pump the grout with sufficient pressure as the auger is withdrawn to fill the auger hole, preventing hole collapse and to cause the lateral penetration of the grout into soft or porous zones of the surrounding soil. Carry a head of at least 5 feet of grout above the injection point around the perimeter of the auger to displace and remove any loose material from the hole. Maintain positive rotation of the auger at least until placement of the grout.

11. Once the grout head has been established, greatly reduce the speed of rotation of the auger and commence extraction at a rate consistent with the pump discharge. Maintain extraction at a steady rate to prevent a locked-in auger,

necking of the pile, or a substantially reduced pile section. Ensure grout starts flowing out from the hole when the cutting head is at least 5 feet below the ground surface. Place a minimum volume of grout in the hole of at least 115% of the column of the auger hole from a depth of 5 feet to the tip. Place a minimum volume of grout in the hole of at least 105% of the column of the auger hole from the ground surface to a depth of 5 feet. Do not include any grout needed to create surplus grout head in the volume of grout placed into the hole. If the grout does not flow out from the hole when the cutting head is at least 5 feet below the ground surface, redrill the pile under the direction of the Engineer. If grouting is interrupted for any reason, reinsert the auger by drilling at least 5 feet below the tip of the auger when the interruption occurred, and then regrout.

Use this method of placement at all times. Do not depend on the stability of the hole without the earth filled auger. Place the required steel reinforcement while the grout is still fluid, but no later than 1/2 hour after pulling of the auger.

12. Assume responsibility for the grout volume placed. If less than 115% of the theoretical volume of grout is placed in any 5 foot increment (105% in the top 5 foot increment), reinstall the pile by advancing the auger 10 feet or to the bottom of the pile if that is less, followed by controlled removal and grout injection.

13. Furnish and install the reinforcing steel and anchoring bolts as shown in the Contract drawings.

14. Use reinforcement that is without kinks or nonspecified bends, free of mud, oil or other coatings that could adversely affect the bond. Make splices in reinforcement as shown on the Contract drawings, unless otherwise approved by the Engineer.

15. Leave any temporary supports of/for items placed into a grouted pile (reinforcement template, anchor bolt template, precast column supports, etc.) in place for a minimum of 12 hours after completion of the pile. Do not place wall panels or other significant loads, before the grout has set a minimum of seven days or reached the 28 day strength.

455-45 Construction Tolerances.

Locate piles as shown on the drawings, or as otherwise directed by the Engineer. Locate pile centers to an accuracy of ±3 inches. Ensure that the top of pile elevation is within an accuracy of ±3 inches of the plan elevation.

Locate all precast post, anchor bolts, etc. within the following tolerances unless otherwise shown in the plans: variation from plumb (±1/4 inch/post height); specified elevation (±1/2 inch); and specified location (±1/4 inch).

455-46 Unacceptable Piles.

Repair or replace unacceptable piles, as directed by the Engineer, at no cost to the Department. Unacceptable piles are defined as piles that fail for any reason, including but not limited to the following: piles placed out of position or to improper elevation; piles with reduced cross section, contaminated grout, lack of grout consolidation (honeycombed), or deficient grout strength; and piles with

reinforcement, anchor devices or other components cast or placed into the fluid grout out of position.

455-47 Auger Cast Pile Installation Plan.

At the preconstruction conference, but no later than 30 days before auger cast pile construction begins, submit an auger cast pile installation plan for approval by the Engineer. Provide the following detailed information on the plan:

1. Name and experience record of auger cast pile superintendent or foreman in responsible charge of auger cast pile operations. Place a person in responsible charge of day to day auger cast pile operations who possesses satisfactory prior experience constructing shafts similar to those described in the Contract documents. The Engineer will give final approval subject to satisfactory performance in the field.
2. List and size of the proposed equipment, including cranes, augers, concrete pumps, mixing equipment etc., including details of proposed pump calibration procedures.
3. Details of pile installation methods.
4. Details of reinforcement placement and method of centering in pile, including details of all temporary supports for reinforcement, anchor bolts, precast columns, etc.
5. Details of how and by whom the grout volumes will be determined, monitored and documented.
6. Required submittals, including shop drawings and concrete grout design mixes.
7. Other information shown in the plans or requested by the Engineer.

455-48 Inspection and Records.

The Engineer will monitor pile installation.

455-49 Method of Measurement.

455-49.1 Protection of Existing Structures: The quantity to be paid for, when included in the Contract Documents, will be at the Contract lump sum price.

455-49.2 Auger Cast Pile: The quantity to be paid for will be at the Contract unit price per foot between tip and required pile top elevations for all piles completed and accepted.

455-50 Basis of Payment.

455-50.1 Protection of Existing Structures: When separate payment for Protection of Existing Structures is provided, price and payment will be full compensation for all work necessary to evaluate the need for, design of, and to provide the necessary features to protect the existing structures, including all cost of work shown in the plans or described herein for protection of existing structures.

When a separate payment for Protection of Existing Structures is not provided, the cost of settlement monitoring will be included in the cost of the structure. Work ordered by the Engineer for protection of existing structures, other than settlement monitoring, will be paid for as Unforeseeable Work.

455-50.2 Auger Cast Piles: Price and payment will be full compensation for all labor, materials, and incidentals for construction of auger cast piles of the sizes and depths indicated on the Contract drawings or otherwise required under this Contract. Price and payment will also include the removal and proper disposal off site of all spoil from the auger operation and all excess grout displaced from the auger hole, unless otherwise approved by the Engineer. Work to remove and replace unsuitable material when necessary as specified in 455-44 will be considered Unforeseeable Work.

455-50.3 Payment Items: Payment will be made under:

Item No. 455- 18-	Protection of Existing Structures - lump sum.
Item No. 455-112-	Auger Grouted Piles - per foot.

SECTION 458
BRIDGE DECK JOINTS

458-1 Description.

Furnish and install bridge deck joints of the types and at the locations shown in the plans. This Section covers the following types of joints:

Poured Joint
Poured Joint with Backer Rod System
Strip Seal Joint System

458-2 Materials.

458-2.1 Poured Joint: Meet the requirements of Section 932 for Joint Sealer or a Type A, B, or C Low Modulus Silicone Sealant material that is on the Qualified Products List (QPL).

458-2.2 Poured Joint with Backer Rod System: Furnish Poured Joint with Backer Rod Systems consisting of Type D Silicone Sealant material, Foam Backer Rods, Sidewalk Cover Plates (as required) and all associated miscellaneous components.

The Type D Silicone Sealant material used in the system shall be listed on the Qualified Products List (QPL) and meet the requirements of Section 932.

458-2.3 Strip Seal Joint System: Furnish Strip Seal Joint Systems in accordance with ASTM D 5973 and Design Index No. 21100. Furnish Strip Seal Joint Systems that are on the Qualified Products List (QPL). Manufacturers seeking approval of Strip Seal Joint Systems for inclusion on the QPL shall submit an application in accordance with Section 6. Design documentation showing the expansion joint system shall include installation details and temporary or sacrificial support brackets, bolts, clamps, etc. that are compatible with decks constructed with or without blockouts. Furnish joint systems consisting of watertight steel Edge Rails, Elastomeric Strip Seals, Sidewalk Cover Plates (as required) and all associated miscellaneous components. Obtain the Elastomeric Strip Seals from the Edge Rail Manufacturer.

458-2.4 Sidewalk Cover Plates: Furnish 1/4 inch thick slip resistant galvanized steel Sidewalk Cover Plates in accordance with ASTM A 36 or A 709, Grade 36 or 50 and Design Indexes 21100 and 21110. Sidewalk Cover Plates shall be an anti-slip steel surface consisting of a random hatch matrix or other suitable pattern. Do not use diamond plate or surface applied slip resistant tapes, films, nonmetallic coatings or other similar materials. Sidewalk Cover Plates shall have a minimum coefficient of friction on the top galvanized surface of 0.8 in dry condition, as determined by ASTM F 1677 or F 1679, and 0.68 or 0.52 in a wet condition, as determined by ASTM F 1679 or ASTM F 1677 (respectively). After shop fabrication, hot-dip galvanize in accordance with Section 962 and the Cover Plate manufacturer's recommendations. Furnish flat head Stainless Steel Sleeve Anchors in accordance with ASTM F 593 Group 1 Alloy 304 for attaching Sidewalk Cover Plates. Install Sleeve Anchors in accordance with the anchor manufacturer's instructions. Submit shop drawings for Sidewalk Cover Plates showing all materials, project specific details and dimensions. Provide Certification from the manufacturer that the Sidewalk Cover Plates meet the minimum coefficient of friction requirements.

458-3 Fabrication and Installation.

458-3.1 General: Install the joint in accordance with the specific requirements of this Article, the plan details and the details shown on the Design Standards for the particular type of expansion joint called for.

458-3.2 Poured Joint: Install the joint at the locations and in accordance with the details shown in the plans and the manufacturer's recommendations.

458-3.3 Poured Joint with Backer Rod System:

458-3.3.1 Casting Expansion Joint Opening: When casting the bridge deck, approach slab or raised sidewalk adjacent to the expansion joint at temperatures other than 70°F, adjust the joint opening (Dim. "A") as shown on Design Standards Index No. 21110 at 70°F by the amount of the adjustment per 10°F shown in Structures Plans, Poured Expansion Joint Data Table. For temperatures above 70°F decrease the opening. For temperatures below 70°F increase the opening.

458-3.3.2 Installation of Poured Joint System: After deck profiling, grinding, and grooving operations are complete, install Poured Joint with Backer Rod in accordance with the manufacturer's recommendations, when the joint opening is ± 1/4inch of the design joint opening (Dim "A" at 70°F) shown in the Structures Plans, Poured Expansion Joint Data Table. The minimum opening must not be less than 1 inch at the time of installation. Place Poured Joint Material only when the ambient temperature is between 55°F and 85°F and is expected to rise for the next three hours minimum to provide for adequate joint opening and compression of the Poured Joint Material during curing.

458-3.4 Strip Seal System:

458-3.4.1 Elastomeric Seal Fabrication: Furnish continuous heavy duty bridge deck Elastomeric Seals sized in accordance with the manufacturer's recommendations, to perform satisfactorily for the opening range shown. Minimum movement classification is 4 inches. Shop vulcanization is restricted to

use on horizontal turns on skewed bridges at upturn ends where the horizontal turn angle is greater than 35 degrees. Field vulcanization is not permitted.

458-3.4.2 Edge Rail Fabrication:

(a) Furnish extruded, hot rolled or machined solid steel Edge Rails in accordance with ASTM A 709, Grade 36, 50 or 50(W). Furnish Edge Rails with a minimum mass of 19.2 lb/ft excluding studs, a minimum height of 8 inches, a minimum thickness of 1/2 inch and a maximum top surface (riding surface) width of 2 inches. Edge Rails manufactured from bent plate or built up pieces are not acceptable.

(b) Furnish Anchor Studs in accordance with ASTM A 108, and electric arc end-weld Anchor Studs with complete fusion. Anchor Studs may be piggy backed to achieve required lengths.

(c) Perform all shop welding in accordance with the Bridge Welding Code ANSI/AASHTO/AWS D1.5. Do not weld to surfaces in contact with the Elastomeric Seal or the top surface (riding surface) except as shown in the Shop Splice Detail. Do not weld inside seal cavity.

(d) Fabricate Edge Rail Assemblies in one piece including upturns, except where the length or configuration prohibits shipping or proper installation or where phase construction requires separate assemblies. Shop splice sections of Edge Rail to obtain the required length by partial penetration double v-groove welds on prepared beveled edges and seal welds as shown in the Shop Splice Detail. Weld all around the joint as far as practical to achieve a watertight seal. Do not use short pieces of Edge Rail less than 6'-0" long unless required at curbs, sidewalks or phase construction locations.

(e) After shop fabrication, hot-dip galvanize Edge Rail in accordance with Section 962 and the manufacturer's recommendations.

(f) Furnish temporary or sacrificial support brackets, bolts, clamps, etc. that are capable of resisting shipping, handling and construction forces without damage to the Edge Rail Assemblies or galvanized coating and are adjustable to account for variable temperature settings. Do not use temporary or sacrificial support brackets, bolts, clamps, etc. between the faces of the Edge Rails.

(g) Clearly match mark corresponding Edge Rail Assemblies with joint location and direction of stationing.

(h) Submit shop drawings showing all joint materials and project specific details and dimensions. Include name of manufacturer, seal model number, seal movement range and the assigned Qualified Products List Number.

458-3.4.3 Installation:

(a) Install the Edge Rail Assemblies at proper grade and alignment before or after deck planing in accordance with the manufacturer's instructions. When installed after deck planing and grinding, install the Edge Rail Assemblies in the blockouts on a profile tangent between the ends of the deck and/or approach slab to within a +0" and -1/4" variation. When installed before deck planing, install the Edge Rail Assemblies 3/8", ±1/16", below the top surface of the deck or approach slab to compensate for concrete removal during planing and grinding.

(b) Bolt, weld or clamp Edge Rail Assemblies in position using temporary or sacrificial brackets as required. For phased construction, install Edge Rail Assemblies in a given subsequent phase to align with those installed in an adjacent prior phase after deflection and rotation due to deck casting of adjoining spans has occurred.

(c) For installation of Edge Rail Assemblies at temperatures other than 70°F, adjust the opening of the joint (Dim. "A") as shown on Design Standard Index No. 21100 by the amount of the adjustment per 10°F shown in Structures Plans, Strip Seal Expansion Joint Data table. For temperatures above 70°F decrease the opening. For temperatures below 70°F, increase the opening.

(d) After galvanizing, do not weld within 2 inches of Edge Rail surfaces exposed in the completed structure. Do not weld expansion joint components to or electrically ground to reinforcing steel or structural steel. Seal field butt joints and empty shipping and erection holes with caulk before placing deck concrete.

(e) Protect galvanized Edge Rail Assemblies during screeding operations per the manufacturer's recommendations. Provide temporary blocking material in the Edge Rail seal cavities to prevent concrete intrusion during deck pour and finishing.

(f) Loosen any temporary or sacrificial support brackets, bolts, clamps, etc. that span across the joint after initial set of concrete, but not more than two hours after conclusion of concrete placement.

(g) Install Elastomeric Seal after completion of deck casting. Remove all joint form material and blocking material prior to installing Elastomeric Seal. Field install Elastomeric Seal in accordance with manufacturer's recommendations. Thoroughly coat all contact surfaces between the Elastomeric Seal and the Edge Rail seal cavities with an adhesive lubricant before setting Elastomeric Seal in place.

458-4 Method of Measurement.

The poured joint without backer rod will be incidental to the concrete work and included in the cost of the concrete. Poured joints with backer rod and strip seal joints will be the plan quantity length of each type of joint constructed and accepted.

458-5 Basis of Payment.

458-5.1 Basic Items of Joints. The Contract unit price per foot for Joints will be full compensation for all work and materials necessary for the complete installation. Such price and payment will include, but not be limited to, the following specific incidental work:

(a) Any work required to clean and prepare the adjacent bridge deck, deck block out or deck joint gap.

(b) Any repairs to the galvanizing on metallic joint components.

(c) Any additional work or materials required for non standardized or special construction or installation techniques.

(d) Any cost of erection and removal of any temporary supports which may be necessary for ensuring proper alignment and positioning of the joint relative to the bridge deck.

458-5.2 Payment Items: Payment shall be made under:

Item No. 458 - 1- Bridge Deck Expansion Joint – per foot.

SECTION 459
BITUMEN COATING AND POLYETHYLENE SHEETING ON CONCRETE PILES

459-1 Description.

Furnish and apply bituminous coating and primer, or install polyethylene sheeting and lubricant to prestressed concrete piles.

459-2 Materials.

459-2.1 Bituminous Coating: Use an asphalt type bituminous coating meeting the requirements of Section 916, with a minimum viscosity (at 140ºF) of 3,000 poises and a maximum of 1,000 poises. Apply bituminous coating uniformly over an asphalt primer.

459-2.2 Primer: Meet the requirements of ASTM D 41.

459-2.3 Polyethylene Sheeting: Use polyethylene sheeting that is 6 mils thick and is clean, new and has a smooth surface.

459-2.4 Lubricant: Use a lubricant between the two layers of sheeting that is either a vegetable oil or other approved environmentally and functionally acceptable lubricant.

459-3 Construction Requirements.

Before surfaces are coated with bitumen, dry and thoroughly clean them of dust and loose materials. Do not apply primer or bitumen in wet weather or when the temperature is below 65ºF.

Apply the primer to the surfaces and allow it to dry completely before applying the bituminous coating. Apply primer uniformly at the quantity of 1 gal/100 ft^2 of surface.

Apply bitumen uniformly at a temperature of not less than 300ºF, or more than 350ºF, and apply either by mopping, brushing, or spraying at the project site. Completely fill all holes or depressions in the concrete surface with bitumen. Apply the bituminous coating to a minimum dry thickness of 1/8 inch, but not less than 8 gal/100 ft^2.

Store bitumen coated piles before driving, and protect piles from sunlight and heat. Ensure that pile coatings are not damaged during storage, hauling, or handling. Take appropriate measures to preserve and maintain the bitumen coating. At the time of pile driving, ensure that the bitumen coating has a minimum dry thickness of 1/8 inch. If necessary, recoat the piles, at no cost to the Department, to comply with the requirements of this Section.

Ensure that all surfaces to be wrapped with polyethylene sheeting are dry and thoroughly cleaned of dust and loose materials.

Place the sheeting on the pile to the limits shown on the plans. Wrap the pile with a minimum of 2 1/4 wraps of sheeting. Apply a uniform coating of a lubricant between the first and the second layers. Ensure that this coating fully covers the entire surface of the first layer of sheeting. Once the pile has been wrapped with the minimum of 2 1/4 wraps of sheeting, secure the sheeting with tape or other means that does not damage the sheeting or restrict its movement. Do not place any tape or other material other than the lubricant between the first and second layers of sheeting. Protect the sheeting from construction damage. Where sheeting has been damaged, completely remove the damaged sheet of polyethylene and replace it, at no cost to the Department, as directed by the Engineer.

Where the sheeting will not wrap the specified limits of the pile in one sheet, overlap the previous sheet with each subsequent sheet by 12 inches.

459-4 Method of Measurement.

459-4.1 Bitumen Coating: The quantity will be paid for by the square yard of coating in place on concrete pile surfaces.

459-4.2 Polyethylene Sheeting: The quantity will be paid for by the square yard of wrapped concrete pile surfaces.

459-5 Basis of Payment.

459-5.1 Bitumen Coating: Price and payment will be full compensation for all work specified in this Section, including furnishing all labor, materials, tools, equipment, and incidentals, and doing all the work involved in applying the bituminous coating and primer, as specified in the Contract Documents.

459-5.2 Polyethylene Sheeting: Price and payment will be full compensation for furnishing all labor, materials, including primer and lubricant, tools, equipment, and incidentals, and for doing all the work involved in installing the polyethylene sheeting and lubricant, as specified in the Contract Documents.

459-5.3 Payment Items: Payment will be made under:

Item No. 459- 70-	Bitumen Coating on Concrete Piles - per square yard.
Item No. 459- 71-	Polyethylene Sheeting on Concrete Piles - per square yard.

SECTION 460
STRUCTURAL STEEL AND MISCELLANEOUS METALS

460-1 Description.

460-1.1 General: Prepare, fabricate, assemble, erect, and perform all nondestructive testing for structural steel or miscellaneous metal structures, or portions thereof in accordance with the Contract Documents.

As used in this specification, the following terms shall apply:

Main or primary load-carrying member or component: This designation refers to the following;

1. Longitudinal or transverse rolled beams or fabricated girders (I or box, curved or straight)

2. All truss members not designated as cross frames

3. Cross frames, diaphragms and connection plates of horizontally curved beams or girders

4. Rib members of steel arches

5. Bracing members subjected to and specifically designed for traffic live load and/or other loads

6. Cross frames or diaphragms at pier and abutment supports of tub or box girders (trapezoidal members) and their connection plates

7. Attachments and components of the above such as splice, cover, cross frame and diaphragm connection and gusset plates, but not transverse and bearing stiffeners (unless acting as a cross frame or diaphragm)

8. Cables, moment release pins and links, and hangers

9. All steel substructure members except those designated as secondary in the Contract Documents

10. Other members as may be identified in the Contract Documents

Miscellaneous components – This designation refers to, but is not limited to, the following:

1. Ladders
2. Platforms
3. Bearings
4. Railings
5. End Wall Grates
6. Roadway Gratings
7. Metal Drainage Components
8. Steel Expansion Joint and Components

460-2 Materials.

Provide the materials specified in the Contract Documents in accordance with Sections 6, 105, ASTM A 6, and AASHTO/AWS D1.5, Bridge Welding Code as supplemented by the AASHTO Guide for Highway Bridge Fabrication with HPS70W Steel. Fabricate all unpainted steel elements using steels with weathering characteristics as defined in ASTM A 709 for grades with a "W" suffix.

Structural components designated as "fracture critical" shall conform to the provisions of the AASHTO/AWS D1.5, Bridge Welding Code, Section 12-AASHTO/AWS Fracture Critical Control Plan for Non-Redundant Members, in additional to the requirements of the Contract Documents.

Ensure that structural steel and miscellaneous metal components and products for use on Department projects are obtained from a fabricator listed on the Department's list of Producers with Accepted Quality Control Programs for Metal Fabricators and certified by the AISC Quality Certification Program with the AISC categories modified as follows:

1. Standard for Steel Building Structures - required for miscellaneous components or as approved by the Engineer.

2. Simple Steel Bridge Structures - Required for bolted highway sign, lighting and traffic structures fabrication, bridge components such as cross-frames and diaphragms not designated as main or primary load-carrying members, and unspliced rolled beam bridges. Fabricators qualified under this category are also qualified to perform work as described under the Conventional Steel Building Structures Category.

3. Major Steel Bridges - Required for all steel bridges (including welded or bolted truss structures), welded truss and pole type highway sign, lighting and traffic structures, and bridge elements not defined as miscellaneous components or covered by Simple Steel Bridge Structures in 2 above. Fabricators qualified under this category are also qualified to perform work as described under the Simple Steel Bridge and Conventional Steel Building Structures Categories.

4. Fracture Critical Endorsement - Required for any fabrication conducted on fracture critical structures or components.

Producers seeking inclusion on the list of Producers with Accepted Quality Control Programs for Metal Fabricators shall meet the requirements of 105-3.

Meet the additional following requirements:

Steel and Miscellaneous Metal Items	Section 962
Material Testing and Certifications	Section 962
Galvanizing	Section 962
Structural Coatings	Section 560
Structural Coating Materials	Section 975

460-3 Pre-Assembly Requirements.

460-3.1 Shop Drawings: Shop drawings are required for work items as specified in 5-1.4.2 of the Standard Specifications. When shop drawings are required, submit such drawings in accordance with Section 5. For drawing presentation format, refer to the AASHTO/NSBA Steel Bridge Collaboration "Guidelines for Shop Detail Drawing Presentation".

460-3.2 Welding Procedures: Submit all welding procedures to the Engineer.

Such procedures shall contain a notation that they have been reviewed by a Certified Welding Inspector, and shall be signed, dated and stamped accordingly.

Except as noted in the Contract Documents, perform all shop and field welding in accordance with the AASHTO/AWS D1.5, Bridge Welding Code. Additional/alternate requirements for hollow steel structural sections and non-dynamically loaded members or components are noted in 460-6.

460-3.3 Quality Control Plan: Develop and implement a Contractor Quality Control Plan to verify that all materials and workmanship meet the requirements of the Contract Documents. Develop the plan in conformance with Section 105.

Do not commence work until the Quality Control Plan is approved. Provide sufficient detail in the plan to enable the Engineer to determine the adequacy of the plan. As a minimum, provide the following information in the plan:

1. Name, address, and facility or site number of the fabricator.

2. A description of the fabricator's organization including the following;

a. Clearly established lines of authority.

b. List of personnel showing their experience and qualifications.

c. Position, title and name of the individual assigned to the position.

d. A list of function and duties assigned to the position.

e. Organizational Chart.

f. The fabricator's AISC Certifications, indicating the facilities appropriate certification levels for all work to be performed, and ASIC approved Quality System Documentation.

g. A statement signed by management affirming the fabricator's commitment to achieving a quality product and implementation of this commitment through all personnel.

h. Department, including lines of authority and position titles.

i. A detailed description of the responsibilities of the Quality Control Department.

3. A description of the Contractor procedures that will ensure quality materials and workmanship, clearly addressing the methods used, frequency of inspections or tests, and personnel responsible as appropriate. Include forms or other documents as well. Include procedures that explain how the following tasks will be performed that ensure compliance with the requirements of the Contract documents:

a. Material traceability;

b. Hot and/or cold bending;

c. Cambering and heat-curving, including temperature measurement, patterns and sequences, and supporting or loading positions with copies of the design computations if other than restraining forces are applied;

d. Shop assembly/laydown, including drilling and/or punching;

e. Post heat and/or stress relieving procedures;

f. Heat straightening;

g. Installation of high strength bolts and rotational capacity (RC) tests; and Direct Tension Indicator (DTI) Verification tests

h. Field welding;

i. Blast cleaning, painting, galvanizing and/or other applied coatings;

j. Use of ASTM A 490 bolts;

k. Horizontal jacking of substructure units;

l. Removal of lubricants from exposed surfaces of installed fastener assemblies.

460-3.4 Pre-Assembly Meeting: Prior to commencing work, a meeting shall be held between the Contractor and the Engineer. Representatives of the Fabricator, Suppliers or subcontractors may attend the meeting if requested by the Engineer or Contractor. During this meeting, the Engineer may review various aspects of the job, including but not limited to, any of the following:

1. Plant and Personnel Certification.
2. Organizational Structure of Contractor personnel.
3. Traceability of Materials to Pre-Qualified Fabricator.
4. Shop Drawing requirements, submittal, review and approval process.

5. Fabrication Procedures, especially shop assembly, welding and painting.

6. Sampling and Testing Procedures.

7. Project specific areas of concern for fabrication, inspection and testing.

8. Handling of Material Test Reports.

9. Work Schedule.

10. Lines of Communication.

11. Availability of Quality Control and Verification Inspectors during specific fabrication/erection operations.

12. Loading and Transporting.

13. Handling of non-conformance and repair issues.

14. Special Requirements.

15. Consistency between fabrication shop drawings and the erection plan, specifically between the fabrication shop blocking diagrams and available site locations for temporary support during erection.

460-3.5 Access to Fabrication Facilities: Provide the Engineer full access of facilities or site where the work is being stored, fabricated, assembled or erected.

Provide and maintain office facilities at the fabrication facility for the Department's inspectors that ensure a reasonable amount of privacy, are clean, properly illuminated, heated or air-conditioned as necessary and are relatively free of noise, dust and odors. Locate the office reasonably close to the work and provide access any time fabrication, assembly or erection operations are in progress. Provide a desk, chair, and a four-drawer locking file cabinet for the use by each inspector and the Engineer. Provide a telephone within the office with an outside line suitable for modem communication. Provide ready access to adequate parking, fax and copy machines, and clean, contractor-maintained restrooms within a reasonable distance to the office.

The Engineer may observe any or all activities and perform nondestructive testing of materials, components and the fabricated product to the extent considered necessary to confirm the conformance with Contract Documents.

460-3.6 Notification Prior to Commencement of Assembly: Notify the Engineer at least one week prior to beginning assembly, when conducted in-state, and at least two weeks prior to beginning assembly, when conducted out-of-state.

460-4 Shop Workmanship and Assembly.

460-4.1 Handling, Transporting and Storage of Materials:

460-4.1.1 General: Handle, transport and store plates, shapes, assemblies, fastener components and other parts in a manner that protects them from damage and facilitates subsequent inspections in a safe manner.

Provide storage which will keep materials, assemblies, other components and parts clean, and free from dirt, grease, other foreign matter, unacceptable corrosion or coating deterioration, and any other adverse environmental conditions.

460-4.1.2 Bulk Materials: Ensure that all bulk materials, such as shear studs, are stored together in individual LOTs and that the outside of each container has a list and description of the contents. Maintain a separate list of the weights of all tools and erection materials.

460-4.1.3 Fastener Assemblies (Bolts, Nuts and Washers): Transport and store fastener assemblies in sealed, watertight containers. Label the side of each container with the supplier's name and LOT identification number, and marked to identify the contents and size of the fastener components. Ensure that all surfaces of the nuts are lubricated prior to their placement in watertight containers. Provide containers for components that are capable of protecting them from moisture and other harmful materials. Maintain containers in their sealed conditions until they are opened for use at their assembly locations.

Do not remove more fastener assemblies from the protected area than can be installed and tightened during a work shift. Leave the containers unopened until needed for assembly. At the end of the work shift, return unused fastener assemblies to the protected storage area for future use. Protect opened storage containers from contamination.

460-4.1.4 Coatings: Store coatings in accordance with Sections 962, and 975 and the manufacturer's recommendations. Notify the Engineer if the manufacturer's recommendations vary from that provided in the Contract Documents.

460-4.1.5 Anchor Rods and Nuts: Ship anchor rods and nuts as an assembly. Washers may be shipped separate from the assembly.

460-4.2 Material Traceability:

460-4.2.1 General: All materials arriving at the shop shall be properly identified in accordance the requirements of ASTM A 6. Document all main load-carrying member material, high-strength fastener assemblies, and weld materials incorporated into the work through the entire fabrication process. Document this material traceability in a report type format that correlates heat numbers to their respective locations in the completed members. Provide diagrams and sketches as requested by the Engineer for clarity.

At the fabrication facility, maintain the records of the material testing and certification processes and component/part identification as part of the Fabricator's permanent project records for a period of not less than two years as measured from the last shipment of materials from the Fabricator's facility. Provide a copy to the Engineer.

Mark the weight on members weighing more than three tons, in a visible location.

460-4.2.2 Match Marking of Members and Assemblies: Match mark all connecting members or parts that have been reamed or drilled while assembled. The Fabricator shall provide a diagram showing all marks and clearly indicate the location of all the marks on the shop drawings.

Use painted marks, attached metal tags, other durable methods which do not degrade the finish of the piece, or low-stress type steel die stamps to identify and match mark pieces. If steel die stamps are used, they must be blunt nosed or interrupted dot dies, manufactured to produce impressions that are rounded at the bottom of the impression and do not exceed a depression of

0.030 inch and a maximum character height of 0.5 inch. Remark coated type markings as necessary to maintain continuity in traceability.

Mark splice plates and girders so that upon erection, the mark on the splice plate is located opposite a matching mark on the girder. Place the mark on web splice plates, midway down the long side of the plate, on either the right or left side, to correspond with the girder to which the splice plate will be temporarily attached for shipping to the erection site. Make a matching stamp on the girder web opposite the mark on the splice plate.

Place the mark on top or bottom flange splice plates, on the right or left end of the plate, corresponding to the girder to which the plate will be attached for shipment to the erection site. Place a corresponding mark on the girder flange opposite the mark in the splice plate.

As an alternate location for tub girder bottom flange splice plates, place the mark midway down the long side of the plate, on either the right or left side, to correspond with the girder to which the splice plate will be temporarily attached for shipping to the erection site. Make a matching mark on the girder flange opposite the mark on the splice plate.

Mark girders and beams on the left end, according to the orientation shown in the shop drawings, near the top flange. Mark diaphragms in the middle upper portion of the web. Mark cross frames in the middle of the top or bottom horizontal member. Do not use die stamps on fracture critical members or use die stamps near edges of members or components subject to tensile stresses as specifically noted in the Contract Plans or as directed by the Engineer.

Ensure that during fabrication, the heat number is maintained on each primary load-carrying component by paint until the component is permanently joined into a piece marked member or assembly.

460-4.3 Workmanship:

460-4.3.1 Cutting, Shearing and Machining: Cutting (including burning and sawing), shearing, and machining shall be accomplished in accordance with the AASHTO/AWS 1.5, Bridge Welding Code and the following requirements:

Plane, mill, grind or thermally cut the sheared edges of main load-carrying member plate components greater than 5/8 inch thick to a depth of 1/4 inch.

Cut and fabricate steel plates so that the primary direction of rolling is parallel to the direction of the member or component main stress. For flanges and webs, the direction of rolling is parallel to the flanges unless noted otherwise in the Contract Documents. Web splice plates may be rolled parallel to their length with the approval of the Engineer.

460-4.3.2 Cold Bending:

460-4.3.2.1 General: Submit cold bending procedures to the Engineer for review. Perform cold bending in accordance with the AASHTO/AWS D1.5, Bridge Welding Code and the provisions below. Do not cold bend fracture critical materials or main load-carrying members or components. Visually inspect all load points. Large dents or upsets will be cause for rejection. As a minimum, visually inspect all load points. Inspect any

potentially damaged areas discovered using magnetic particle examination or ultrasonic examination.

460-4.3.2.2 Minimum Bend Radii and Other Requirements: Remove all sharp edges (including edges of holes if affected by the cold bending) by grinding to a 1/16 inch radius. Submit material preparation procedures to the Engineer for review.

Unless otherwise approved, the minimum bend radii for cold bending (at room temperature), measured to the concave face of the plate, are given in Table 460-1, Minimum Cold-Bending Radii. If a smaller radius is required, heat may need to be a part of the bending procedure. Submit the heating procedure for the Engineer's review. For materials and grades not shown in Table 460-1, follow minimum bend radii recommendations of the plate producer.

Table 460-1 - Minimum Cold-Bending Radii

ASTM A 709 Grade and thickness (t) in inches	Up to 3/4 inch	Over 3/4 inch to 1 inch	Over 1 inch to 2 inches	Over 2 inches
36	1.5t	1.5t	1.5t	2.0t
50	1.5t	1.5t	2.0t	2.5t
50S	1.5t	1.5t	2.0t	2.5t
50W	1.5t	1.5t	2.0t	2.5t
HPS 50W	1.5t	1.5t	2.0t	2.5t
HPS 70W	1.5t	1.5t	2.5t	3.0t
100	1.75t	2.25t	4.5t	5.5t
100W	1.75t	2.25t	4.5t	5.5t

The preferred orientation of bend lines is perpendicular to the direction of final rolling of the plate. If the bend line is parallel to the direction of final rolling, multiply the suggested minimum radii in Table 460-1 by 1.5.

460-4.3.3 Straightening: Member components, such as plates, angles or shapes, are to be straightened before the parts are assembled. Perform straightening such that no cracking or other damage occurs in the part. If heat is to be used for straightening, follow the provisions of 460-4.3.4.

460-4.3.4 Heat Application:

460-4.3.4.1 General: At various points during the fabrication of structural steel, applications of heat may be necessary for hot-bending, cambering, curving or straightening. Use the temperature limits and guidelines given in this Section, unless alternate procedures have been approved by the Engineer. Routine straightening of material other than quenched and tempered material shall be done in accordance with the temperature limits and guidelines as specified herein, but do not require a submitted procedure.

Heat curving may be used in conjunction with a cut-curve procedure, in which a portion of the curvature is obtained by cutting the plates to all or part of the required radius, except as limited by 460-4.3.4.4.

460-4.3.4.2 Heating Process and Equipment:

460-4.3.4.2.1 Maximum Temperatures: The maximum allowable temperature to which the material can be heated is given in Table 460-2, Maximum Temperature Limits for Heat Applications.

Table 460-2, Maximum Temperature Limits for Heat Applications	
ASTM A 709 Grade	Maximum Temperature, °F
36, 50, 50S, & 50W	1,200
70W	1,050
HPS 70W	1,100
100 & 100W	1,100

460-4.3.4.2.2 Timing of Heat Applications: Conduct heating operations prior to the application of coatings.

460-4.3.4.2.3 Allowable Preload Stresses: Preload compressive stresses will be permitted up to 0.5 times the minimum specified yield strength (Fy) of the material. This stress limit is applicable to all steels covered by this specification as listed in Table 460-2. If jacks are used, energize and lock off prior to the application of heat.

460-4.3.4.2.4 Heating Tips: Apply heat using orifice tips only. Select tip sizes proportional to the thickness of the heated material.

460-4.3.4.2.5 Torches: Manipulate the heating torches to guard against general and surface overheating. In addition, place heat reflective sheet material against the web before applying heat to the inside flange surface. When heating the inside flange surface, point the torches to prevent applying heat directly to the web.

460-4.3.4.2.6 Heating Patterns: Fundamental heating patterns (such as vee, line, edge, spot, and strip) may be used separately or in combination. Mark vee and strip heat patterns on the material surfaces prior to heating. When heating, bring the steel within the planned pattern to the specified heating temperature as rapidly as possible without overheating the steel. Apply heat in accordance with the approved procedure.

460-4.3.4.2.7 Thin Wide Plates: Prevent buckling of thin wide plates by not applying excessive heat.

460-4.3.4.2.8 Verification of Temperatures: Use temperature-sensitive crayons, pyrometers, or infrared non-contact thermometers for verifying temperatures during heating operations. When heating patterns are used, make regular verifications of the temperatures throughout the pattern. Remove the heating flame from the material before taking measurements.

460-4.3.4.2.9 Cooling: Prior to the use of any artificial cooling, allow steel to cool below 600°F. Use only dry compressed air. Do not quench with water or a water and air mixture.

460-4.3.4.2.10 Reheating: Reheat only after the material has cooled below 250°F.

460-4.3.4.2.11 Over Heating: The Engineer will reject the product, if any portion of the material is exposed to heating higher than the allowable temperature.

460-4.3.4.3 Heat-Curving of Bridge Members (Weak Axis Shaping):

460-4.3.4.3.1 General: Rolled beams and girders may be heat-curved at the job site, provided that the heating is performed in accordance with the Engineer's approval.

460-4.3.4.3.2 Sequence of Operations: Heat curve members prior to the attachment of longitudinal stiffeners.

460-4.3.4.3.3 Web Position: When the radius is less than 1,000 feet, heat curve members with the web in the horizontal position or preloaded to induce stress prior to heating. Otherwise, members may be heat-curved with the web in either the vertical or horizontal position.

When heat-curving with the web in the horizontal position, provide intermediate safety catch blocks between supports of the member and not more than 2 inches below the flanges to catch the member in case of a sudden sag.

When heat-curving with the web in the vertical position, the member shall be braced or supported in such a manner that the tendency of the member to deflect laterally during the heat-curving process will not cause the member to overturn.

460-4.3.4.3.4 Subsequent Heats: If multiple locations are to be heated, do not reheat the same location until after at least three heats at other locations.

460-4.3.4.3.5 Locating Heating Patterns: Space the heating patterns along the full length of each flange to produce a circular (not parabolic) curvature. Adjust the heating patterns to produce the necessary curvature. Compensate for differences in flange thickness and width as necessary. Use enough heating patterns in each piece to eliminate chording effects.

460-4.3.4.4 Minimum Radius for Heat-Curving: Heat-curving of beams and girders is allowed when the horizontal radius of curvature measured to the centerline of the member web is greater than both values calculated by Equations 4.1 and 4.2 below, and greater than 150 feet at any and all cross sections throughout the length of the member. Do not heat curve steels manufactured to a yield strength greater than 50.0 ksi, other than ASTM A 709, Grade HPS 70W.

$$R = \frac{14bD}{\sqrt{F_y \psi t}} \text{ in.} \qquad \text{(Equation 4.1)}$$

$$R = \frac{7500b}{F_y \psi} \text{ in.} \qquad \text{(Equation 4.2)}$$

where:

Fy = specified minimum yield point of member web, ksi;

ψ = ratio of the total cross section area to the cross-sectional area of both flanges;

b = width of the widest flange, inch;

D = clear distance between flanges, inch;
t = web thickness, inch;
R = radius, inch.

In addition to the above requirements, do not heat curve if the radius is less than 1,000 feet when the flange thickness exceeds 3 inches or the flange width exceeds 30 inches.

460-4.3.4.5 Heat-Cambering (Strong Axis Shaping):

460-4.3.4.5.1 General: Procedures for cambering of built-up plate girders shall be submitted as a part of the Quality Control Plan. In the procedures, address any proposed preloading and heat application and control. Minor heat adjustments in camber at the finishing stage of the girder do not require approval if the patterns and temperatures are followed in accordance with the approved procedures.

Do not utilize heat-cambering as the primary source of vertical camber in horizontally curved main load-carrying members; cut the web plate to the required position. Only use heat-cambering on horizontally curved main members to adjust cut cambering with the approval of the Engineer.

460-4.3.4.5.2 Web Position: Support members to be heat-cambered with the web vertical. Space supports to take maximum advantage of dead load in the member prior to the application of heat.

460-4.3.4.5.3 Subsequent Heats: If multiple locations are to be heated, do not reheat the same location until after at least three heats at other locations.

460-4.3.4.5.4 Rolled Beams: Rolled beams may be heat-cambered to provide the required curvature at the producing mill. Attach all detail material, such as connection plates, bearing stiffeners and gusset plates, after the beam has been heat-cambered.

460-4.3.4.6 Heat-Straightening Damaged Structural Steel:

460-4.3.4.6.1 General: Submit procedures for heat-straightening for the Engineer's review prior to beginning the work. Describe in detail the distortion to be corrected and all details for preloading, heating, cooling, verifying final dimensions, and nondestructive testing.

460-4.3.4.6.2 Cracking: As a minimum, visually inspect all heat-straightened areas. Notify the Engineer when suspected areas of cracking are found. Inspect these areas by one or more of the following methods, as directed by the Engineer:

1. Visual inspection;
2. Liquid penetrant examination as described in ASTM E 165;
3. Magnetic particle examination as described in ASTM E 709;
4. Ultrasonic examination as described in Section 6, Part C of the AASHTO/AWS D1.5, Bridge Welding Code;
5. Radiographic examination as described in Section 6, Part B of the AASHTO/AWS D1.5, Bridge Welding Code.

460-4.3.4.6.3 Restraining Forces: Restraining forces (usually jacks) shall be set to restrain the steel during heating, but allow free contraction during cooling. In addition, apply the restraining forces in a direction tending to restore the member and limit the magnitude so that the material is not overstressed during heating.

460-4.3.4.6.4 Heating: Heat the steel in a single pass following the specified pattern and allow it to cool to below 250°F prior to reheating. Select heating patterns and sequences appropriate for the type of damage and shape of the cross section. Simultaneous vee heats may be used provided the clear spacing between vees is greater than the width of the plate element.

460-4.3.4.6.5 Subsequent Repair: Heat cambered members damaged after cambering may be repaired. However, do not repair previously heat-straightened members in the same region of damage without the approval of the Engineer.

460-4.3.4.7 Hot Bending: Where a smaller radius than that allowed in 460-4.3.2 is required, non-primary load-carrying components may be bent using heating together with mechanical force in accordance with the guidelines provided in 460-4.3.4.2 Apply heat uniformly through the thickness of the plate. Provide the hot bending procedures to the Engineer for review.

460-4.3.4.8 Heat Treatment:

460-4.3.4.8.1 General: When any special form of heat treatment is required, it will be described in the Contract Documents. Perform heat treatments following any boring, machining and/or straightening operations.

460-4.3.4.8.2 Stress Relief: Where required, perform thermal stress relief in accordance with the procedure outlined in the AASHTO/AWS D1.5, Bridge Welding Code. Provide welding materials consistent with the stress relieving process utilized.

460-4.3.4.8.3 Normalizing and Annealing: Where required by the Contract Documents, perform normalizing and annealing as defined in ASTM A 941. Maintain temperatures uniformly throughout the furnace during heating and cooling so that the temperatures at any points on the member do not differ by more than 130°F.

460-4.3.4.9 Bolt Holes:

460-4.3.4.9.1 General: Unless shown otherwise in the Contract Documents, the bolt (and anchor rod) hole geometry is to be as shown in Table 460-3, Bolt Hole Geometry.

Table 460-3, Bolt Hole Geometry

Bolt Diameter (d), inch	Standard (Diameter, inch)	Oversize (Diameter, inch)	Short-Slotted (Width, inch by Length, inch)	Long-Slotted (Width, inch by Length, inch)
1/2	9/16	5/8	9/16 x 11/16	9/16 x 1 1/4
5/8	11/16	13/16	11/16 x 7/8	11/16 x 1 9/16
3/4	13/16	15/16	13/16 x 1	13/16 x 1 7/8
7/8	15/16	1 1/16	15/16 x 1 1/8	15/16 x 2 3/16
1	1 1/16	1 1/4	1 1/16 x 1 5/16	1 1/16 x 2 1/2
> 1 1/8	d + 1/16	D + 5/16	(d + 1/16) x (d +	(d + 1/16) x

Table 460-3, Bolt Hole Geometry				
			3/8)	(2.5 x d)
Note: Except as shown elsewhere in the Contract Documents, bolt holes in the connections of primary members are to be standard size unless.				

460-4.3.4.9.2 Holes, Tolerances and Quality: Make bolt (and anchor rod) holes using any method suitable to the Fabricator and as specified below; except holes for high strength fasteners in main or primary load-carrying members which are not to be punched full size, but may be thermally cut in accordance with 460-4.3.4.9.4 and ground smooth with the approval of the Engineer.

The misalignment of holes in a bolt group relative to the same holes in the component or components it is joined to in a connection, shall not exceed 1/32 inch for 85% of the bolt holes in that group. Bolt holes are to be normal to the work and have no tears, cracks, fins, dirt, loose rust, burrs or other anomalies, and the surface is to be flat within a slope of 1/20. Bolt holes are to be round within ± 1/32 inch and within ± 1/32 inch of the specified size. For subsize holes, a pin 1/8 inch smaller than the subsize holes must be able to pass through all assembled plies in at least 75% of the locations prior to reaming. Holes inclined more than 3 degrees to a surface in any direction must have a hardened beveled washer provided at that face. Unless specified elsewhere in the Contract Documents, it is not required to coat the inside of the bolt holes.

460-4.3.4.9.3 Slotted Holes: Slots may be made by a single punch, or by joining two adjacent drilled or punched holes when punching is permitted. When joining holes, thermal cutting is to follow the common tangent to the two holes, and this cut is to be ground. Do not make slotted holes more than 1/32 inch in width nor 1/16 inch greater in length than specified. Grind smooth any flame cut portions of the slot to ANSI 1000 micro-inches.

460-4.3.4.9.4 Holes in Plates Not Subjected to Tensile Stress: Large diameter holes in heavy plates not subjected to tensile stress (such as bearing plates) and slotted holes in materials not subject to tensile stress may be thermally cut, followed by appropriate grinding to smooth the periphery. Stop the practice if gouges or other defects occur, or if directed by the Engineer. These holes are to meet the following criteria:

Do not thermally cut holes in ASTM A 709, Grades 100 or 100W steels. Provide hole centerlines aligned within ± 1/16 inch of theoretical. The inside (cut) faces of the hole are to be perpendicular to the plane of the plate. Eighty-five percent of the (open) hole diameter is not to exceed that specified in the Contract Documents, ± 1/16 inch. Local notches, gouges or the maximum diameter shall not exceed that specified in the Contract Documents ± 3/32 inch.

460-4.3.4.9.5 Punching: Punch holes only under the following conditions:

1. Final members that contain no more than five thicknesses (plies) of material.

2. ASTM A 709, Grade 36 material less than 3/4 inch in thickness.

3. ASTM A 709, Grades 50, 50S, 50W or HPS 50W materials less than 5/8 inch in thickness.

4. ASTM A 709, Grade HPS 70W and Grade 100 or 100W materials less than 1/2 inch in thickness.

460-4.3.4.9.6 Edge Distance: Provide minimum as-fabricated distance from the center of a bolt hole to an edge as given in Table 460-4, Edge Distances.

Fastener Size, Inch	Sheared Edge, Inch	Rolled Edges of Plates or Shapes or Gas Cut Edges Inch
5/8	1 1/8	7/8
3/4	1 1/4	1
7/8	1 1/2	1 1/8
1	1 3/4	1 1/4

460-4.3.4.9.7 Bolted Splice Gaps: Unless shown elsewhere in the Contract Documents, the tolerance for bolted splice gaps (open distance face-of-web/flange to face-of-web/flange) shall be from zero (no gap between faces) to a maximum of 1/8 inch greater than the gap shown on the Contract Plans. If no gap is shown in the Contract Plans, assume that a nominal gap of 3/8 inch is required. In addition, meet the edge distance requirements, provided above.

460-4.3.4.9.8 Maximum Edge Distance: Unless otherwise specified in the Contract Documents, the maximum fabricated distance from any edge to the center of the hole shall be 8 times the thickness of the thinnest outside plate, not to exceed 5 inches with no additional tolerance allowed.

460-4.3.4.9.9 Spacing of Bolt Holes: Space bolt holes within ± 1/8 inch of that shown in the Contract Documents.

460-4.3.4.9.10 Holding of Plies: When drilling or reaming is accomplished through multiple plies of material, do not hold the materials together by welds not specified in the Contract Drawings.

460-4.3.4.10 Contact and Bearing Surfaces: Provide surface finishes of bearings, base plates, and other contact surfaces in accordance with the ANSI surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness and Lay, Part I, given in Table 460-5, ANSI Surface Roughness Requirements.

Table 460-5, ANSI Surface Roughness Requirements	
Steel slabs	ANSI 2000 micro-inch
Heavy plates in contact with shoes to be welded	ANSI 1000 micro-inch
Milled ends to compression members, milled or ground ends of stiffeners or rockers	ANSI 500 micro-inch
Bridge rollers and rockers	ANSI 250 micro-inch
Sliding bearings	ANSI 125 micro-inch

Table 460-5, ANSI Surface Roughness Requirements	
Pins and pin holes	ANSI 125 micro-inch

460-4.3.4.11 Cleaning and Coating (Including Galvanizing):

460-4.3.4.11.1 General: Clean and coat the work in accordance with Sections 560, and 562, 460-2 and/or 460-7.2.

460-4.3.4.11.2 Removal of Lubricants: Remove lubricants from the exposed surfaces of installed fastener assemblies and other surfaces in accordance with the approved Quality Control Plan or the paint manufacturer's recommendations prior to painting. Demonstrate the procedures to the Engineer prior to preparations for painting. Bring to the Engineer's attention any Manufacturer's processes or procedures that conflict with those specified in the Contract Documents.

460-4.4 Member Geometry:

460-4.4.1 General:

460-4.4.1.1 Tolerances: Provide dimensional tolerances as follows:

1. Rolled shapes, plates, bars, wide flange sections and miscellaneous steel in accordance with ASTM A 6;

2. Fabricate girders in accordance with the AASHTO/AWS D1.5, Bridge Welding Code and as described below;

3. For built-up members not specifically covered by AASHTO/AWS D1.5, apply AASHTO/AWS D1.5, Bridge Welding Code, except as noted below or as directed by the Engineer.

460-4.4.1.2 Camber and Sweep: Tolerances for camber and sweep of continuous and simply supported girders of any shape shall be as described in the AASHTO/AWS D1.5, Bridge Welding Code. The camber and sweep tolerances for steel pier caps shall be the same as those specified for girders. Measure sweep for horizontally curved members from the theoretical centerline for comparison to the aforementioned requirements.

460-4.4.1.3 Alternate Sections: Rolled sections or fabricated sections of equal or slightly greater dimensions than the section specified may be proposed for the Engineer's approval. Changes that reduce fatigue resistance or significantly affect splice design or deflection will require complete design calculations.

460-4.4.1.4 Web Flatness: Maximum deviation from flatness for webs of curved and/or cambered sections shall be the same as for straight built-up girders. Measure curved girder web flatness using a straightedge oriented perpendicular to the flanges ('vertical', flange to flange).

460-4.4.1.5 Girder Length: If measuring girder length with a device that is free of thermal effects, appropriately adjust the measurements to the reference temperature shown in the Contract Documents. Measure the length of horizontally curved girders along the arc.

460-4.4.2 Specialty Structures:

460-4.4.2.1 Box Members as Bent Caps:

460-4.4.2.1.1 Tolerances: Unless otherwise shown in the Contract Documents, submit tolerances for bearing planes and box twist to the

Engineer for review and approval. Prior to submitting these tolerance values for approval, coordinate between the Erector and the Fabricator.

460-4.4.2.1.2 Bearings: Unless otherwise specified in the Contract Documents, each bearing is to be true to a tolerance of 1/32 inch across its entire width in either direction.

460-4.4.2.1.3 Beam Trueness: Unless otherwise specified in the Contract Documents, the plane of beam supports on the box girder (the bearing area specifically attached to the box girder) is to be true to the box girder bearing within 1/16 inch in the short direction and true to the vertical axis of the nesting girders (those girders attached to or resting on the box girder) within 1/16 inch.

460-4.4.2.2 Trapezoidal Bridge Members: As a minimum, trapezoidal bridge members (tub or box girders) shall meet AASHTO/AWS D1.5, Bridge Welding Code dimensional tolerances. Camber may be verified with the girder in its upright position, supported to avoid dead load deflections.

460-4.4.2.3 Pinholes: Unless shown elsewhere in the Contract Documents, bore pinholes:

1. True to the specified diameter;
2. Smooth to ANSI 3 (125 micro-inches);
3. At right angles with the axis of the member;
4. Parallel with each other; and
5. With a diameter of the pinhole not exceeding that of the pin by more than 0.015 inch for pins 5 inches or less in diameter, or 1/32 inch for larger pins.

460-4.4.2.4 Truss Chord Joints: Abutting joints in truss chords not specified to be mill-to-bear, shall have openings of 1/4 inch ± 1/8-inch.

Abutting joints in truss chords specified to be mill-to-bear, shall be faced and brought into bearing. When assembled, provide 85% or more of the abutting surfaces in full contact. Allowable visible gaps shall not exceed 1/64 inch.

460-4.4.2.5 Horizontally Curved Beams and/or Skewed Steel Girders: Account for torsion induced deflections for horizontally curved beams and/or skewed steel girders. Unless otherwise defined in the Contract Documents, a horizontally curved beam or girder is a longitudinal or transverse bridge component with a radius less than 10,000 feet anywhere along its continuous length.

460-4.5 Shop Assembly:

460-4.5.1 General: Ensure the fit of all connections and the geometry of all components. Unless specified elsewhere in the Contract Documents, check the fit of all longitudinal girder/beam lines in accordance with 460-4.5.1.1. Perform this prior to transporting the pieces in question to the site for erection.

460-4.5.1.1 Progressive Girder or Truss Assembly: Assemble the structure for a minimum of three spans, panels, field sections, segments or longitudinal chords of the structure. Successive assemblies shall consist of at least one longitudinal segment of the previous assembly, repositioned as necessary for accurate alignment, plus two or more longitudinal segments added

at the advancing end. For entire structures less than 150 feet in length or less than three segments, assemble the entire longitudinal line. Meet the requirements of 460-4.5.1.4 when utilizing computer-numerically-controlled drilling equipment.

When a transverse structural steel member or members is required for the continuation of the uninterrupted girder or beam line, truss, arch rib, bent tower face or rigid frame, and is designated elsewhere in the Contract Documents to be shop assembled, the Fabricator may include this member or component in a separate subassembly and not the three segment longitudinal assembly (discussed above). If combined in a different subassembly, include the longitudinal member(s) or component(s), as designated elsewhere in the Contract Documents to be shop assembled, that frame directly into the transverse structural member. Do not include the transverse member(s) in the longitudinal assembly unless directed so elsewhere in the Contract Documents or by the Engineer. Account for end rotations and deflections as necessary, and submit the procedure to the Engineer for review.

460-4.5.1.2 Progressive Chord Assembly: When specified elsewhere in the Contract Documents, assemble the truss chords for a minimum of three panels or longitudinal segments of the structure. Successive assemblies shall consist of at least one longitudinal segment of the previous assembly, repositioned as necessary for accurate alignment, plus two or more longitudinal segments added at the advancing end. For entire structures less than 150 feet in length or less than three segments, assemble the entire longitudinal line. Meet the requirements of 460-4.5.1.4 when using computer-numerically-controlled drilling equipment.

Account for transverse members indicted elsewhere in the Contract Documents to be included in the shop assembly as in 460-4.5.1.1.

When assembled in accordance with this subsection, the holes of the connections will be so located that they will be drilled to the final geometric angles. This will require that the truss members, when erected under the no load (or practically no load or stress) condition, must be bent and forced to fit the end conditions. This condition will introduce an initial reverse secondary stress that will theoretically wane when the structure assumes the loading for which it is cambered. Submit the procedure to the Engineer for review.

460-4.5.1.3 Special Complete Structure Assembly: When specified elsewhere in the Contract Documents, this type of shop assembly will include assembling the entire structure including the diaphragms, cross frames, integral steel substructure and floor components. Miscellaneous components are not included unless directed elsewhere in the Contract Documents. Establish procedures for each structure or structure type including consideration of incremental erection, temporary field support locations, stage construction and final tightening of field connections. Submit the procedures for review by the Engineer.

460-4.5.1.4 Computer-Numerically-Controlled (CNC) Drilling Associated with Progressive Girder, Truss or Chord Assembly: If the Fabricator chooses to drill the holes in all plies of all connections of the continuous main girder or beam line, truss, arch rib, bent, tower face or rigid frame and any intersecting (transverse) members utilizing computer-controlled-

numerical drilling procedures, piece-wise assembly of the entire continuous girder or beam line, truss, arch rib, bent, tower face or rigid frame is not required if the following requirements are met:

Prior to transporting to the site, perform a check fit of the first three spans, panels, field sections, segments or longitudinal chords; or entire first bent, tower face or rigid frame of the structure to ensure the accuracy of the CNC procedures and equipment.

As selected by and at the discretion of the Engineer and prior to transporting to the site, perform another check fit of a different assembly of three spans, panels, field sections, segments or longitudinal chords; or another entire bent, tower face or rigid frame of the structure to ensure that the accuracy of the CNC procedures and equipment is maintained. If either of the above fails to meet the Contract requirements, assemble the entire girder or beam line, truss, arch rib, bent, tower face or rigid frame as originally prescribed in 460-4.5.1.1 or 460-4.5.1.2 as prescribed elsewhere in the Contract Documents. Account for transverse members indicated elsewhere in the Contract Documents to be included in the shop assembly as in 460-4.5.1.1.

460-4.6 Evaluation of Work: The Engineer will evaluate and accept materials and work conforming to the Contract Documents. These evaluations may take place prior to or following delivery of the materials to the site of the structure. Materials or work that fails to meet Contract requirements will be rejected.

The Engineer may, at his sole discretion, permit further inspections and testing of materials or work that fail to meet Contract requirements for acceptance. The cost of such inspections and tests shall be borne by the Contractor.

Bring to the attention of the Engineer, all nonconforming work and or materials that cannot be brought into conformance with the Contract Documents using pre-established procedures as outlined in the Department approved Quality Control Plan. Submit the following information to the Engineer:

A cover letter prepared on the Contractor's letterhead and addressed to the Engineer briefly describing the nonconforming work and the proposed credit to the Contract proportionate to the nonconformance. For each fabricating facility and for each project within that fabrication facility, submittals must be numbered consecutively beginning with the number 1, at the start of each project. Erectors will start with one for each individual project.

A completed Department Nonconforming Structural Steel and Miscellaneous Metal Component Data Sheet, prepared by the Contractor and countersigned by the Engineer's designated representative to indicate agreement between the Contractor and the Department regarding the nonconformance, not any solution, resolution or credit. If the Contractor and the Engineer's designated representative are not in agreement regarding the nonconformance, the Engineer's designated representative will either reject the submittal indicating the reason(s) for the rejection or modify the submittal and forward to the Engineer. In the event of modification, the Contractor will initial the submittal before being

forwarded to the Engineer, thereby indicating the Contractor's concurrence with the modification.

A list of supporting information such as sketches, documentation, calculations, pictures, etc., must be included in the appropriate space on the Nonconforming Component Data Sheet. Supporting information regarding Contract Document noncompliance in the form of separate documents is only necessary when space on the Department Nonconforming Structural Steel and Miscellaneous Metal Component Data Sheet is inadequate for the required data. All of the supporting information required for the form must be prepared by, or under the supervision of, the Specialty Engineer who will sign and seal one (1) complete copy of the supporting information.

If requested by the Engineer, submit a structural and durability evaluation of the proposed repair and/or remediation. This evaluation must be conducted under the supervision of a Specialty Engineer and the submittal is to bear the Specialty Engineer's signature and seal.

460-4.7 Member or Component Certification: Coordinate with the Engineer to schedule final inspection of the completed work within two weeks prior to shipment or erection to verify that all Contract Document requirements have been met. After verification that all Contract Document requirements have been met and all necessary repairs have been satisfactorily completed, the Quality Control Manager shall certify, by initials and/or signature, such materials, components or members. The record shall include certification for:

A. items being shipped or stored prior to final assembly. Affix a certification in the form of a stamp or tag in accordance with 460-4.2 and as indicated in the Quality Control Plan, and with a copy of the certification placed in the Contractor's permanent project records,

B. work being placed into its final position. Document as indicated in the approved Quality Control Plan, in the Contractor's permanent project records.

Submit a summary certification at the least once a month or with each payment request that includes the following or similar wording. 'The undersigned, being a responsible official of (insert Contractor identification) certifies that the materials, components or members listed herein have been produced under strict quality control and meet the requirements of the Contract Documents.' Include a positive identification in the certification such that the applicable materials, components and/or members can be uniquely identified utilizing just the summary certification document. The Quality Control Manager shall sign this summary certification.

460-5 Bolted Connections.

460-5.1 General: Use ASTM A 325 bolts in all bolted structural steel connections, unless the connected assemblies or parts are designated as miscellaneous components and the fastener assembly is specified elsewhere in the Contract Documents. Tighten ASTM A 325 bolts in accordance with the procedures specified below for turn-of-nut or direct-tension-indicator (DTI) tightening.

Lubricate and maintain consistency in lubrication of fastener assembly during Rotational Capacity (RC) testing and installation. Assemblies that exhibit a loss of lubrication, as determined by the Engineer, may be relubricated and retested prior to installation.

Use ASTM A 490 bolts only with the approval of the Engineer. Provide procedures in accordance with for the handling, lubrication, installation, tightening and testing of ASTM A 490 bolts. Do not install ASTM A 490 bolts without prior approval of the procedures by the Engineer.

When the Engineer approves ASTM A 307 bolts for use in miscellaneous components, tighten them such that the plies of the joint are in firm contact. Use three to five impacts of an impact wrench or the full effort of a person using an ordinary spud wrench to obtain a snug connection.

Fasten aluminum, other materials or assemblies of dissimilar materials in accordance with the Contract Documents.

Install ordinary rough or machine bolts and nuts in accordance with the Contract Documents.

460-5.2 Testing:

460-5.2.1 Rotational Capacity (RC) Tests: At the location of and prior to installation of permanent high-strength fasteners in main or primary load-carrying member connections, perform RC tests in accordance with Florida Method FM 5-581 (for long bolts) or FM 5-582 (for short bolts) to ensure that the fasteners are capable of developing the specified strength and that the fasteners are properly lubricated. As a minimum, test two assemblies per LOT designation. The bolt, nut and washer shall come from the same LOT and be packed in the same container (or group of containers assigned the same LOT), except in special cases where nuts and washers have only one production LOT number for each size.

Short bolts may also be tested using FM 5-583 with DTIs calibrated with long bolts installed in a Tension Measuring Device.

Washers are required for RC tests even though they may not be required for jobsite installation. Where washers are not required for jobsite installation, LOT identification is not required. The washer coating shall be the same as that for the bolt and nut.

Perform the RC test in a manner that replicates the anticipated fastener installation the technique (e.g. If a spud wrench is to be used as a part of the installation process, use the wrench similarly for the RC test).

If any of the required tests fails, the entire LOT will be rejected.

460-5.2.2 Verification of Direct Tension Indicator (DTI) Device Performance: On a daily basis (when DTI devices are being installed) and at the location of installation, perform DTI Verification tests in accordance with Florida Method FM 5-583. Perform this test on a minimum of two high-strength fastener assemblies from each fastener assembly LOT and position of the DTI prior to production installation. If either assembly fails, test additional fastener assembly LOT/DTI combinations as requested by the Engineer to verify that the Requirements of the Contract Documents have been satisfied. These two tests are in addition to the RC tests required in 460-5.2.1. If, after additional testing, the

DTI fails to meet the requirements of FM 5-583, the LOT will be rejected by the Engineer.

460-5.3 Reuse and Retightening: Do not reuse ASTM A 490 bolts or galvanized ASTM A 325 bolts. Black ASTM A 325 bolts with free spinning nuts may be reused one time with the Engineer's approval. Previously tightened bolts that may have been loosened by the tightening of adjacent bolts can be further tightened from the original position. Ensure proper lubrication prior to retightening. Discard and replace fractured or damaged bolts.

460-5.4 Assembly of Bolted Connections:

460-5.4.1 General: Verify that the faying surfaces are in accordance with the Contract Documents, are free of dirt or other foreign materials, and that the geometry of the bolt holes and the connection meets the requirements of 460-4.3.4.9.

Install fastener assembly components of the same LOT and of the size and quality specified in the Contract Documents. Provide final bolts, cylindrical erection pins or other fit-up bolts as indicated in the Erection Plan.

When it is impractical to turn the nut, tighten the fastener by turning the bolt while preventing the nut from rotating. During this tightening operation, do not allow the rotation of the part of the fastener assembly not turned by the wrench.

460-5.4.2 Preparation of Faying Surfaces: Provide coated and non-coated faying surfaces in accordance with the Contract Documents. Faying surfaces specified as blast-cleaned must satisfy SSPC SP-10 'Near-White Blast Cleaning.'

When painting of the slip-critical faying surface of bolted connections is required, use only the prime coat. Prepare and coat the faying surfaces prior to installation of the fasteners. Provide certification of the slip critical classification required in the Contract Documents.

Provide certification to the Engineer that galvanized faying surfaces meet or exceed a Class C slip critical classification, unless a different classification is required elsewhere in the Contract Documents. Mechanically roughen galvanized faying surfaces in accordance with the galvanizer's recommendations.

460-5.4.3 Reaming: Do not over size bolt holes by reaming (or any other method) without the approval of the Engineer.

460-5.4.4 Drifting: Do not over size, stretch or otherwise damage bolt holes by improper and excessive drifting.

460-5.4.5 Splice Plate Filler Material: Unless otherwise specified in the Contract Documents, provide filler material edges within 1/8 inch of the adjacent splice material edge.

460-5.4.6 Installation of Fastener Assemblies: Unless shown otherwise in the Erection Plan, install the bolts of the connection by progressing systematically from the most rigid part of the connection to the free edges. Install bolts in all holes of the connection and bring them to a 'snug tight' condition. Following the sequence indicated in the Erection Plan, further tighten all the bolts in the connection.

For ASTM A325 bolts, obtain the required bolt tension as shown in Table 460-6, Minimum Required Fastener Tension in accordance with the turn-of-nut method specified in 460-5.4.8, or when DTIs are used, the DTI tightening method specified in 460-5.4.9.

For connections (such as large main load-carrying members or truss joints) in which previously tightened high strength bolts become loose and require retightening upon the tensioning of others, install into a minimum of ten percent of the holes fully tensioned bolts prior to final tensioning of the permanent bolts. Distribute these first bolts randomly throughout the connection. If directed by the Engineer, remove the initial bolts and install permanent bolts at each location, otherwise retighten in accordance with 460-5.3.

Table 460-6, Minimum Required Fastener Tension	
Bolt Size,inch	Tension ASTM A 325 bolts,kips
5/8	19
3/4	28
7/8	39
1	51
1 1/8	56
1 1/4	71
1 3/8	85
1 1/2	103

460-5.4.7 Bolt Tension: Provide a Skidmore-Wilhelm Calibrator, or other equivalent bolt tension measuring device, wherever final connections are being made. Confirm the accuracy of the tension measuring device by having it calibrated by an approved testing agency once a year.

460-5.4.8 Turn-of-Nut Tightening: For each work shift, perform tests utilizing a representative sample of five fastener assemblies, from each LOT to be installed that shift. Perform the tests using the tension measuring device, following the same procedure to be used for actual installation of the fastener assemblies, to a snug-tight tension and corresponding torque, which, when the additional turns required in Table 460-7, Nut Rotation from the Snug-Tight Condition are added, will result in at least 1.05 times the minimum required fastener installation tension as shown in Table 460-6. Place a washer under the part turned in the tightening of the bolt. Consider the job inspection snug-tight torque as the average of three test values determined after rejecting the high and low-test values.

For fastener assemblies too short to fit in the tension measuring device, modify the determination of the job inspection snug-tight torque in accordance with FM 5-582.

460-5.4.8.1 Snug-Tight Condition: In the turn-of-nut method, first bring all the fastener assemblies of the connection to a ‘snug-tight’ condition to ensure that all parts of the connection are in firm contact with each other. For the purposes of this specification, “firm contact” shall mean the condition that exists on a faying surface when the plies are solidly seated against each other, but not

necessarily in continuous contact. Regard snug-tight as the tightness required to produce the bolt tension, which following the final applied rotation, produces at least 1.05 times the minimum required bolt tension in accordance with Table 460-6, Minimum Required Fastener Tension. In the presence of the Engineer, and on a daily basis, determine the job inspection snug-tight torque as specified herein.

460-5.4.8.2 Final Tightening: After verification of the snug-tight condition in accordance with 460-5.4.11 by the Engineer, tighten all fastener assemblies in the joint by applying the applicable amount of nut rotation specified in Table 460-7, Nut Rotation from the Snug-Tight Condition. Once snug-tight, bring all fasteners to the required tension within the same work shift.

Table 460-7, Nut Rotation from the Snug-Tight Condition

Bolt Length Measured from Underside of Head to End of Bolt	Both Faces Normal to Bolt Axis	One Face Normal to Bolt Axis and Other Face Sloped Not More than 20:1.Bevel Washer not Used.	Both Faces Sloped Not More than 20:1 from Normal to Bolt Axis. Bevel Washers not Used.
Up to and Including Four (4) Diameters	1/3 turn	1/2 turn	2/3 turn
Over Four (4) Diameters but not Exceeding Eight (8) Diameters	1/2 turn	2/3 turn	5/6 turn
Over Eight (8) Diameters but Not Exceeding Twelve (12) Diameters	2/3 turn	5/6 turn	1 turn

Notes:
1. Nut rotation is relative to the bolt, regardless of the element being turned.
2. Tolerance for bolts installed by 1/2 turn or less is ± 30 degrees. For bolts installed by 2/3 turn or more, the tolerance is ± 45 degrees.
3. Nut rotations given are only applicable to connections in which all material within the grip of the bolt is steel.
4. For bolt lengths exceeding 12 diameters, establish the required rotation by performing actual tests in a suitable tension device simulating the actual conditions. Submit procedures to the Engineer for review.

460-5.4.9 Direct-Tension-Indicator (DTI) Tightening: After complying with the requirements of 460-5.2.2, install and tighten DTI devices following the procedures described in the DTI Verification Test. Do not permit the DTI to turn during installation and tightening. Provide washers in accordance with 460-5.4.10.

460-5.4.9.1 Snug-Tight Condition: Install the bolts as specified through Step 3 (Snug-Tight Condition) of the DTI Verification test. If the 0.005 inch feeler gage is refused in more gaps than shown in the Table in Step 3.5 of the test, or the DTI device becomes loose and can be spun by hand, remove the bolt and DTI device, discarding the DTI device. Provide a new DTI device and reinstall the assembly and bring to the snug-tight condition.

460-5.4.9.2 Final Tightening: After verification by the Engineer that the snug-tight condition for all bolts has been met, tighten all fastener assemblies in the joint such that the number of spaces in which the 0.005 inch thickness gauge is refused is equal to or greater than the number shown in Table 460-8, DTI Device Tightening Criteria. Once snug-tight, bring all fasteners to the required tension within the same work shift.

Table 460-8, DTI Device Tightening Criteria						
Number of Spaces in DTI	4	5	6	7	8	9
Minimum Spaces in which Gage is Refused	2	3	3	4	4	5

Do not tighten the assembly beyond the smallest gap permitted in Step 3.5 of FM 5-583. Remove and replace bolts, discarding the DTI, which have a DTI with a smaller gap or no gap.

460-5.4.10 Washers:

460-5.4.10.1 General: Provide ASTM F 436 hardened steel washers as follows:

1. For connections (and all associated testing) using ASTM A 490 bolts, use a hardened washer under each element.
2. For connections using ASTM A 325 bolts, use hardened washers under the turned element.
3. Use hardened steel washers as part of the Rotational Capacity tests.
4. Where the outer face of the bolted parts has a slope of greater than 20:1 with respect to a plane normal to the bolt axis, use a hardened, beveled washer to compensate for the lack of parallelism.
5. Where bolts are to be installed in a oversized or slotted hole in an outer ply, provide a single washer satisfying ASTM F 436, or continuous bar satisfying ASTM A 709: for ASTM A 325 bolts, provide a thickness of at least 5/16 inch; and for ASTM A 490 bolts, provide a thickness of 3/8 inch. Provide these washers or bars to completely cover the slot after installation. Provide a finish consistent with the bolt specified.
6. In non-Direct-Tension-Indicator (DTI) applications, clip washers on one side to a point not closer than 7/8 of the bolt diameter from the center of the washer, if necessary.

460-5.4.10.2 Use of Washers with Direct-Tension-Indicators (DTIs) Devices: When DTIs are used; use ASTM F 436 hardened washers as follows:

1. When the nut is turned and the DTI is located under the bolt head, a hardened washer is to be located under the nut.
2. When the nut is turned and the DTI is located under the nut, a hardened washer is to be located between the nut and the DTI.
3. When the bolt head is turned and the DTI is located under the nut, a hardened washer is to be located under the bolt head.

4. When the bolt head is turned and the DTI is located under the bolt head, a hardened washer is to be located between the bolt head and the DTI.

460-5.4.11 Inspection:

460-5.4.11.1 Turn-of-Nut Tightening:

1. Once the snug-tight condition is achieved for all of the fastener assemblies of the connection, within 24 hours of snugging the first bolt in the connection and in the presence of the Engineer, verify for a minimum of three (3) bolts [two (2) for two bolt connections] or 10% of the fastener assemblies, that the job inspection snug-tight torque has been attained. These fasteners are to have a snug-tight torque equal to or exceeding that specified in 460-5.4.8. Perform this check using the same torque wrench used in 460-5.4.8. For bolts tested in accordance with FM 5-583 or when multiple torque wrenches are required, provide a calibrated torque wrench or wrenches.

2. If the tested fasteners do not obtain the job inspection snug-tight torque, test all remaining untested fastener assemblies using the torque wrench in the connection in question. Following testing of all assemblies, bring to snug-tight all assemblies and retest as stated above. Resnug and retest as necessary using the calibrated torque wrench until the minimum testing stated above is performed favorably.

3. Following confirmation of the snug-tight condition as performed by the Contractor, and in the presence of the Engineer, match mark the fastener assemblies on the end of the bolt thread and on the nut, and then tighten the nut the amount of rotation specified in Table 460-7, Nut Rotation from the Snug-Tight Condition. The Engineer will accept the connection as fully tightened when all of the following conditions are met:

a. the rotation specified in Table 460-7 has been achieved,

b. there are no loose assemblies in the connection,

c. all plies of the connection are in firm contact,

d. there are no indications that excessive stretching or yielding has occurred in the fastener assembly,

e. bolt stick-through is consistent per LOT.

460-5.4.11.2 Direct-Tension-Indicator (DTI) Tightening: Prior to bringing the connection to a snug-tight condition, verify in the presence of the Engineer that the ‘dimples’ of the DTI are not deformed or damaged. Bring the connection to a snug-tight condition and tighten in accordance with the requirements of 460-5.4.9. The Engineer will accept the connection as fully tightened when all of the following conditions are met:

a. the requirements of 460-5.4.9 have been achieved,

b. there are no loose assemblies in the connection,

c. all plies of the connection are in firm contact,

d. there are no indications that excessive stretching or yielding has occurred in the fastener assembly,

e. Bolt stick-through is consistent per LOT.

460-6 Welding.

460-6.1 General: Except as noted in the Contract Documents, perform all shop and field welding in accordance with the AASHTO/AWS D1.5, Bridge

Welding Code. Additional or alternate requirements for hollow steel structural sections and non-dynamically loaded members or components are listed below.

460-6.2 Welding on Non-Dynamically Loaded Elements: Perform welding on miscellaneous components and other statically (non-dynamically, non-cyclically, etc.) loaded structural elements in accordance with the AWS D1.1, Structural Welding Code, or the AASHTO/AWS D1.5, Bridge Welding Code. Unless otherwise specified in the Contract Documents or as approved by the Engineer, follow the Bridge Welding Code for weld inspection and welder certifications.

460-6.3 Electroslag Welding: Use Narrow-Gap Improved Electroslag Welding (NGI-ESW) for joining non-fracture critical members or components up to 3 inches thick. These members or components may be subjected to tension, compression or stress reversal. Inspect 100% of all NGI-ESW welds subject to tension stresses or reversal of stress by both UT (ultrasonic examination as described in Section 6, Part C of the AASHTO/AWS D1.5, Bridge Welding Code) and RT (radiographic examination as described in Section 6, Part B of the AASHTO/AWS D1.5, Bridge Welding Code).

Perform NGI-ESW welding in accordance with the AASHTO/AWS D1.5, Bridge Welding Code. Supplemented by the recommendations from the following references:

1. Report No. FHWA-SA-96-053, “Technical Information Guide for Narrow.Gap Improved Electroslag Welding”.

2. Report No. FHWA-SA-96-052, “Process Operational Guide for Narrow.Gap Improved Electroslag Welding”.

460-6.4 Welding of Hollow Structural Steel Sections (Pipes and Tubes): Except as noted in the Contract Documents, perform all shop and field welding of Hollow Structural Shapes in accordance with the AWS D1.1, Structural Welding Code as amended herein.

460-6.4.1 Highway Signs, Luminaires and Traffic Signals: For structural steel sign structures, lighting poles, and traffic signal poles, comply with the additional requirements of AASHTO Standard Specification for Structural Steel Supports for Highway Signs, Luminaires and Traffic Signals, Section 1.4.2, Welding of Steel Structures.

460-6.4.2 Bridge Structures: For tubular bridge structures including pedestrian bridges, comply with the requirements of the AWS D1.1 Structural Welding Code as amended by the following:

1. Qualify all welding processes in accordance with the AASHTO/AWS D1.5, Bridge Welding Code. Comply with all qualification criteria including production thickness and position limitations. Use ASTM A 709 Grade 50 for this test.

2. UT NDE technicians performing inspection of TKY welds are to be qualified to the requirements and recommendations for operator qualification specified in API Recommended Practice 2X, Third Edition, 1996, including a practical test with mockup tubular welds containing built-in flaws,

3. Perform nondestructive testing of all tubular complete joint penetration groove welds in main members using Ultrasonic Testing in accordance with the AWS D1.1, Structural Welding Code.

Perform ultrasonic testing at the following frequency:

1. One hundred percent of each joint subject to tension or reversal of stress.

2. Twenty-five percent of each joint subject to compression or shear.

If unacceptable discontinuities are found in the joint, the remainder of the joint shall be tested.

Perform Magnetic Particle Testing on 12 inches in every 10 feet on each fillet and partial penetration groove welds in main members but no less than 12 inches on welds less than 10 feet.

460-6.5 Field Welding: Field weld only with the approval of the Engineer. Provide any additional field welding procedures as requested by the Engineer for review.

460-6.6 Tack Welds: Do not weld or tack any fill plates, brackets, clips, shipping devices, or other materials not required by the Contract Documents or allowed by the AASHTO/AWS D1.5 Bridge Welding Code.

460-7 Erection.

460-7.1 Pre-erection Requirements:

460-7.1.1 Quality Control Plan: Develop an Erection Quality Control Plan for review and approval of the Engineer.

460-7.1.2 Submittals: Meet the requirements of Sections 5 and 103 for any required submittals. Provide submittals to the Engineer for review by the Department in accordance with Section 5 and the Contract Documents.

460-7.1.3 Erection Plan: Submit, for the Engineer's review, an Erection Plan locating all primary members, lifting equipment and temporary supports or braces, and bolting pattern tightening procedures not considered routine. Ensure that the plan includes the Specialty Engineer's signature and stamp. Include supporting calculations indicating that the design unit stresses indicated in the Contract Documents have not been exceeded. Provide this Plan or Plans to the Engineer three weeks before erecting the piece or pieces.

Include the following information in the Erection Plan:

1. A plan of the work area showing all substructure units and foundations; surface roads and railroads; all streams, creeks and rivers; and all overhead and underground utilities.

2. The erection sequence for all primary load-carrying members and all primary load-carrying member bracing. Note any and all permanent or temporary support and/or bracing locations, including crane-holding positions.

3. The center of gravity locations, pick weight and delivery orientation for all primary load-carrying members and pick weight.

4. Identify any bolting requirements not considered routine.

5. Locate all pick crane work points.

6. Identify all temporary works and staging areas such as barges, mats and temporary excavation support.

7. Provide capacity charts on the drawings for each crane configuration and boom extension utilized.

8. Details of all temporary bracing, falsework, towers and shoring.

9. Provide any procedures requested by the Engineer and not contained in the Quality Control Plan.

460-7.2 Special Weathering Steel Requirements:

460-7.2.1 General: Do not use marking materials (grease sticks, crayons) that leave behind a residual film that may affect the weathering process of the steel. Store the girders as required for non-weathering steels.

460-7.2.2 Steel Preparations: Prior to erection, perform the following as appropriate:

Blast clean the exposed fascia of the exterior girders (both I and box) to meet SSPC-SP10 criteria; blast clean the remaining exposed surfaces of steel trapezoidal girders, not required to be prepared otherwise, to meet SSPC-SP6 criteria; for steel I-girders, if a non-uniform mill scale finish has developed, as determined by the Engineer, blast clean all remaining exposed surfaces, not required to be prepared otherwise, to an SSPC-SP6 criteria; coat the inside of box members including, but not limited to, all bracing members, cross frames and diaphragms with only the prime coat. For the bottom or walking surface, certify that the applicable OSHA requirements on slip resistance will be obtained after applying the coating. Reapply the coating as necessary to satisfy the OSHA requirements. Submit the composition of coating to the Engineer for review.

460-7.2.3 Concrete Substructure Preparations: Prior to erection of the girders, wrap all exposed substructure concrete surfaces with polyethylene sheeting, or equal, as approved by the Engineer, to protect them against staining from the weathering steel components. Leave the sheeting in place and keep it free of tears or separations until just prior to the preparation for and application of the Class 5 Finish. In any case, do not remove the sheeting prior to placement of the concrete deck. As directed by the Engineer, clean all visible stains on concrete in areas not receiving a Class 5 Finish by sandblasting and follow-on cleaning using a stain remover or commercial cleaner after completion of the structure in accordance with Section 400.

460-7.2.4 Structure and Site Clean Up: Upon the completion of construction, remove all oil, dirt, grease or other foreign material, including excessive or uneven mill scale from the steel. Remove lubricants from the exposed surfaces of installed fastener assemblies and other surfaces in accordance with the manufacturer's recommendations. Follow procedures specified in Section 560 as appropriate. Final surface finish is to be an even mill scale as approved by the Engineer.

460-7.3 Coordination with Substructure: Prior to the erection of primary load-carrying members, conduct a survey to document the vertical, longitudinal and transverse position of all substructure units and anchor rod locations. Appropriately account for ambient temperature in the survey.

Should a discrepancy be identified with the Contract Documents, submit the necessary details to the Engineer for resolution.

460-7.4 Placing Anchor Rods: Locate and place anchor rods within the tolerance shown in the Contract Documents or within 1/4 inch of the theoretical location shown. If anchor rods cannot be located to the specified tolerance, place

only with the approval of the Engineer. Unless shown otherwise in the Contract Documents, provide galvanized anchor rods, nuts and washers as follows:

1. Set the anchor rods in preformed holes vertical to the plane of the bridge seat.

2. Provide 4 inch diameter holes.

3. Provide non-shrink grout/mortar of a strength greater than or equal to that of the substructure concrete strength, or as shown elsewhere in the Contract Documents.

4. Install the rods in accordance with the grout/mortar manufacturer's recommendations.

5. Clean the threads of the anchor rods as necessary without damaging the coating.

460-7.5 Preparation of Bearing Areas and Setting of Bearings: Prior to placing superstructure bearing units (including but not limited to neoprene pads and masonry plates), prepare the top of concrete pad (bearing area) in accordance with Section 400. If a discrepancy is identified, report it to the Engineer for resolution.

For expansion bearings with slotted holes for anchor rods, which allow movement of the superstructure with respect to the substructure, vary the location of the slotted plate in relation to the anchor rods, in accordance with the prevailing temperature at the time of setting.

For fixed bearings at multiple adjacent piers, if necessary, horizontally jack the substructure units to correctly set the centerline of bearing. Adequately account for temperature.

Unless specified elsewhere in the Contract Documents, locate the theoretical centerline of bearings to within 1/16 inch transverse to longitudinal girder lines; and in the direction parallel to the longitudinal girder line locate the theoretical centerline of bearing within 1/4 inch of the theoretical centerline of bearing.

After setting the bearings and installing anchor rod nuts, washers and any other associated hardware specified in the Contract Documents, clean the protruding/exposed surfaces of the assembly of all deleterious material. Finish-coat metal parts in accordance with 460-4.3.4.11.

460-7.6 Tightening of Anchor Rod Nuts:

460-7.6.1 Fixed Bearings: Tighten anchor nuts to a 'snug tight' condition such that the different mating surfaces (such as the top of concrete, neoprene and steel) are in firm contact. The nut is to be tight enough to develop friction between surfaces to prevent sliding, but not over-tightened that bulging or damage occurs in any of the mating materials.

460-7.6.2 Expansion Bearings: Draw down the nut such that a total gap of 1/16 inch exists between the washer and nut and washer and bearing surface. Tighten a second nut of the same specification to a snug tight condition against the first nut maintaining the required gap.

460-7.7 Final Position of Girder Webs: Unless shown elsewhere in the Contract Documents, detail the girders and cross frames as directed by the Engineer. The final condition is to be defined as with the deck and parapets cast, but without any future wearing surface. A web will be considered plumb if it is

within a tolerance horizontally between the top and bottom of the web of 3/32 inch per foot of web depth compared against the theoretical position as required in the Contract Documents. Measure the out-of-plumb perpendicular to the face of the web. Erect trapezoidal girders to the geometry shown in the Contract Documents to the same 3/32 inch per foot of web depth tolerance.

460-7.8 Inspection and Final Acceptance:

460-7.8.1 General: Perform Quality Control inspections of all phases of the work. The inspection frequency and depth shall be sufficient to ensure that all materials and workmanship incorporated into the work meet the requirements of the Contract Documents and that the processes are controlled to ensure that the final finished product(s) conform to the physical characteristics and dimensions required by the Contract Documents. The Quality Control Manager shall be responsible for all inspection operations. An adequate number of Quality Control Inspectors shall be available to ensure review of all materials and fabrication processes are preformed in accordance with the Quality Control Plan. Weekly meetings shall be held with the Engineer to review inspection findings. The review of this information is to identify any refinements and/or improvements in the process being utilized in the work. The frequency of the meetings may be altered by the Engineer.

460-7.8.2 Inspection/Final Acceptance: Ensure the final alignment, profile and fastening of the erected steel is in accordance with the Contract Documents.

460-8 Method of Measurement.

460-8.1 General: The quantities to be paid for will be the items covered by this Section, following acceptance by the Engineer. Partial payments may be made for fabricated components yet to be assembled into larger components, members and assemblies as allowed for elsewhere in the Contract Documents.

460-8.2 Deductions and Allowances: No deductions from the computed weight of rolled or fabricated structural steel or miscellaneous components will be made for sheared edges, punchings, holes, milling, plaining or other items of waste associated with the finished components or parts.

460-8.3 Weights of Structural Steel and Miscellaneous Materials: The weights of structural steel will be taken as nominal weights as reported in the AASHTO LRFD Bridge Construction Specifications and ASTM Specifications, in that order of precedence, using the dimensions shown in the Contract Documents.

460-8.4 Structural Steel: The quantity of structural steel and miscellaneous metals becoming part of the completed structure and accepted by the Engineer will be paid for at the quantity shown in the Contract Documents, or as modified by the Engineer, measured in pounds, or by the Contract lump sum price for Structural Steel.

460-8.5 High-Strength Fastener Assemblies: The weight of high-strength fastener assemblies (including nuts and washers) installed by the Contractor and accepted by the Engineer will be computed on the basis of an average length in accordance with Table 460-9:

Table 460-9, Weights of High-Strength Fastener Assemblies					
Diameter of High-Strength Fasteners, inch	3/4 inch	7/8 inch	1 inch	1 1/8 inch	1 1/4 inch
Weight per 100, pounds	52	100	135	182	238

The weight of high-strength fastener assemblies will be included in the determination of the weight of the completed structure in determining the quantity paid when payment is not by Lump Sum. The Engineer will determine values for sizes of high-strength fastener assemblies not shown.

460-8.6 Welding and Welds; Fasteners Not Designated as High-Strength; Anchor Rods, Nuts, Bolts and Associated Washers; Transporting; Handling; and Erection: Welding and welds; fastener assemblies not designated as high-strength; anchor rods, nuts, bolts and associated washers; transporting; handling; and erection are considered incidental to the work and will not be paid for separately.

460-8.7 Shims and Fill Plates: The quantity of shims and fill plates will be included in the determination of the weight of the completed structure in determining the quantity paid when payment is not by Lump Sum.

460-8.8 Coatings: The preparation, application, clean-up and the consumables used in the coatings process are considered incidental to the work and will not be paid for separately. When required by the Contract Documents and upon the Engineer's prior approval, apply coating in accordance with Section 649.

460-8.9 Weathering Steel Preparation, Handling and/or Clean-up: The preparation, handling, and/or clean-up of weathering steel or the 'rust' marks on other items (concrete units, etc.) caused by the development of the patina are considered incidental to the work and will not be paid for separately.

460-8.10 Shear Connectors: Shear connectors are considered incidental to the work and will not be paid for separately.

460-8.11 Span Jacking (Fixed Bridge): Jacking of substructure units of adjacent fixed piers required to set bearing in accordance with the Contract Documents is considered incidental to the work and will not be paid for separately.

460-9 Basis of Payment.

460-9.1 General: Prices and payments will be for full compensation for all work specified in this Section completed and accepted, including but not limited to testing, bolting, welding, cleaning and coating, temporary works and erection. No separate payment will be made for falsework or other erection expense.

460-9.2 Payment Items: Payment will be made under:

Item No. 460- 1-	Structural Steel – Rehab – per pound.
Item No. 460- 2-	Structural Steel - New/Widening – lump sum.
Item No. 460- 6-	Ladders & Platforms – lump sum.

Item No. 460- 13-	Structural Steel Rehab – Sandwich Plate System - per square yard.
Item No. 460- 70-	Aluminum Bullet Railings – per foot.
Item No. 460- 71-	Metal Traffic Railing – per foot.
Item No. 460- 81-	Rivet or High-Strength Bolt Replacement – each.
Item No. 460- 95-	Structural Steel Repair – per pound.
Item No. 460- 98-	Pipe Hanger – each.
Item No. 460-112-	Anchor Bolt Replacement – each.

SECTION 461
MULTIROTATIONAL BEARINGS

461-1 Description.

Furnish and install multirotational bearings in accordance with the recommendations of the manufacturer and details shown in the plans. Submit for the Engineer's approval, shop drawings and design calculations prepared, signed and sealed by a Specialty Engineer prior to fabrication of bearings.

461-2 Materials.

Provide materials in accordance with the AASHTO LRFD Bridge Design Specifications and as follows. Furnish structural steel conforming to ASTM A-709 Grade 50W. Coat all exposed steel surfaces with a thermal sprayed coating (metalization). Blast clean surfaces with grit abrasive in accordance with Steel Structures Painting Council Surface Preparation Specification No. 10, SSPC-SP10, Near-White Blast Cleaning, to a surface profile of .002-.004 inch. Use the electric arc spraying process. Provide wire material for the metalized primer consisting of 85% zinc and 15% aluminum, each being 99.9% pure metal. Apply the metalized primer to obtain a thickness of 0.01 inch minimum and 0.02 inch maximum. Do not apply when the surface temperature of the steel is less than 5ºF above the dew point. Prepare a sample coupon using the same processes used to prepare the surface and apply the coating to the bearing. Test the coating bond strength on the coupon in accordance with ASTM D-4541. The bond strength must be a minimum of 700 psi. If the bond strength of the coating on the coupon is deficient, test the coating on the bearing. If the required bond strength is achieved, repair the coating. Provide the Engineer with a certified statement that the coating applicator has performed successful thermal spray operations within the last 12 months.

Perform any required touchup repair and field metalizing after any field welding with materials and procedures in accordance with Section 975.

Use stainless steel sheet meeting ASTM A-240, Type 316.

Use a stainless steel sheet in the expansion multirotational bearings at least 1/16 inch thick and polished to a surface finish of less than 10 micro inches root mean square on the side of contact with the PTFE.

Blast clean the surface of plates to which the stainless steel sheet is to be attached to near white, SSPC-SP10. Abrade the back of the stainless steel sheet

that is to be in contact with the steel plate using emery cloth. Position the stainless steel sheet on the steel plate, clamp and bond firmly in place using a quick-set epoxy applied in the center portion only. Apply the stainless steel sheet to the blast cleaned surface of the steel plate as soon as possible after blasting and before any visible oxidation of the blast cleaned surface occurs. Ensure that the epoxy conforms to Federal Specification MMM-A-134 Type I. Weld the stainless steel sheet to the steel plate continuously around its perimeter using a tungsten inert gas welder. Weld in a controlled manner using multiple passes or stitch welding techniques to control heat build-up. As a mating surface for the stainless steel sheet, use an unfilled virgin PTFE sheet (recessed) or a glass-fiber filled PTFE sheet (recessed). Obtain the PTFE sheet by skiving fillets formed under hydraulic pressure and heat. The resin shall meet the requirements for ASTM D-1457.Bond the PTFE and the piston using a heat cured, high temperature epoxy capable of withstanding temperatures of -40^{o}F to 250^{o}F

461-3 Design.

Design all bearings to be replaceable without removing the masonry plate or sole plate. Ensure that multirotational bearings are designed by the manufacturer for the loads and movements shown on the contract drawings. Obtain all multirotational bearings from the same manufacturer.

Design guided multirotational bearings for a lateral load equal to 10% of the vertical load capacity of the bearing or the lateral load indicated in the plans, whichever is greater.

For projects designed with the AASHTO LRFD Bridge Design Specifications, use multirotational pot or disc bearings designed and fabricated by the manufacturer in accordance with AASHTO LRFD Bridge Design Specifications for the loads and movements designated in the plans.

For projects designed using the AASHTO Standard Specifications for Highway Bridges, use multirotational pot or disc bearings designed by the manufacturer in accordance with FHWA Structural Bearing Specification SBS-1010-93 for the loads and movements designated in the plans and fabricated in accordance with this specification.

461-4 Testing and Certification.

Ensure the manufacturer verifies the adequacy of the bearings by testing random samples manufactured for this project for the following conditions:

(a) Test the bearings for a period of 24 hours under the maximum vertical load with the maximum rotational displacements applied. The maximum reactions, rotations and movements are shown in the plans for each type of bearing.

(b) In addition, test expansion bearings under maximum vertical load during six cycles of maximum longitudinal movement (One cycle shall consist of starting with the bearing elements centered, moving the maximum distance (half the total longitudinal movement) in one direction, then moving back through the center point to the maximum distance in the opposite direction and then back to the starting point).

(c) In addition test the lateral capacity of bearings with laterally restricted movement by applying the maximum vertical load and the required lateral load. Apply and release the lateral load six times in a direction 90 degrees from the bearing's unrestricted longitudinal movement direction. Apply and release the required lateral load 6 times in a direction 180 degrees from the initial lateral load direction.

Based on the maximum loads and movements shown on the plans, group the bearings into common design types for both fixed and expansion bearings. Clearly indicate this grouping on the shop drawing for approval by the Engineer. One bearing of each type and size so designated must be tested. All test results must comply with the manufacturer's design data as shown in the approved shop drawings; the bearings tested must show no visible deficiencies including extrusion of the elastomer between the piston and the base plate cylinder and the PTFE surfaces shall show no deterioration. Prior to shipment to the project site, submit the test data for the bearings tested to the Engineer with the manufacturer's certification of specification compliance for all bearings. Unsatisfactory test results will be cause for rejection of all multirotational bearings represented by the test. Any observed separation between the rotational element and the bearing plate will be cause for rejection.

Provide written certification from the manufacturer that the multirotational bearings have been fabricated and installed in accordance with the specification requirements and manufacturer's requirements prior to acceptance by the Department.

461-5 Construction.

Store multirotational bearings delivered to the bridge site under cover on a platform above the ground surface. Protect bearings at all times from damage and ensure they are clean, dry and free from dirt, oil, grease or other foreign substances before placement. Install the bearings in accordance with the recommendations of the manufacturer, contract drawings, and as may be directed by the Engineer. If there is any discrepancy between the recommendations of the manufacturer, these Specifications, and contract drawings, the Engineer will be the sole judge in reconciling any such discrepancy.

Obtain the services of a representative, employed by the manufacturer of the bearings, to supervise the installation of the bearings. Do not install the bearings until the representative is on the job site. Assume this responsibility at no further expense to the Department.

461-6 Basis of Payment.

Prices and payments will be full compensation for furnishing all labor, materials, tools, equipment, testing, manufacturer's installation supervision, and incidentals to complete the work in accordance with the Contract drawings, the manufacturer's requirements, and these Specifications.

Payment will be made under:

Item No. 461-113-	Multirotational Bearing Assembly - Fixed - each.

Item No. 461-114- Multirotational Bearing Assembly - Expansion - each.

SECTION 470
TIMBER STRUCTURES

470-1 Description.

Furnish and erect treated timber into various structures.

470-2 Materials.

Meet the following requirements:

Timber ..... Section 952
Preservative ..... Section 955

Use timber as specified in the plans.

470-3 Timber Handling.

Handle treated timber with rope slings, without sudden dropping, breaking of outer fibers, bruising, or penetration of the surface with tools. Do not use cant dogs, hooks, or pike poles.

470-4 Cutting and Framing.

Before treatment, cut and frame all timbers which are shown by the plans to be furnished in special lengths or framed to detailed dimensions. Limit the cutting of treated timber to minor fitting which might be necessary and that is authorized by the Engineer. For all places where the surface is broken, by cutting or otherwise, thoroughly coat with the preservatives and by the methods specified in AWPA M4.

470-5 Bolt Holes.

The Contractor may drill holes in the field. For timbers originally treated with pentachlorophenol, creosote, creosote solutions, or waterborne preservatives, field treat all cuts, abrasions, bolt holes, and recesses that occur after treatment with two liberal applications of a compatible preservative in accordance with the requirements specified in AWPA standard M4, Standard for the Care of Pressure-Treated Wood Products.

470-6 Pile Caps.

Ensure that pile caps have full even bearing on all piles in the bent, and secure them to each pile by a 3/4 inch diameter drift bolt extending at least 9 inches into the pile. Where so shown in the plans, cover the tops and ends of pile caps with 10 ounce, minimum weight, copper sheet meeting the requirements of ASTM B-370.

470-7 Floors.

Attach the planks to each joist or nailing strip with at least two 8 inch nails for 3 inch planks, or two 10 inch nails for 4 inch planks. Use nails that are at least 1/4 inch in diameter. For treated timber floors where a bituminous wearing

surface is to be applied, lay the planks with the best side up and with adjacent edges in contact. Grade the planks as to thickness before laying, and lay the planks so that no two adjacent planks vary in thickness more than 1/8 inch. Cut the floor to straight lines along the side of the roadway and walkway.

470-8 Framing.

Cut and frame truss and bent timbers to a close fit in such manner that they will have even bearing over the entire contact surface of the joint. Do not perform blocking or shimming of any kind in making the joints. The Engineer will not accept open joints.

470-9 Holes for Bolts, Dowels, Rods, and Lag Screws.

Bore holes to the diameters shown in the following table:

Hole Use	Hole Diameter
Drift Bolts and Dowels	1/16 inch less in diameter than the bolt or dowel to be used
Machine Bolts	Same diameter as the bolt
Rods	1/16 inch greater in diameter than the rod
Lag Screws	Not larger than the body of the screw at the base of the thread

470-10 Stringers.

The Contractor may use butt joints for outside stringers, but shall frame interior stringers to bear over the full width of floor beam or cap at each end. Separate the ends at least 1/2 inch to allow circulation of air, and securely fasten the ends to the timber on which they rest.

470-11 Railings.

Construct railings of treated dressed lumber.

470-12 Hardware.

470-12.1 General: Use hardware, including bolts, drift pins, dowels, rods, nuts, washers, spikes, nails and all similar incidental metal items, necessary to complete the work in accordance with the details shown in the plans. Use common wire nails as commercially manufactured. Use ogee washers of cast or malleable iron. The Contractor may use other hardware of steel, iron, or any similar material ordinarily used in the manufacture of such articles.

470-12.2 CCA, ACQ-D, and CA-B Treated Timber Structures: Use the fasteners and connectors as described in the following table:

TABLE – HARDWARE REQUIREMENTS FOR TREATED TIMBER		
Environmental condition where structure will be located	Fasteners	Connectors
Permanent wood foundations and/or where	304 or 316 Stainless Steel	304 or 316 Stainless Steel

salt spray if prevalent		
Structures that will be exposed to standing water or rainwater	304 or 316 Stainless Steel	304 or 316 Stainless Steel
Structures that will be situated indoors and remain dry in service	304 or 316 Stainless Steel Hot-dipped galvanized fasteners meeting ASTM A-153 requirements	304 or 316 Stainless Steel Hot-dipped galvanized connectors meeting the requirements of ASTM A-653 Class G185 sheet or better
Do not use aluminum in direct contact with treated wood.		

470-12.3 Bolts: Use bolts of the sizes shown in the plans with square heads and nuts and with screw threads that make close fits in the nuts. Upon completion of the installation, check all nuts for tightness, and cut off protruding bolt ends so that not more than 1/4 inch extends beyond the nut.

470-12.4 Inspection: The Engineer will inspect the hardware for quality of manufacture and accuracy of size prior to use on wood structures.

470-13 Countersinking.

Perform countersinking wherever the heads of screws or bolts would otherwise interfere with the assembly of the work. Fill recesses formed by countersinking with hot asphalt.

470-14 Method of Measurement.

470-14.1 General: The quantity to be paid for will be the plan quantity, in feet board measure, of such timber actually incorporated in and forming a part of the completed structure.

470-14.2 Method of Calculation: For calculating the quantity of timber, the width and thickness will be taken as the actual sizes shown in the plans or ordered by the Engineer. Where special sizing is required, the width and thickness to be used will be that of the smallest commercial size from which the special piece could be cut. Lengths to be used in the calculations will be the overall lengths of the pieces as shown in the plans, except that, where the lengths actually incorporated in the structure are less than the lengths shown in the plans, the lengths actually incorporated will be used in the calculations. Deductions will not be made for copes, scarfs, or crownings.

470-15 Basis of Payment.

Prices and payments will be full compensation for all the work specified in this Section, including all copper covering over pile heads, caps, etc., as shown in the plans, all hardware except such plates, lag screws, and other metal parts as may be shown in the plans to be paid for as structural steel and all paint materials and all excavation, painting, and incidentals necessary to complete the work.

Payment will be made under:

Item No. 470- 1- Treated Structural Timber - per Thousand Board Measure.

SECTION 471
PLASTIC FENDER SYSTEM COMPONENTS

471-1 Description.

Construct fender systems using plastic components in accordance with the Contract Plans and Design Standards.

471-2 Materials.

Meet the following requirements:

Structural Plastics.....Section 973

471-3 Construction Details.

Protect materials at all times against exposure to extreme heat or impact. Transport Structural Plastic in a manner that will minimize scratching or damage to the outer surfaces, stack on dunnage above ground so that it may be easily inspected and store in a manner that will avoid damage. Handle and lift Structural Plastic with nylon slings. Do not use sharp instruments in handling the product. Structural Plastic damaged in shipping or handling will be rejected.

Structural Plastic sections containing cracks in the reinforcing rods or cracks, partial or full depth, across the section or splits will be rejected.

Cut, bevel, drill, countersink and otherwise install Structural Plastic in accordance with the manufacturer's recommendations. Set all material accurately to required levels and lines, with members plumb and true and accurately cut and fitted. Securely attach all materials to substrate by anchoring and fastening as shown on the plans. Perform all cutting and drilling in a manner that allows for the collection of all debris and dispose of properly.

Install piles in accordance with Section 455. After driving, cut off piles at the elevation shown on the plans to a tolerance of +0.0"/-2.0" using sawing or other means as approved by the Engineer to provide a smooth level cut.

471-4 Method of Measurement.

The quantity of dimensional fiberglass fiber reinforced lumber, fiberglass structurally reinforced composite lumber to be paid for will be the plan quantity, in feet board measure, computed based upon the dimensions shown in the plans. The quantity of fiberglass structurally reinforced composite piles to be paid will be the length in feet furnished and driven to the authorized lengths, as approved by the Engineer.

471-5 Basis of Payment.

Price and payment will be full compensation for the work specified in this Section including all material, storage costs, disposal of unused material and waste, transportation costs, labor, equipment, fasteners and other necessary items

required for completing the work. No separate payment will be made for plates, bolts, screws or other hardware necessary to complete the work.

Price and payment for Plastic Fender System Components including fiberglass structurally reinforced composite piles will be full compensation for all labor, equipment and materials required to furnish and install the piles to the elevation shown in the plans. No separate payment will be made for pile cut-offs. Plastic Fender System Components including fiberglass structurally reinforced composite piles to be paid for under Section 455.

Payment will be made under:

Item No. 471-1	Plastic Marine Lumber – MB.

SECTION 502
SHEAR CONNECTORS

502-1 Description.

Furnish and install welded shear connectors on steel beams and girders at locations shown in the Contract Documents. Field weld shear connectors located on the top flange only after the deck forms are in place. However, if workers who walk on the top flange of erected girders have 100% fall protection in compliance with OSHA requirements, shear connectors located on the top flange of girders may be furnished and installed in the fabrication plant.

502-2 General Requirements.

502-2.1 Design: Provide shear connector studs of a design suitable for end-welding to steel beams and girders, with automatically timed stud welding equipment. Provide the type, size or diameter, and length of stud as specified by the Contract Documents, and as approved by the Engineer. Meet the allowable tolerances on dimensions as specified in 502-7.

502-2.2 Arc-Shield: Furnish an arc-shield (ferrule), of heat-resistant ceramic or other suitable material, with each stud. Use material that is not detrimental to the welds, does not cause excessive slag, and has sufficient strength not to crumble or break due to thermal or structure shock before the weld is completed.

502-2.3 Flux: Furnish flux for welding with each stud, either attached to the end of the stud or combined with the arc-shield for automatic application in the welding operation.

502-2.4 Coatings: Do not paint or galvanize studs.

502-2.5 Qualification: Use only qualified studs, passing the tests prescribed in 502-6. Use the same arc-shield in production as used in the qualification tests.

502-2.6 Data to be Submitted: Before placing orders for studs, submit to the Engineer, for his approval, the following information on the studs to be purchased:

(1) The name of the manufacturer.

(2) A detailed description of the stud and arc-shield to be furnished.

(3) A certification from the manufacturer that the stud is qualified as specified in 502-2.5.

(4) A copy of the qualification test report as certified by the testing laboratory.

502-2.7 Freedom from Defects: After welding, ensure that the studs are free from any defect or substance that would interfere with their function as shear connectors.

502-3 Materials.

502-3.1 Metal: For shear connector studs, meet the requirements of ASTM A-108, cold-drawn bar, Grades 1015, 1017, or 1020, either semi-killed or fully-killed. If using flux-retaining caps, use caps of a low-carbon grade steel suitable for welding and meeting the requirements of ASTM A-109.

502-3.2 Mechanical Properties: For tensile properties as determined by tests of bar stock after drawing, or of finished studs, meet the following requirements:

Tensile strength	60,000 psi (minimum)
Yield strength*	50,000 psi (minimum)
Elongation	20% in 2 inches (minimum)
Reduction of area	50% (minimum)

*As determined by 0.2% offset method.

Determine tensile properties in accordance with ASTM A-370. Perform tensile tests of finished studs on studs welded to test plates. If fracture occurs outside of the middle half of the gage length, repeat the test.

502-3.3 Quality and Finish: Provide finished studs of uniform quality and condition, free from injurious laps, fins, seams, cracks, twists, bends, and other injurious defects. Produce a finish by cold drawing, cold rolling, or machining.

502-3.4 Certification: Ensure that the manufacturer certifies that the studs, as delivered, are in accordance with the materials requirements of this Subarticle. Furnish certified copies of in-plant quality control test reports to the Engineer upon request.

502-4 Construction Requirements.

502-4.1 Equipment: End weld stud shear connectors to steel beams or girders with automatically timed stud welding equipment connected to a suitable power source.

502-4.2 Interlocking: If two or more stud welding guns are to be operated from the same power source, interlock them so that only one gun at a time can operate and the operating gun finishes each weld before starting another weld.

502-4.3 Condition of Studs: At the time of welding, ensure that the studs are free from rust, rust pits, scale, oil, and other deleterious matter which would adversely affect the welding operation.

502-4.4 Weather Limitations: Do not weld when the base metal temperature is below 0ºF, or when the surface is wet or exposed to rain or snow.

502-4.5 Position of Welding Gun: While operating, hold the welding gun in position without movement until the weld metal has solidified.

502-4.6 Preparation of Areas: Prepare the surface where studs are to be welded by wire-brushing, peening, prick-punching, grinding, or other approved methods to remove paint, scale, rust, oils, or other deleterious matter which would adversely affect the welding operation.

502-4.7 Spacing: Ensure that longitudinal and lateral spacing of studs with respect to each other and to edges of beam or girder flanges does not vary more than 1/2 inch from the dimensions shown in the plans. However, the Engineer will allow a variation of 1 inch where required to avoid interference with other attachments on the beam or where welding a new stud to replace a defective stud. Provide a minimum distance of 1 inch from the edge of a stud to the edge of a beam, but where possible provide at least 1 1/2 inches.

502-4.8 Testing: After allowing them to cool, bend the first two studs welded on each beam or girder, 45 degrees by striking the stud with a hammer. If failure occurs in the weld of either stud, correct the procedure, and weld and test

two successive studs successfully before welding any more studs to the beam or girder. Inform the Engineer of any changes in the welding procedure at any time during construction. When the temperature of the base metal is below 32ºF, bend one stud in each 100 studs welded 45 degrees in addition to the first two bent as specified above.

502-4.9 Repair of Welds: The Contractor may repair studs, on which a full 360 degrees weld is not obtained, in accordance with the procedures of ANSI/AASHTO/AWS D1.5, Bridge Welding Code.

502-4.10 Reduction in Height: If the reduction in the height of studs as they are welded becomes less than 1/16 inch, immediately stop welding and correct the cause. Do not resume welding until the cause has been corrected.

502-4.11 Replacing Studs: Before welding the replacement stud, remove the defective stud, grind the area smooth and flush or, in the case of a pullout of metal, fill the pocket with weld metal, using the shielded metal-arc process with low-hydrogen welding electrodes, and then grind flush. In compression areas of flanges, the Contractor may weld a new stud adjacent to the defective area in lieu of repair and replacement of the existing weld.

502-5 Inspection Requirements.

502-5.1 Bend Test: If visual inspection reveals any stud which does not show a full 360 degrees weld, any stud which has been repaired by welding, or any stud in which the reduction in height due to welding is less than normal, strike such stud with a hammer and bend 15 degrees off the vertical. For studs showing less than a 360 degrees weld, bend the stud in the direction opposite to the lack of weld. Replace studs that crack in either the weld or the shank. The Engineer may select additional studs to be subjected to the bend test specified above. The Contractor may leave the tested studs that show no sign of failure in the bent position.

502-5.2 Unsatisfactory Work: If, during the progress of the shear connectors work, inspection and testing indicate that the shear connectors being obtained are not satisfactory, make such changes in welding procedure, welding equipment, and type of shear connector as necessary to secure satisfactory results, at no expense to the Department.

502-5.3 Requalification: If the Engineer requests, require the manufacturer of the studs to submit sample studs for requalification in accordance with the procedures of 502-6, at no expense to the Department.

502-6 Qualification Procedure.

502-6.1 Purpose: The purpose of this procedure is to prescribe weldability tests which will qualify a shear connector stud for welding under shop or field conditions. The Contractor may have a university, independent laboratory, other testing authority, or agency perform the tests. Ensure that the agency performing the tests submits to the manufacturer of the stud a certified report giving procedures and results for all tests, including the information listed under 502-6.9.

502-6.2 Duration of Qualification: Once a type and size of stud with arc-shield has been qualified, the Engineer will consider the stud qualified until the

manufacturer makes any change in the base of the stud, the flux, or the arc-shield, which affects the welding characteristics.

502-6.3 Preparation of Specimens: Prepare test specimens by welding representative studs to the center of square specimen plates, 1/2 to 3/4 inch thick, of structural steel, ASTM A-36. The manufacturer may weld studs to a large plate and cut the specimen plates to a size suitable for test equipment used.

502-6.4 Welding Procedure: Weld studs with manufacturer recommended power source, welding gun, and control equipment. Measure welding voltage, current, and time by suitable instrumentation, and record these measurements for each specimen. Ensure that lift and plunge are at the manufacturer-recommended optimum setting.

502-6.5 Number of Test Specimens:

(1) Weld 30 test specimens consecutively, with optimum current and time. Make the optimum current and time the midpoint of the range normally recommended by the manufacturer for production welding.

(2) Weld 30 test specimens consecutively, with time held constant at optimum but with current 10% below optimum.

(3) Weld 30 test specimens consecutively, with time held constant at optimum but with current 10% above optimum.

502-6.6 Qualification Tests:

502-6.6.1 Tensile Tests: Subject ten of the specimens welded in accordance with 502-6.5 (1), ten in accordance with 502-6.5 (2), and ten in accordance with 502-6.5 (3) to a tensile test. The Engineer will consider a stud qualified if all test specimens have a tensile strength above the minimum specified in 502-3.2.

502-6.6.2 Bend Tests: Place 20 of the specimens welded in accordance with 502-6.5 (1), 20 in accordance with 502-6.5 (2), and 20 in accordance with 502-6.5 (3) in a bend testing device, and bend alternately 30 degrees in opposite directions until failure occurs. The Engineer will consider a stud qualified if, on all test specimens, fracture occurs in the shank of the stud and not in the weld.

502-6.7 Retest: If weld failure occurs in any of the tensile or bend test groups, the Contractor may retest that group. If weld failure repeats, consider the stud as having failed to qualify.

502-6.8 Qualification: For a manufacturer's studs and arc-shields to be qualified, ensure that each group of 30 studs, by test or retest, meets the requirements prescribed in 502-6.6.

502-6.9 Report of Tests: Include the following in the laboratory report:

(a) Drawings which show shapes and dimensions with tolerances of studs, arc-shields, and flux.

(b) A complete description of materials used in the studs and arc-shields, including the quantity and analysis of the flux.

(c) A certification that the studs and arc-shields described in the report are qualified in accordance with 502-6.8.

502-7 Dimensions and Tolerances.

Meet the following dimensions and tolerances:

C	L*	H	T
3/4 - 1/64 inch	4 +0.062 inches 4 -0.125 inches	1 1/4 ± 1/64 inch	3/8 inch minimum
7/8 - 1/64 inch	4 +0.062 inches 4 -0.125 inches	1 3/8 ± 1/64 inch	3/8 inch minimum
*4 inches length is standard. The Contractor may obtain other lengths by special order.			

Where:

C = Shaft diameter
L = Total stud length measured from top of head to base of shaft
H = Diameter of head
T = Thickness of head

502-8 Method of Measurement.

For the purpose of payment, shear connectors will be classified as Structural Steel. The quantity to be paid for will be determined in accordance with Section 460.

502-9 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including furnishing and installing shear connectors.

Payment will be made in accordance with Section 460.

SECTION 504
STEEL GRID FLOORS

504-1 Description.

Furnish and erect open-type steel grid roadway and sidewalk floors, on the movable spans of bridges and at other locations shown in the plans. Where specified in the plans, completely fill the floor with concrete.

504-2 Materials and Construction Methods.

504-2.1 General: Meet the following requirements:

Portland Cement Concrete.....Section 346
Structural Steel and Miscellaneous Metals.....Section 460
Shop, Field, and Maintenance Painting of Structural Steel.....Section 560

504-2.2 Roadway Floor: Construct the roadway floor as an open steel grid with rectangular openings. Place and weld the grid to the floor stringers as shown in the plans. If the flooring requires secondary or supplemental stringers, the Department will consider these stringers and their fastenings a part of, and included in, the materials to be furnished and erected under this Section.

504-2.3 Sidewalk Floor: Erect sidewalk flooring consisting of a system of main bars and secondary bars, arranged in a system of rectangular, reticulum or U-shaped openings. Do not allow the clear distance in any opening to exceed 5/8 inch in one direction. Do not allow the longest dimension of any opening to

exceed 3 inches. Place and weld the floor to the supporting members in accordance with the details shown in the plans, or in accordance with the manufacturer's directions as approved by the Engineer.

504-2.4 Conformance with Manufacturer's Specifications: Meet the manufacturer's specifications for the material and construction methods, as approved by the Engineer, for any type of steel floor used.

504-2.5 Use of Trade Names: Where the plans refer to the type of floor by manufacturer's designation or trade name, the Contractor may use a similar floor providing equivalent section modulus per unit width, and equivalent surface qualities, if approved by the Engineer.

504-3 Painting.

Apply to all exposed areas of steel grid floors the same number, type, and thicknesses of paint coatings as are specified for painting structural steel. Prepare the surface the same as required for painting structural steel. Although not required, the Contractor may apply paint on areas to be covered by concrete.

504-4 Method of Measurement.

The quantities to be paid for will be the plan quantity, in square feet, installed, complete and accepted. Proper deductions for open joints in the floor will be made in calculating plan quantity.

504-5 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including furnishing and installing the complete floor above the tops of the main floor members shown in the plans, furnishing and installing any secondary joists which are required in addition to the main floor members, filling any specified portion with concrete, furnishing paint materials, painting, and welding.

Payment will be made under:

Item No. 504- 1-	Steel Roadway Floor - per square foot.
Item No. 504- 2-	Steel Roadway Floor - per square foot.

SECTION 506
BRIDGE DRAINAGE SYSTEM

506-1 Description.

Construct drainage facilities and accessories to collect and dispose of water from drains on the bridge structures, in accordance with the details shown in the plans.

506-2 Materials.

Use materials as specified or required in the plans. For aluminum materials, submit six certified copies of the mill analysis, along with a certificate from the producer stating that the materials used meet all requirements of these Specifications. Forward such reports to the Engineer.

506-3 Method of Measurement.

The quantity for Bridge Drainage System to be paid for will be at the Contract lump sum price.

If Bridge Drainage Piping is included in the Contract, the quantity to be paid for will be at the length, in feet.

If Bridge Drains are included in the Contract, the quantity to be paid for will be at the Contract unit price for each.

506-4 Basis of Payment.

Prices and payments will be full compensation for all work, equipment, and materials specified in this Section or shown on the plans, including the complete installation of the drainage system for the bridge structure.

Payment will be made under:

Item No. 506- 1-	Bridge Drainage System - lump sum.
Item No. 506- 2-	Bridge Drainage Piping - per foot.
Item No. 506- 3-	Bridge Drains - each.

SECTION 510
NAVIGATION LIGHTS FOR FIXED BRIDGES

510-1 Description.

Furnish and install navigation lighting systems, including all wiring, conduit, wiring devices, transformers, enclosures, grounding system, controls, protective devices, lights, etc., as shown in the plans and in compliance with Code of Federal Regulations (CFR), Title 33, Part 118, which is further clarified in U.S. Coast Guard (USCG) Publication "A Guide to Bridge Lighting". Navigation lights must operate from sunset to sunrise and during periods of low visibility.

510-2 Coordination of Electrical Work.

Use experienced personnel in the type of work required by the Contract Documents to provide a complete and satisfactory fitting and fully operational installation. Perform all electrical work either by, or under the immediate supervision of an electrical journeyman.

Schedule and arrange electrical work in a neat, well-organized manner without interference with the work scheduling of other trades.

510-3 Materials and Equipment.

Meet the equipment and material requirements as shown in the Contract Documents.

Furnish and install only materials and equipment of new stock meeting ANSI, NEC, NEMA, and UL requirements, and approved by the Engineer, except where the Contract Documents allow or specify the use of other than new equipment.

Furnish and install marine type products manufactured of corrosion resistant materials.

Furnish and install only fasteners manufactured from ASTM 316 stainless steel with yield strength 35,000 psi or higher.

Furnish and install ASTM 300 series stainless steel conduit straps or hangers held at not less than two points.

Furnish and install framework for supporting boxes, switches, and other externally mounted electrical devices fabricated from ASTM A709 Grade 36 hot-dip galvanized structural steel.

510-4 Navigation Lights and Aids.

510-4.1 Navigation Lights: Equip all navigation lights with a LED array with a minimum of 50,000 hour life and bright enough to meet the visibility requirements of CFR Title 33, Part 118. Mount LED arrays on an internal shock and vibration isolator. Provide, in the circuit, a lightning surge suppressor capable of absorbing multiple strikes without replacement. Provide special power supply to provide current limited DC voltage to the LED array.

Furnish and install fixtures with unpainted housings of heavy duty cast aluminum or bronze construction with a 1 1/2 to 2 inch threaded conduit opening on the bottom. Use only marine type mounting boxes with minimum 3/4 inch conduit opening. Furnish and install fixtures with lenses that are standard marine molded, single-piece fresnel type, rigid, heat resistant glass or U.V. resistant polycarbonate and inside diameter of 7 to 8 inch. Furnish all stainless steel closure bolts, lens tie rods, and attachment hardware for a complete and accepted installation.

Furnish and install Pier/Fender Lights, Center Channel Lights and Channel Margin Lights with cast aluminum or bronze swivel assembly and mounting bracket, complete with stainless steel pivot, watertight "O" ring seal, bronze bearings, cable entrance fitting, and stainless steel service chain rated for a minimum 225 pounds load. Use a 1 1/2 or 2 inch galvanized pipe or stainless steel pipe as a hanger stem with automatic lock at service and operating positions. Furnish and install a 60% counterweight if stem exceeds 5 feet in length.

Ensure the Pier/Fender Light is equipped with a red 180 degree lens, the Center Channel Light is equipped with a green 360 degree lens and the Channel Margin Light is equipped with a red 180 degree lens.

510-4.2 Clearance Gauge Lights: Furnish and install one-piece die-cast aluminum fixture housing fitted with watertight gasket, stainless steel hinges and fasteners, and adjustable aiming capability, equipped with a 120 V_{ac}, 50 watt, high-pressure sodium lamp. Use a heavy cast aluminum connection box body and cover with stainless steel swing bolts, watertight gasket and provisions for mounting to a platform with four stainless steel lag bolts or screws.

510-5 Disconnect Switches.

Furnish and install switches that are HP rated and meet Federal and NEMA Specifications with NEMA Type 4X (stainless steel) enclosures, and with metal factory nameplates that are front cover mounted and contain a permanent record of switch type, catalog number, and HP rating. Provide switch with visible blades, reinforced fuse clips, and non-teasible, positive, quick make-quick break

mechanisms. Provide switch assembly plus operating handle as an integral part of the enclosure base.

Use switches with defeat able door interlocks that prevent the door from opening when the operating handle is in the ON position, and whose handle position is easily recognizable and is padlockable in the OFF position. Use heavy-duty switches with line terminal shields.

510-5.1 Fusible Switch Assemblies: Furnish and install NEMA KS 1 type; load interrupter enclosed knife switch. Provide fuse Clips that are designed to accommodate Class R fuses.

510-5.2 Non-fusible Switch Assemblies: Furnish and install NEMA KS 1; HD type, load interrupter enclosed knife switch.

510-5.3 Enclosures: Furnish and install NEMA KS 1 type enclosure as shown in the Contract Documents.

510-5.4 Installation: Install disconnect switches where indicated in the Contract Document or where required by the Engineer. Use separate conduits for line and load conductors. Install fuses in fusible disconnect switches.

510-6 Supporting and Mounting Devices.

Ensure the sizes, and types of anchors, fasteners and supports used are adequate to carry the load of the equipment and conduit, including the wire in the conduit.

Space conduit supports to avoid conflicts with reinforcing steel at 5 feet maximum. For concrete mounting, use anchor bolts and all matching parts and tools recommended by and provided by the same manufacturer, as well as suitable for dynamic loading caused by vibration due to traffic. To mount conduit supports and pull boxes, use 1/4 inch ϕ anchor system. To mount channel lights use minimum 1/2 inch ϕ anchor system with 3 1/2 inch embedment and 8 inch edge distance.

Use ASTM 300 series stainless steel conduit straps or hangers held at not less than two points.

Do not use powder-actuated anchors. Do not drill or weld structural steel members. Do not use bolts smaller than 1/4 inch in diameter except as may be necessary to fit the mounting holes in small and light devices. Install surface-mounted boxes with minimum of three anchors.

510-7 Conduit.

510-7.1 General: Furnish and install conduit in the quantities and sizes required to complete the work as shown on the plans and as required by NEC. Use products listed and classified by UL as suitable for purpose specified and shown. Do not use non-metallic flexible conduit, aluminum, or electrical metallic tubing (EMT).

510-7.2 Liquid-Tight Flexible Metal Conduit: Furnish and install, liquid-tight flexible metal conduit of interlocked steel construction with PVC jacket, and fittings meeting the requirements of ANSI/NEMA FB 1.

510-7.3 PVC Conduit: Furnish and install, schedule 80 PVC 3/4 inch minimum diameter conduit meeting the requirements of ASTM D1785 and

NEMA TC 2 and fittings and conduit bodies meeting the requirements of ASTM D2467 and NEMA TC 3.

510-7.4 Fiberglass Reinforced Epoxy Conduit: Furnish and install rigid non-metallic fiberglass reinforced epoxy conduit and fittings manufactured in accordance with the applicable standards of ANSI and NEMA TC-14B.

Ensure the conduit has a bell and spigot type coupling and the coupling seal is made rigid by using an adhesive that will provide a water and vapor tight joint with a tensile strength equal to that listed for the conduit. An alternative type assembly may be used by applying a triple seal ribbed gasket of water resistant rubber material. Ensure the gasket is held firmly in place with a compatible adhesive.

Ensure that all fittings, adapters, and bends are manufactured from the same materials as the conduit and conform to the dimensional requirements of NEMA TC-14.

Use only fiberglass reinforced epoxy conduit and fittings made by the same manufacturer to insure proper fit and assembly, listed on the UL approved list and labeled for Type I service sizes 2 to 6 inches.

Ensure that each piece of conduit and fitting is clearly marked with durable contrasting ink, stenciled with the following:

1. Nominal size,
2. Bends to show the degree and radius of curvature,
3. Type: SW or HW,
4. Manufacturers' name or trademark.

510-7.5 Installation: Install conduit in accordance with National Electrical Contractors Association (NECA) "Standard of Installation" and manufacturer's instructions.

Arrange supports to prevent misalignment during wiring installation. Support conduit using straps, lay-in adjustable hangers, clevis hangers, and split hangers. Do not support conduit with wire or perforated pipe straps, plastic straps, or plastic hangers. Ensure that all wire used for temporary supports is removed upon completion of installation.

Install an expansion fitting for specified PVC conduit at all structure expansion joints or where movement between adjacent sections of conduit is expected. Provide certification to the Engineer from the manufacture that the expansion fitting meets the following minimum requirements: compatibility with the connected conduits, water proof, UV protected, and allows longitudinal movement equal to that of the expansion joint or movement expected.

Route exposed conduit parallel and perpendicular to walls or route conduit in the railings. Install conduits to be continuous and watertight between boxes or equipment. Protect conduits at all times from the entrance of water and other foreign matter by being capped or well plugged overnight and when the work is temporarily suspended.

Cut conduit square using saw or pipe cutter; de-burr cut ends. Bring conduit to shoulder of fittings; fasten securely. Use conduit hubs to fasten conduit to metal boxes. Do not install more than the equivalent of three 90 degree bends (total 270 degrees) between boxes. Use conduit bodies to make sharp changes in direction such as around diaphragms.

Join PVC conduit using cement recommended by manufacturer. Wipe PVC conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for a minimum of 20 minutes before pulling conductors.

Do not use flexible conduit extensions greater than 24 inches in length. Ensure that all flexible conduit extensions are equipped with bonding jumpers.

Do not allow moisture traps; provide pull box with drain fitting at low points in exposed conduit system.

510-8 Wiring.

510-8.1 General: Do not use aluminum conductors. Use only SE or RHW on incoming service and use single conductor with XHHW insulation, unless otherwise noted in the plans.

Do not use wire smaller than No. 12 AWG.

Furnish insulated conductors of seven or nineteen strand copper with a minimum 98% conductivity and connector accessories for copper in sufficient quantities for a complete installation.

510-8.2 Installation: Use pull boxes wherever necessary to facilitate the installation of the conductors. Do not use condulets for pulling more than ten conductors or for branching conductors.

Splice only in accessible boxes. Make lug connections with high pressure indent connector tools as recommended by the lug manufacturer. Make splices and taps to carry full ampacity of conductors without perceptible temperature rise. Tighten all connections to manufacturer's recommendations. Tape un-insulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor. Ensure all splices are waterproof.

Use solderless pressure connectors with insulating covers for No. 8 AWG and smaller wire splices and taps. Use split bolt connectors for No. 6 AWG and larger wire splices and taps.

Pull all conductors into a raceway at the same time. Use soap base wire pulling lubricant for pulling No. 4 AWG and larger wire.

510-8.3 Testing: Test each circuit for continuity and short-circuits for its complete length before being connected to its load.

Inspect wire and cable for physical damage and proper connection.

510-9 Method of Measurement.

The quantity to be paid for will be at the Contract lump sum price, completed and accepted.

510-10 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 510- 1- Navigation Lights - lump sum.

SECTION 514
PLASTIC FILTER FABRIC (GEOTEXTILE)

514-1 Description.

Install a plastic filter fabric.

514-2 Material.

Meet the plastic filter fabric requirements as specified in Section 985.

514-3 Construction Methods.

514-3.1 General: Place the fabric in the manner and locations as shown on the construction drawings, in accordance with the manufacturer's directions, and as specified in these Specifications. Place the fabric on areas with a uniform slope that are reasonably smooth, free from mounds and windrows, and free of any debris or projections which might damage the fabric.

Loosely lay the material. Do not stretch the material. Replace or repair any fabric damaged or displaced before or during placement of overlying layers to the satisfaction of the Engineer and at no expense to the Department.

When overlapping is necessary, the Contractor may sew the seams to reduce overlaps as specified in 985-3.

Schedule work so that covering the fabric with the specified material does not exceed the manufacturer's recommendations for exposure to ultraviolet light or five days, whichever is less. If the Engineer determines the exposure time was exceeded, the Contractor shall replace the fabric at no expense to the Department.

514-3.2 Subsurface Drainage: When indicated in the plans, place the fabric with the long dimension parallel to the trench. Place the fabric to provide a minimum 12 inch overlap for each joint. Do not drop the filter material from heights greater than 3 feet.

514-3.3 Stabilization and Reinforcement: Overlap adjacent strips of fabric a minimum of 2 feet.

514-3.4 Riprap Filter: Overlap adjacent strips of fabric a minimum of 24 inches, and anchor them with securing pins (as recommended by the manufacturer) inserted through both strips of fabric along a line through the midpoint of the overlap and to the extent necessary to prevent displacement of the fabric.

Place the fabric so that the upstream (upper) strip of fabric overlaps the downstream (lower) strip.

Stagger vertical laps a minimum of 5 feet. Use full rolls of fabric whenever possible in order to reduce the number of vertical laps.

Do not drop bedding stone or riprap from heights greater than 3 feet onto the fabric.

514-4 Method of Measurement.

When separate payment is indicated in the plans, the quantity to be paid for will be the area, in square yards, of plastic filter fabric placed excluding all laps, completed and accepted.

When no separate payment for furnishing and placing the plastic filter fabric is contained in the proposal, the Contractor shall include the cost of all work in the Contract price for the item or items to which it is incidental.

514-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including furnishing, placing, and sewing or overlapping the fabric.

Payment will be made under:

Item No. 514- 71- Plastic Filter Fabric - per square yard.

SECTION 520
CONCRETE GUTTER, CURB ELEMENTS, AND TRAFFIC SEPARATOR

520-1 Description.

Construct portland cement concrete curb and gutter, concrete traffic separator, valley gutter, special concrete gutter, and any other types of concrete curb not specified in other Sections.

520-2 Materials.

520-2.1 Concrete: Use concrete meeting the requirements of Section 347.

520-2.2 Reinforcement: For all steel reinforcement required by the plans, meet the requirements of Section 415.

520-2.3 Joint Materials: Meet the requirements of Section 932.

520-3 Forms.

520-3.1 Form Materials: Construct forms for this work of either wood or metal. Provide forms that are straight, free from warp or bends, and of sufficient strength, when staked, to resist the pressure of the concrete without deviation from line and grade. For all items constructed on a radius, use flexible forms.

520-3.2 Depth of Forms: Ensure that forms have a depth equal to the plan dimensions for the depth of concrete being deposited against them.

520-3.3 Machine Placement: The Contractor may place these items by machine methods with the approval of the Engineer provided that the Contractor consistently produces an acceptable finished product, true to line, grade, and cross section.

520-4 Excavation.

Excavate to the required depth, and compact the foundation material upon which these items are to be placed as specified in 120-9.

520-5 Placing Concrete.

Place the concrete in the forms, and tamp and spade it to prevent honeycombing, and until the top of the structure can be floated smooth and the edges rounded to the radius shown in the plans.

520-6 Joints.

520-6.1 Contraction Joints: Except for machine placed items, the Contractor may form joints by using dummy joints (either formed or sawed) or by using sheet metal templates. If using sheet metal templates, ensure that they are of the dimensions, and are set to the lines, shown in the plans. Hold templates firmly while placing the concrete. Leave templates in place until the concrete has set sufficiently to hold its shape, but remove them while the forms are still in place.

Saw contraction joints, for machine placed items, unless the Engineer approves an alternate method. Saw the joints as soon as the concrete has hardened to the degree that excessive raveling will not occur and before uncontrolled shrinkage cracking begins.

Space contraction joints at intervals of 10 feet except where closure requires a lesser interval, but do not allow any section to be less than 4 feet in length.

520-6.2 Expansion Joints: Construct expansion joints at all inlets, at all radius points, and at other locations indicated in the plans. Locate them at intervals of 500 feet between other expansion joints or ends of a run. Ensure that the joint is 1/2 inch in width.

520-7 Finishing.

520-7.1 Repair of Minor Defects: Remove the forms within 24 hours after placing the concrete, and then fill minor defects with mortar composed of one part portland cement and two parts fine aggregate. The Engineer will not allow plastering on the face of the curb. Remove and replace any rejected curb, curb and gutter, or valley gutter without additional compensation.

520-7.2 Final Finish: Finish all exposed surfaces while the concrete is still green. In general, the Engineer will only require a brush finish. For any surface areas, however, which are too rough or where other surface defects make additional finishing necessary, the Engineer may require the Contractor to rub the curb to a smooth surface with a soft brick or wood block, using water liberally. Also, if necessary to provide a suitable surface, the Engineer may require the Contractor to rub further, using thin grout or mortar.

520-8 Curing.

520-8.1 General: Continuously cure the concrete for a period of at least 72 hours. Commence curing after completely finishing and as soon as the concrete has hardened sufficiently to permit application of the curing material without marring the surface. Immediately replace any curing material removed or damaged during the 72 hour period.

After removing the forms, cure the surfaces exposed by placing a berm of moist earth against them or by any of the methods described below, for the remainder of the 72 hour curing period.

520-8.2 Wet Burlap Method: Place burlap, as specified in 925-1, over the entire exposed surface of the concrete, with sufficient extension beyond each side to ensure complete coverage. Overlap adjacent strips a minimum of 6 inches. Hold the burlap securely in place such that it will be in continuous contact with

the concrete at all times, and do not allow any earth between the burlap surfaces at laps or between the burlap and the concrete. Saturate the burlap with water before placing it, and keep it thoroughly wet throughout the curing period.

520-8.3 Membrane Curing Compound Method: Apply clear membrane curing compound or white pigmented curing compound, as specified in 925-2, by a hand sprayer meeting the requirements of 350-3.10, in a single coat continuous film at a uniform coverage of at least one gallon per 200 square feet. Immediately recoat any cracks, checks, or other defects appearing in the coating. Thoroughly agitate the curing compound in the drum prior to application, and during application as necessary to prevent settlement of the pigment.

520-8.4 Polyethylene Sheeting Method: Place polyethylene sheeting, as specified in 925-3, over the entire exposed surface of the concrete, with sufficient extension beyond each side to ensure complete coverage. Overlap adjacent strips a minimum of 6 inches. Hold the sheeting securely in place and in continuous contact with the concrete at all times.

520-9 Backfilling and Compaction.

After the concrete has set sufficiently, but not later than three days after pouring, refill the spaces in front and back of the curb to the required elevation with suitable material. Place and thoroughly compact the material in layers not thicker than 6 inches.

520-10 Surface Requirements.

Test the gutter section of curb and gutter with a 10 foot straightedge laid parallel to the centerline of the roadway and while the concrete is still plastic. Perform straightedging along the edge of the gutter adjacent to the pavement or along other lines on the gutter cross-section, as directed by the Engineer. Immediately correct irregularities in excess of 1/4 inch.

520-11 Method of Measurement.

For curb or curb and gutter, the quantity to be paid will be plan quantity, in feet, measured along the face of the completed and accepted curb or curb and gutter.

For valley gutter or shoulder gutter, the quantity to be paid will be plan quantity, in feet, measured along the gutter line of the completed and accepted valley gutter or shoulder gutter.

For concrete traffic separator of constant width, the quantity to be paid will be plan quantity, in feet, measured along the center of its width, completed and accepted, including the length of the nose.

For concrete traffic separator of varying width, the quantity to be paid will be plan quantity, in square yards, completed and accepted.

520-12 Basis of Payment.

520-12.1 General: Price and payment will be full compensation for all work specified in this Section.

520-12.2 Excavation: Excavation will be paid for as Roadway Excavation in accordance with 120-12.2.

520-12.3 Reinforcement: Reinforcing steel will not be paid for separately. The Contractor shall include the cost of the steel in the Contract unit price for the item in which the steel is placed.

520-12.4 Joint Materials: The Contractor shall include the cost of all joint materials in the Contract unit price for the item in which they are used.

520-12.5 Asphalt Curb Pad: When detailed in the plans this material shall be included in the Contractors unit price for the item in which it is used.

520-12.6 Payment Items: Payment will be made under:

Item No. 520- 1-	Concrete Curb and Gutter - per foot.
Item No. 520- 2-	Concrete Curb - per foot.
Item No. 520- 3-	Concrete Valley Gutter - per foot.
Item No. 520- 4-	Special Concrete Gutter - per foot.
Item No. 520- 5-	Concrete Traffic Separator - per foot.
Item No. 520- 6-	Concrete Shoulder Gutter - per foot.
Item No. 520- 70-	Concrete Traffic Separator - per square yard.

SECTION 521
CONCRETE BARRIERS, TRAFFIC RAILING BARRIERS AND PARAPETS

521-1 Description.

Construct Precast or Cast In Place concrete barriers, traffic railing barriers and parapets, herein referred to as "Barrier Wall", in accordance with the Design Standards and/or details shown in the plans. Use stationary removable forms or sliding forms to construct the barrier wall. Do not use permanent precast concrete barrier wall on bridge or box culvert structures.

Provide written certification from the manufacturer of the Precast Barrier Wall that the Barrier Wall meets the requirements of this Section. Barrier Wall is produced using certification acceptance; therefore, assume responsibility for performance of all quality control testing and inspections required by Sections 346 and 400 for Barrier Wall construction. Perform all Quality Control Testing and inspections using CTQP qualified testing personnel. Perform compressive strength testing in a laboratory inspected by CCRL or CMEC.

Ensure that each shipment of products to the job site includes a list of products shipped and the required written certification statement for each product. Provide this list and certification(s) to the Engineer.

521-2 Materials.

Meet the following requirements:

Portland Cement Concrete	Section 346
Reinforcing Steel	Section 415
Joint Materials	932-1.1
Joint Materials*	932-1.2 and 932-1.3
Reflector Elements*	Section 993

*Qualified Products List (QPL) item(s)

521-3 Use of Precast Temporary Barrier Wall. .

521-3.1 General: Meet the requirements of 102-9.5.2.

521-3.2 Precast Temporary Barrier Wall Meeting the Requirements of the Design Standards, Index No. 415: Use Precast Temporary Barrier Wall when certification is provided to the Engineer that the Precast Temporary Barrier Wall was constructed in accordance with and meets the requirements of the Design Standards, Index No. 415, and meets the approval of the Engineer.

521-3.3 Procurement of Proprietary Precast Temporary Barrier Wall: Obtain and use Precast Temporary Barrier Wall listed on the Departments Qualified Products List (QPL) from a manufacturing plant that is currently on the list of the Producers of Incidental Precast/Prestressed Concrete Products. Producers seeking inclusion on the list shall meet the requirements of 105-3.

Ensure each Precast Temporary Barrier Wall Section has permanent clear marking, showing the manufacture date, serial number, and manufacturer's name or symbol and the Department approved drawing number that it meets. The markings may be located on a plate, plaque, or cast in the panel.

521-3.4 Procurement of Precast Temporary Barrier Wall Meeting the Requirements of Design Standards, Index No. 414: Obtain and use Precast Temporary Barrier Wall from a manufacturing plant that is currently on the list of the Producers of Incidental Precast/Prestressed Concrete Products. Producers seeking inclusion on the list shall meet the requirements of 105-3.

521-3.5 Reflector Elements: Mount reflectors onto the barriers in accordance with the details shown in the plans and the Design Standards.

521-4 Construction.

521-4.1 General: The Contractor may use stationary removable forms or slip form construction methods provided a completed barrier wall with acceptable alignment and finish is obtained. Construct forms of metal or timber with a form liner. Do not use forms which are damaged or are not in alignment. At no expense to the Department, remove and replace sections of barrier wall having unconsolidated concrete, surface blemishes, deviations in alignment or profile which exceed tolerances, or other defects which cannot be repaired to the satisfaction of the Engineer.

521-4.2 Stationary Form Construction: Provide precast or cast in place concrete barrier wall constructed using stationary forms in accordance with Section 400 and providing a Class 3 finish. Align and erect the stationary form so that all plane surfaces of the finished wall will have no deviation greater than 3/8 inch measured as an ordinate between the concrete and a 10 foot straightedge. Correct all alignment deviations greater than 3/8 inch. Straightedge by half lapping the straightedge for the full length of all plane surfaces.

521-4.3 Slip Form Construction: When electing to use the slip form method in lieu of the stationary forming method, place the concrete with a slip form machine approved by the Engineer.

Provide a finished texture to the slip formed barrier wall by hand troweling, brushing, or both to eliminate pockmarks, blemishes and any other discontinuities in surface texture. Ensure that the final finish has a fine texture and is free of pinholes, pockmarks, and blemishes.

Remove and recast or repair sections of slip formed barrier wall having areas of unconsolidated concrete, having surface blemishes, and/or having pockmarks greater than 1/2 inch in diameter after hand troweling and brushing. Repair areas of unsatisfactory surface finish by hand methods using mortar screened from the concrete used to construct the barrier wall. Use the mortar screened from the barrier wall concrete only to fill holes and surface blemishes below the slip formed surface of the concrete. Do not use mortar as a surface overlay coating on the barrier wall concrete.

During the finishing operation, while the concrete remains plastic, straightedge all plane surfaces of the slip formed barrier wall with a 10 foot straightedge. Straightedge by half lapping the straightedge for the full length of the plane surfaces. Correct any deviation found during straightedging, greater than 3/8 inch, measured as an ordinate between the concrete surface and the straightedge, in an approved manner at no expense to the Department. Do not use surface overlay coatings of mortar screened from the concrete, or surface overlay coatings of concrete to correct alignment deviations.

521-5 Curing.

Meet the requirements of Section 400.

521-6 Joints.

521-6.1 General: Place expansion and contraction joints in concrete barrier wall either mounted on or adjoining rigid structures in a manner similar to the type and method of jointing used in the supporting or adjoining structure or as shown in the Contract Documents. Place expansion and contraction joints in concrete barrier wall supported by soil or flexible foundation materials in the manner detailed in the plans.

521-6.2 Contraction Joints in Barrier Wall Supported by or Adjoining Rigid Structures: The Contractor may form or saw contraction joints. When sawing contraction joints, saw them as soon as the concrete has hardened sufficiently to permit sawing without raveling and before uncontrolled cracking occurs, but in no case later than 12 hours after casting. Match contraction joints to adjacent contraction joints in the structure. Space contraction joints at 15 to 30 foot intervals. For barrier wall on bridge structures or approach slabs, space contraction joints as shown in the Contract Documents.

521-6.3 Expansion Joints in Barrier Wall Supported by or Adjoining Rigid Structures: Construct expansion joints at right angles to the face, and extend them through the entire cross-section of the barrier wall. Construct barrier wall expansion joints at the same location and width as the expansion joints in the structure on which the wall rests and at other locations shown in the Contract Documents. When constructing reinforced barrier wall, form expansion joints with an expansion filler material or removable forming materials and secure to the forms as required to provide proper position. When using slip forming to construct non-reinforced barrier wall, construct expansion joints as in reinforced barrier wall or saw the joint through the plastic concrete the full depth and width of the barrier section. Where using the plastic sawing method, place close fitting

shields over the concrete on each side of the joint for protection during sawing and hand finishing of the concrete at the joint.

521-7 Repairs and Rejection.

For permanent precast concrete barrier wall that has not been installed, evaluate cracks, spalls and other deficiencies in accordance with 450-12. Repair deficiencies in accordance with 450-13 or the plant's approved repair methods that are included as part of the QCP. Ensure that the original performance and durability of the repaired barrier wall is maintained. Use materials for concrete repair that will meet or exceed the strength requirement for the class of concrete used. Materials meeting the requirements of Section 930 may be substituted for non-shrink grout when required by 450-13. Concrete barrier wall is subject to rejection if it fails to conform to any of the Specification requirements after repair. The disposition of concrete cracks in barrier wall after installation shall be in accordance with 400-21.

521-8 Method of Measurement.

The quantity to be paid for under this Section will be the plan quantity, in feet, completed and accepted. The quantity will be measured along the top of the barrier wall from the begin to end station, including transitional and end sections, with no deduction for expansion joints or open joints. Barrier wall on bridge structures and approach slabs to be removed shall be included in the cost of Removal of Existing Structures. Barrier wall to be removed along roadways are included in the cost of clearing and grubbing, or if a pay item is included, in the cost of Removal of Concrete Barrier Wall.

521-9 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including all reinforcing steel, conduits, materials and incidentals necessary to complete the work.

Payment will be made under:

Item No. 521- 1-	Concrete Barrier Wall - per foot.
Item No. 521- 5-	Concrete Traffic Railing Barrier (Bridge) – per foot.
Item No. 521- 6-	Concrete Parapet (Bridge) – per foot.
Item No. 521- 7-	Retaining Wall System – per foot.
Item No. 521- 8-	Retaining Wall System, Mounted with Sleeper Slab – per foot.
Item No. 521- 72-	Concrete Barrier Wall – per foot.
Item No. 521- 73-	Removal – per foot.

SECTION 522
CONCRETE SIDEWALK

522-1 Description.

Construct concrete sidewalks.

522-2 Materials.

Meet the requirements specified in 520-2.

522-3 Forms.

Provide forms as specified in 520-3.

522-4 Foundation.

Compact fill areas, including cut areas under the sidewalk that have been excavated more than 6 inches below the bottom of sidewalk, to a minimum of 95% of AASHTO T 99 density. The area to be compacted is defined as that area directly under the sidewalk and 1 foot beyond each side of the sidewalk when right-of-way allows.

522-5 Joints.

522-5.1 Expansion Joints: Form 1/2 inch expansion joints between the sidewalk and the curb or driveway or at fixed objects and sidewalk intersections with a preformed joint filler meeting the requirements specified in 932-1.1.

522-5.2 Contraction Joints:

522-5.2.1 Types: The Contractor may use open type or sawed contraction joints.

522-5.2.2 Open-Type Joints: Form open type contraction joints by staking a metal bulkhead in place and depositing the concrete on both sides. After the concrete has set sufficiently to preserve the width and shape of the joint, remove the bulkhead. After finishing the sidewalk over the joint, edge the slot with a tool having a 1/2 inch radius.

522-5.2.3 Sawed Joints: If electing to saw the contraction joints, cut a slot approximately 3/16 inch wide and not less than 1 1/2 inches deep with a concrete saw after the concrete has set, and within the following periods of time:

Joints at not more than 30 feet intervals. ...within 12 hours after finishing.
Remaining joints ..... within 96 hours after finishing.

522-6 Placing Concrete.

Place the concrete as specified in 520-5.

522-7 Finishing.

522-7.1 Screeding: Strike-off the concrete by means of a wood or metal screed, used perpendicular to the forms, to obtain the required grade and remove surplus water and laitance.

522-7.2 Surface Requirements: Provide the concrete with a broom finish. Ensure that the surface variations are not more than 1/4 inch under a 10 foot straightedge, or more than 1/8 inch on a 5 foot transverse section. Finish the edge of the sidewalk with an edging tool having a radius of 1/2 inch.

Apply a tine finish by an approved hand method to curb cut ramps in lieu of a broom finish.

Ensure that the tine finish consists of transverse grooves which are 0.03 to 0.12 inch in width and 0.10 to 0.15 inch in depth, spaced at approximately 1/2 inch center to center.

522-8 Curing.

Cure the concrete as specified in 520-8.

522-9 Method of Measurement.

The quantity to be paid for will be plan quantity, in square yards, completed and accepted.

522-10 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section. Excavation will be paid for under the items for the grading work on the project.

Payment will be made under:

Item No. 522- Concrete Sidewalk - per square yard.

SECTION 523
PATTERNED/TEXTURED PAVEMENT

523-1 Description.

Apply a patterned and/or textured treatment to asphalt or concrete, in accordance with manufacturer's recommendations. Applications include the following:

1. Imprinting patterns into existing or new pavement and covering with a colored coating of surface marking materials.
2. Imprinting patterns into existing or new pavement and inlaying the imprint with preformed thermoplastic material.
3. Colored, preprinted, preformed texturized thermoplastic material that is applied over existing pavement.
4. Colored thermoplastic coating material that can be imprinted and texturized during or after application to existing pavement.

For applications requiring removal and replacement of existing pavement, meet the requirements of Section 350 for cement concrete pavement; the requirements of Section 334 for Superpave asphalt or Section 337 for FC 9.5 and FC 12.5 asphalt.

For the purpose of this Specification, patterns are defined as visible surface markings; imprinted textures are defined as palpable surface markings.

Use the location, pattern/texture type (brick, stone, etc.), and coating color as specified in the plans. Joint openings shall not exceed 1/2 inch in width.

523-2 Materials.

523-2.1 Qualified Products List: Use only patterned/textured pavement products listed on the Qualified Products List. Meet manufacturer's specifications for all pattern/texture templates, coating and coloring materials. Use only material that is delivered to the job site in sealed containers bearing the manufacturer's original labels.

Material coatings used to achieve the pattern/texture and/or color shall produce an adherent, weather resistant, skid resistant surface capable of resisting

deformation to traffic. Surface marking materials must meet the requirements of this Specification and Section 971 with the following exceptions:

1. Color and reflectivity requirements do not apply. Surfaces shall not be made retroreflective.

2. Requirements for minimum set to bear traffic time, do not apply. Do not open to traffic until the coating material has sufficiently dried or cured and is ready to withstand traffic.

3. For thermoplastic materials, the requirements for alkyd based materials only in 971-5.1 and minimum binder content of 971-5.2, do not apply.

4. For thermoplastic materials, the indentation resistance requirements and minimum flashpoint requirements of 971-5.5, do not apply.

Manufacturers seeking approval of their product for inclusion on the QPL must submit an application in accordance with Section 6 along with the following documentation:

1. Manufacturer's specifications and procedures for materials and installation.

2. Manufacturer's Laboratory test data from an independent laboratory verifying the material meets the requirements of this Section.

3. Test data from an independent source verifying that the patterned/textured pavement installed in accordance with the manufacturer's specifications and procedures has been tested in accordance with the ASTM E-274, Skid Resistance of Paved Surfaces using a standard ribbed full Scale Tire at a speed of 40 mph (FN40R), and has a minimum FN40R value of 35.

523-2.2 Performance Requirements: QPL approval will be contingent on a field service test demonstrating that the imprinted texture and coating materials meet the following performance measures at the end of three years from opening to traffic:

1. The imprint must maintain a depth of 50% of the original installed depth and width.

2. Wearing of the material coating shall not expose more than 15% of the underlying surface area.

3. Friction performance of patterned/textured pavement materials must meet or exceed an FN40R value of 35 in accordance with ASTM E-274.

The field service test installation shall be within a marked crosswalk on a roadway with an ADT of 8,000 to 12,000 vehicles per day per lane, approved by the State Materials Office. The test installation shall be a minimum six feet wide and extend from pavement edge to pavement edge across all traffic lanes and shoulder pavement at the crosswalk location. The test installation will be tested for skid resistance and wear in accordance with the specifications.

523-3 Construction.

523-3.1 Surface Protection: Protect treated surfaces from traffic and environmental effects until the area is completely coated/imprinted, and any coatings have dried or cured according to the manufacturer's instructions.

523-3.2 Pavement Cuts: Complete all utility, traffic loop detector, and other items requiring a cut and installation under the finished surface, prior to pattern installation.

523-3.3 Installation Acceptance: For asphalt roadways, apply patterned/textured pavement a minimum of 14 days after placement of the adjacent pavement. Upon completion of the installation, the Engineer will check the area at random locations for geometric accuracy, as specified in the plans. If any of the chosen areas have an imprint width and depth that is less than the manufacturer's specifications, correct the entire textured area, at no additional cost to the Department.

Supply the specified pattern and color samples for the Engineer's use to visually determine that the material matches the color specified in the plans. For any continuous or abutting areas, i.e. all treated areas of an intersection, color materials must be from the same lot/batch.

Provide certification that the textured pavement was installed in accordance with the manufacturer's requirements.

523-4 Method of Measurement.

The quantity to be paid will be the plan quantity in square yards of patterned/textured pavement, completed and accepted. No deduction will be made for the area(s) occupied by ornamental trees within the asphalt area, or any other areas occupied by manholes, inlets, drainage structures, or by any public utility appurtenances within the area. Asphalt or concrete materials placed prior to treatment will be paid separately under the appropriate pay items. Milling required for the placement of patterned/textured pavement will be included in the cost of the patterned/textured pavement.

523-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section. Surface materials, including colors, sealers, and/or resins, shall be included for payment under this Section.

Payment will be made under:

Item No. 523- 1-	Patterned/Textured Pavement - per square yard.

SECTION 524
CONCRETE DITCH AND SLOPE PAVEMENT

524-1 Description.

Construct concrete pavement in the flow channel of drainage ditches and on slopes in accordance with the notes and details shown in the plans.

524-2 Materials.

Concrete .....Section 347
Preformed Expansion Joint Material and Hot Poured Sealer ...Section 932
Filter Fabric .....Section 985

524-3 Forms.

Provide forms as specified in 520-3.

524-4 Foundation.

Shape and compact the foundation materials, upon which the pavement is to be constructed, to a firm, even surface, true to grade and cross-section.

Dispose of surplus material.

524-5 Joints and Weep Holes.

524-5.1 Joints: Form open or tooled (dummy) type joints as shown in the plans. Form open joints by staking a metal bulkhead in place and placing the concrete on both sides of it. When the concrete has set sufficiently to preserve the width and shape of the joints, remove the bulkhead. Upon finishing the pavement over the joint, open and edge the slot with a tool having a 1/4 inch radius.

524-5.2 Method of Placing Slope Pavement: Place slope pavement in vertical strips, 4 feet ±1 inch wide, except taper radii strips from the 4 foot width at the bottom to a minimum width of 1 foot at the top. Score the strips horizontally at intervals of 2 feet ±1 inch, with a tool having a double 1/4 inch radius. Edge construction joints between strips with a tool having a 1/4 inch radius. The Engineer will allow construction joints at horizontal scorings.

524-5.3 Weep Holes: Locate and construct weep holes as shown in the plans. Construct weep holes at the toe of slope for all slope pavements.

524-5.4 Filter Fabric: Locate and construct filter fabric as shown in the plans and Design Standards.

524-6 Placing Concrete.

Place the concrete in the forms, tamp and spade it to prevent honeycombing, and until the top of the structure can be floated smooth and the edges rounded.

524-7 Finishing.

Roughen the surface of ditch pavement after screeding concrete, unless otherwise specified, to the approximate shape and grade by a rake or other suitable tool drawn perpendicular to the direction of flow. Ensure that the furrows are at least 1/4 inch deep.

Strike off slope pavement or smooth surfaced ditch pavement, when specified, true to line and cross-section, and remove all surplus water and laitance from the surface. Lightly broom the finish.

524-8 Curing.

Cure the concrete as specified in 520-8.

524-9 Method of Measurement.

The quantities to be paid for Concrete Ditch Pavement and Concrete Slope Pavement will be the plan quantity, in square yards, completed and accepted. Where the plans show headers or cut-off walls at the end or edge of the pavement, the volume of the additional thickness of pavement that constitutes the headers, calculated in accordance with plan dimensions, will be converted into

equivalent square yards of standard thickness pavement and included in the quantity to be paid for.

No deduction will be made for any areas occupied by manholes, inlets, or other drainage structures or by public utility appurtenances within the pavement area.

524-10 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including all materials and incidentals necessary to complete the work.

Payment will be made under:

Item No. 524- 1-	Concrete Ditch Pavement - per square yard.
Item No. 524- 2-	Concrete Slope Pavement - per square yard.

SECTION 525
ASPHALT CONCRETE CURB

525-1 Description.

Construct an asphalt concrete curb on a previously laid pavement at the locations shown in the plans.

525-2 Materials.

Use a Type SP-12.5 (Traffic Level A, B, or C) asphalt concrete mixture.

525-3 Construction Methods.

Sufficiently roughen the surface of the roadway pavement at the locations where the curb will be constructed to provide suitable bonding of the pavement and the curb.

Lay the curb by a machine or by other methods to provide the required cross-section. The Engineer may allow variation in the plan cross-section for using the particular machine, provided the Contractor obtains the equivalent cross-sectional area and the specified height of curb. Provide appropriate compaction as directed by the Engineer.

525-4 Method of Measurement.

The quantity to be paid for will be the length plan quantity, in feet, completed and accepted. Any additions or deletions thereto as authorized by the Engineer will be determined by plan dimensions, station-to-station dimensions, final measurement, or any combination thereof, as measured along the face of the completed and accepted curb.

525-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including all materials and incidentals necessary to complete the work.

Payment will be made under:

Item No. 525- 1- Asphaltic Concrete Curb - per foot.

SECTION 526
ARCHITECTURAL PAVERS

526-1 Description.

Furnish and install architectural pavers and bedding material manufactured to ASTM standards. Other necessary elements and pay items of this type of paving, such as edge restraints, base and subbase materials are not covered in this Section.

526-2 Materials.

526-2.1 General: Architectural pavers shall meet the following requirements:

Proposed Use	ASTM C 902 (Brick Paver)	ASTM C 1272 (Brick Paver)	ASTM C 936 (Concrete Paver)
Roadways	Do Not Use	X	Do Not Use
Commercial Driveways	Do Not Use	X	X
Sidewalks and Medians	X	Do Not Use	X
Residential Driveways	X	Do Not Use	X

Ensure that the pavers are consistent in color, size and appearance. Architectural paver manufacturer, type, pattern, shape and/or color will be in accordance with plan details, when specified.

526-2.2 Architectural Pavers - Roadway: For installations on roadways and commercial driveways, provide architectural pavers having a minimum thickness of 3 1/8 inch.

526-2.3 Architectural Pavers - Sidewalk: For installations on sidewalks, medians and residential driveways, provide architectural pavers having a minimum thickness of 2 3/8 inch.

526-2.4 Bedding and Joint Sands: Provide clean, non-plastic bedding and joint sand, free from deleterious or foreign matter, natural or manufactured from crushed rock.

Ensure the bedding sand meets the grading requirements of ASTM C 33 Standard Specification for Concrete Aggregate.

Ensure the joint sand meets the grading requirements of ASTM C 144 Standard Specification for Aggregate for Masonry Mortar.

Bedding sand may be used for joint sand. Do not use joint sand for bedding sand.

526-2.5 Bedding and Joint Grouts: A suitable grout, in thickness specified by the manufacturer and approved for use by the Architectural Paver

manufacturer, may be substituted for either bedding sand, joint sand or both when specified in the plans and approved by the Engineer.

526-3 Construction Methods.

526-3.1 General:

526-3.1.1 Submittals: For Architectural Pavers – Roadway, furnish full size samples to the Engineer for approval prior to beginning placement. For Architectural Pavers - Sidewalk, provide the Engineer a certification that the architectural pavers meet the requirements of this Section. In addition, for all architectural pavers, submit a certified sieve analysis for gradation comparing results of the bedding sand and joint sand with the requirements of ASTM C33 or ASTM C144 as applicable.

526-3.1.2 Mock-ups: Prior to beginning placement, install a 6 by 6 foot paver area following these specifications. This area will be used to determine surcharge of the bedding material layer, joint sizes, lines, laying patterns and colors of the job. This area will be adjacent to an edge treatment, incorporated into the work, and will be the standard from which the work will be judged.

526-3.1.3 Environmental Conditions: Cover stockpiled materials with waterproof covering to prevent exposure to rainfall. Do not install bedding materials or architectural pavers during heavy rains or over wet substrata.

526-3.2 Installation: Install the architectural pavers in the following manner:

a. Spread the bedding material evenly over the base course and screed to plan thickness, not to exceed a thickness of 1 1/2 inch. Do not disturb the screeded bedding material. Ensure placement of sufficient bedding material to stay ahead of the laid architectural pavers. Do not use the bedding material to fill depressions in the base course.

b. Lay architectural pavers in the pattern(s) shown in the plans and maintain straight pattern lines.

c. Joints between the architectural pavers, on average, will be between 1/16 to 3/16 inch wide.

d. Fill gaps at the edges of the paved area with cut or edge architectural pavers.

e. When utilizing bedding and joint sand:

1. Use a low amplitude vibrator capable of 5,000 foot-pounds with 7-100 Hz frequencies to vibrate and compact architectural pavers into bedding sand.

2. Vibrate the architectural pavers, sweeping dry joint sand into the joints and vibrating, until the joints are full. Do not vibrate within 3 feet of the unrestrained edges of the architectural pavers.

3. At the end of each day, all work within 3 feet of laying face must be left fully compacted, with sand-filled joints.

4. Sweep off the excess sand.

f. Leave a final surface elevation of architectural pavers of 1/8 to 1/4 inch above adjacent drainage inlets, concrete collars or channels.

g. Do not permit the final surface elevations of the pavers to deviate more than 3/8 inch under a 10 foot long straightedge, or more than 1/8 inch between adjacent pavers.

526-4 Method of Measurement.

The quantity to be paid for will be the area in square yards for Architectural Pavers, measured in place, completed and accepted. Measurement will be as specified in 9-1.3.1. No deduction will be made for the area(s) occupied by ornamental trees left within and any other areas occupied by manholes, inlets, drainage structures or by public utility appurtenances within the normal area(s) of the architectural pavers.

526-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section and the quantity, determined as provided above, will be paid for at the contract unit price per square yard for Architectural Pavers.

Payment shall be made under:

Item No. 526- 1-1-	Pavers, Architectural (Roadway) - per square yard.
Item No. 526- 1-2-	Pavers, Architectural (Sidewalk) - per square yard.

SECTION 527
DETECTABLE WARNINGS ON WALKING SURFACES

527-1 Description.

Furnish and install Detectable Warning devices on newly constructed and/or existing concrete curb ramps and sidewalks constructed in accordance with the Design Standards, where indicated in the plans.

527-2 Materials.

527-2.1 Detectable Warning: Provide Detectable Warnings in accordance with the Americans with Disabilities Act Accessibility Guidelines (ADAAG) Section 4.29.2 - Detectable Warnings on Walking Surfaces. Use Detectable Warnings of materials intended for exterior use applied to concrete and subject to routine pedestrian traffic and occasional vehicular traffic. Use Detectable Warnings with size and pattern shown in the plans comprised of truncated domes aligned in parallel rows in accordance with Index No. 304 of the Design Standards. Do not use detectable warnings with a diagonal pattern.

527-2.1.1 Preformed Materials: Use Detectable Warnings consisting of weather-resistant tiles, pavers or mats that are adhered to concrete and have mechanical bond or fasteners, or torch-applied preformed thermoplastic. Preformed products may be used only if listed on the Qualified Products List in accordance with 527-2.4.

527-2.1.2 Field-Formed Materials: Use Detectable Warnings applied as a secondary application to cured concrete. Products applied as a secondary application on cured concrete, may be used only if listed on the Qualified Products List in accordance with 527-2.4.

527-2.2 Material Properties: Provide Detectable Warnings that meet the following minimum material property requirements when tested in accordance with the indicated Standard appropriate to the material.

PROPERTY	STANDARD	MINIMUM THRESHOLD
Slip Resistance	ASTM C1028, F609, F1677, F1678, F1679; E303	Dry Coefficient of Friction – 0.8 min. and Wet Coefficient of Friction – 0.65 min.; Or 35 BPN (include recessed areas between truncated domes)
Wear Resistance	ASTM C501	Average wear depth on dome ≤0.030" after 1000 abrasion cycles.
Water Absorption[1]	ASTM D570	Not to exceed 5%.
Adhesion/Bond Strength	ASTM C482	No adhesion failure
Non-Hazardous Classification	RCRA Subtitle C	Non-Hazardous
1 Applies only to pavers and tiles consisting of concrete materials.		

527-2.3 Color/Contrast: Use Safety Yellow, Brick Red or Black colored Detectable Warnings, that provide an acceptable color/contrast on concrete sidewalk. Acceptable Detectable Warnings as listed on the Qualified Products List will meet the following criteria for a duration of three years.

COLOR	LIGHT REFLECTANCE VALUES (LRV) CAP Y*
Safety Yellow	25 – 40
Brick Red	5 – 15
Black	0 – 5
*When measured with a spectrophotometer	

527-2.4 Qualified Products List: Methods or products used to form Detectable Warnings in wet concrete will not be permitted. Use Detectable Warnings listed on the Department Qualified Products List (QPL). Manufacturers of Detectable Warnings seeking evaluation of their product shall submit an application in accordance with Section 6. Manufacturers must demonstrate performance in accordance with the requirements of these Specifications and with the acceptance criteria detailed in Index No. 304 of the Design Standards. Submit Applications that include certified test reports from an independent laboratory that shows the Detectable Warning meets the material properties and all requirements specified herein. Application must include manufacturer's installation drawings that describe detailed quality control requirements for installation including, but not limited to: special materials and/or equipment; recommendations for cleaning/preparing substrate surfaces; bonding method describing thickness, spread rate and/or curing time(s) of grout or adhesive

materials; mechanical anchorage; and protection of Detectable Warning materials during set-up/curing period.

In addition, manufacturer's drawings must provide recommended quality control procedures for touch-up and repair of localized areas of installations, for compliance with the acceptance criteria provided in Index No. 304 of the Design Standards.

527-3 Installation Procedures.

527-3.1 Surface Preparation and Installation: Prepare the surface in accordance with the Detectable Warning manufacturer's recommendations. Install Detectable Warnings in accordance with the manufacturer's instructions, using materials and/or equipment recommended and approved by the Detectable Warning manufacturer for adherence to cementitious substrate surfaces. Ensure that all installations are made in accordance with the manufacturer's installation drawings referenced by the QPL.

527-4 Method of Measurement.

Detectable Warnings applied to newly constructed concrete sidewalk/curb ramps will be included in the cost of the concrete sidewalk/curb ramp. Detectable Warnings applied to existing curb ramps will be paid per each Detectable Warning that is furnished, installed and accepted.

527-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including all labor, surface preparation, materials and incidentals necessary to complete the work for Detectable Warnings installed on each curb ramp.

Payment will be made under:

Item No. 527- 1-	Detectable Warnings on Walking Surfaces - each.

SECTION 530
RIPRAP

530-1 Description.

Construct riprap composed of sand-cement or rubble (consisting of broken stone or broken concrete) as shown in the Design Standards and in the plans. When specified in the plans, place bedding stone under the rubble riprap. When specified in the plans or Design Standards, place geotextile fabric under the riprap.

530-2 Materials.

530-2.1 Sand-Cement:

(1) Portland Cement: Provide cement from an approved source meeting the requirements of Section 921. Certify that cement meets the requirements of the Contract Documents.

(2) Fine Aggregate: Meet the requirements of 902-3.3.

(3) Sacks: Provide sacks made of jute, cotton, or scrim reinforced paper capable of holding the sand-cement mixture without leakage. Ensure that sack material is permeable and absorptive enough to permit passage of water to provide for hydration of the cement. Ensure that paper used in sacks is non-asphalt laminated with a polyester fiber scrim reinforcement in a three-way directional pattern, has an embossed finish, and is perforated approximately 3/32 inch in approximate 1 inch centers. Extend perforations continuously through the entire wall.

Provide sacks of uniform size and dimensions, in order to provide uniformity of lines in the completed work. Use sacks that are free from holes and strong enough to withstand handling without ripping or splitting. Use only one type and size of sack at any one structure.

(4) Grout: Provide sand from an approved source meeting the requirements of 902-3.3. Provide cement from an approved source meeting the requirements of Section 921.

(5) Geotextile Fabric: Meet the requirements of Section 514 and Design Standards, Index 199.

530-2.2 Rubble:

530-2.2.1 Rubble (Bank and Shore Protection): Provide sound, hard, durable rubble, free of open or incipient cracks, soft seams, or other structural defects, consisting of broken stone with a bulk specific gravity of at least 2.30. Ensure that stones are rough and angular.

For this application, use broken stone meeting the following gradation and thickness requirements:

Weight Maximum Pounds	Weight 50% Pounds	Weight Minimum Pounds	Minimum Blanket Thickness in Feet
700	300	60	2.5
Ensure that at least 97% of the material by weight is smaller than Weight Maximum pounds]. Ensure that at least 50% of the material by weight is greater than Weight 50% pounds]. Ensure that at least 85% of the material by weight is greater than Weight Minimum pounds.			

530-2.2.2 Rubble (Ditch Lining): Use sound, hard, durable rubble, free of open or incipient cracks, soft seams, or other structural defects, consisting of broken stone or broken concrete with a bulk specific gravity of at least 1.90. Ensure that stones or broken concrete are rough and angular.

Use broken stone or broken concrete meeting the following gradation and thickness requirements:

Weight Maximum Pounds	Weight 50% Pounds	Weight Minimum Pounds	Minimum Blanket Thickness in Feet
75	30	4	1.5
Ensure that at least 97% of the material by weight is smaller than Weight Maximum pounds. Ensure that at least 50% of the material by weight is greater than Weight 50% pounds]. Ensure that at least 90% of the material by weight is greater than Weight Minimum pounds].			

530-2.2.3 Physical Requirements of Broken Stone and Broken Concrete: Use broken stone and broken concrete meeting the following physical requirements:

Absorption (FM 1-T85)	Maximum 5%
Los Angeles Abrasion (FM 1-T 096)	Maximum loss 45%*
Soundness (Sodium Sulphate) (AASHTO T 104)	Maximum loss 12%** (after five cycles)
Flat and elongated pieces	Materials with least dimension less than one third of greatest dimension not exceeding 10% by weight.
Dirt and Fines	Materials less than 1/2 inch in maximum dimension accumulated from interledge layers, blasting or handling operations not exceeding 5% by weight.
Drop Test***(EM 1110-2-2302)	No new cracks developed, or no existing crack widened additional 0.1 inch, or final largest dimension greater than or equal to 90% original largest dimension of dropped piece.

* Ensure that granite does not have a loss greater than 55% and that broken concrete does not have a loss greater than 45%.

** The Engineer may accept rubble exceeding the soundness loss limitation if performance history shows that the material will be acceptable for the intended use. The Engineer will waive the soundness specification for rubble riprap (broken stone and broken concrete) when project documents indicate it will be placed in or adjacent to water or soil with a sulfate content less than 150 parts per million and a pH greater than 5.0.

*** The Engineer will waive the Drop Test unless required to ensure structural integrity. Provide all equipment, labor and testing at no expense to the Department. EM refers to the US Army Corps of Engineer's Specification Engineering Method.

530-2.2.4 Source Approval and Project Control: The Engineer will approve mineral aggregate sources in accordance with 6-2.3 as amended by the following:

(1) The Engineer may perform Independent Verification tests on all materials placed on the project.

(2) The Engineer will check the gradation of the riprap by visual inspection at the project site. Resolve any difference of opinion with the Engineer in accordance with the method provided in FM 5-538. Provide all equipment, labor, and the sorting site at no expense to the Department.

(3) The Engineer may test components in a blend of rubble processed from different geologic formations, members, groups, units, layers or seams. The Engineer may select components based on like color, surface texture, porosity, or hardness. The Engineer will reject any blend if a component that makes up at least five percent by volume of the blend does not meet these specifications.

530-2.3 Bedding Stone: Use Bedding Stone of either a durable quality limestone or other quarry run stone, with a bulk specific gravity of not less than 1.90 and that is reasonably free from thin, flat and elongated pieces. Ensure that the bedding stone is also reasonably free from organic matter and soft, friable particles. Meet the following gradation limits:

Standard Sieve Sizes Inches	Individual Percentage by Weight Passing
12 inches	100
10 inches	70 to 100
6 inches	60 to 80
3 inches	30 to 50
1 inch	0 to 15

The Engineer will conduct source approval and project control of bedding stone as specified in 530-2.2.4. In lieu of limestone or other quarry run stone, the Contractor may substitute non-reinforced concrete from existing pavement that is to be removed and which meets the above requirements for commercial bedding stone.

530-2.4 Geotextile Fabric: Meet the requirements of Section 514 and Design Standards, Index 199.

530-3 Construction Methods.

530-3.1 Sand-Cement:

530-3.1.1 Mixing Materials: Proportion sand and cement in the ratio of 5 cubic feet of sand to 94 lbs. (1 bag) of cement. If proportioning the materials by mass, use a density of 85 lbs\ft^3 (loose volume) for sand. The Contractor may batch sand at the moisture content occurring in the stockpile.

Mix the sand and cement until the mixture is of uniform color.

530-3.1.2 Filling Sacks: Accurately measure the mixed material into each sack, taking care to place the same amount of material in each sack; keep at least the top 6 inches of the sacks unfilled to allow for proper tying or folding and to ensure against breaking of the sack during placing.

530-3.1.3 Placing: Place the filled sacks with their tied or folded ends all in the same direction. Lay the sacks with broken joints, in a regular pattern. Ram or pack the sacks against each other so as to form a close and molded contact after the sand and cement mixture has set up. Remove and replace sacks ripped or torn in placing with sound, unbroken sacks. Then, thoroughly saturate all sacks with water.

530-3.1.4 Grouting: Immediately after watering, fill all openings between sacks with dry grout composed of one part Portland cement and five parts sand.

530-3.1.5 Toe Walls: The Contractor may construct toe walls of riprap for fill slopes of poured in place concrete in lieu of sand cement in sacks. Meet the concrete requirements as specified in Section 347. If using sand cement in

sacks for the toe walls, fill the entire trench excavated for the toe walls with sand cement in sacks.

530-3.2 Rubble: Dump rubble in place forming a compact layer conforming to the neat lines and thickness specified in the plans. Ensure that rubble does not segregate so that smaller pieces evenly fill the voids between the larger pieces.

530-3.3 Bedding Stone: Place bedding stone without puncturing or tearing the geotextile fabric. Remove and replace geotextile fabric damaged as a result of operations at no expense to the Department.

The Engineer will allow an in place thickness tolerance of ±1 inch.

530-4 Method of Measurement.

530-4.1 Sand-Cement: The quantity to be paid for will be the volume, in cubic yards, of sand actually used in the sand cement mixture and grout, satisfactorily placed and accepted.

If sand cement is proportioned by volume, the sand will be measured loose in an approved measure prior to mixing with cement. If sand cement is proportioned by weight, approved scales will be used for this purpose and the volume will be calculated using a standard conversion factor for sand of 85 lbs/ft^3. No adjustment of batch weights to allow for varying moisture content of the sand will be made.

For toe walls, the quantity to be paid for will include only the volume of sand cement in sacks or concrete placed within the neat lines shown in the plans for the toe walls.

530-4.2 Rubble and Bedding Stone: The quantities to be paid for will be the weight, in tons, in surface dry natural state, by railroad scales, truck scales, or barge displacement. The Contractor shall determine the weights as follows:

(1) Railroad Weights: The Contractor shall weigh railroad cars on railroad scales, before and after loading or before and after unloading. If weighed by other than the Engineer, a certified statement of weights will be required. Certificates of weight, furnished by the railroad company, will be acceptable without further certification.

(2) Truck Weights: The Contractor shall weigh trucks on certified scales, loaded and empty, as prescribed above for railroad weights. The Contractor shall weigh trucks in the presence of the Engineer, or furnish certificates of weights.

(3) Barge Displacement: The Engineer will measure each barge. The Contractor shall fit each barge with gauges graduated in tenths of a foot increments. The Contractor shall locate a gauge at each corner of the barge near the lower end of the rake. The Contractor shall furnish additional gauges amidships if the Engineer deems necessary. The Engineer will compute all weights.

530-5 Basis of Payment.

530-5.1 Sand-Cement: Price and payment will be full compensation for all work specified in this Section, including all materials, labor, hauling, excavation, and backfill.

Include the cost of dressing and shaping the existing fills (or subgrade) for placing riprap in the Contract unit price for Riprap (Sand-Cement).

530-5.2 Rubble: Price and payment will be full compensation for all work specified in this Section, including all materials, hauling, excavation, and backfill.

Include the cost of dressing and shaping the existing fills (or subgrade) for placing riprap in the Contract unit price for Riprap (Rubble).

As an exception to the above, concrete that is shown to be removed from an existing structure and subsequently disposed of by being used in the embankment as riprap will not be paid for under this Section. Include the cost of such work under Removal of Existing Structures.

530-5.3 Bedding Stone: Price and payment will be full compensation for all work specified in this Section, including all materials and hauling.

Include the cost of dressing and shaping the existing fills (or subgrade) for placing bedding stone in the Contract unit price for Riprap (Rubble).

530-5.4 Geotextile Fabric: Include the cost of materials and installation of the Geotextile fabric in the contract unit price for Riprap.

530-5.5 Payment Items. Payment will be made under:

Item No.	530- 1-	Riprap (Sand-Cement) - per cubic yard.
Item No.	530- 3-	Riprap (Rubble) - per ton.
Item No.	530- 74-	Bedding Stone - per ton.

SECTION 534
SOUND BARRIERS

534-1 Description.

Furnish and install sound barriers with pile, posts and panels constructed in accordance with Design Standards, Index Nos. 5200 thru 5206 or with pre-approved alternatives listed on the Department's Qualified Products List (QPL), unless the plans otherwise indicate limitations based on specific design or aesthetic criteria unique to the project.

Obtain Precast Concrete Sound Barrier Components from a manufacturing plant that is currently on the list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3.

534-2 Materials.

Meet the following requirements:

Portland Cement Concrete.....Section 346

534-3 Concrete Sound Barrier Component Construction.

Construct concrete components in accordance with Section 400. Precast wall components are produced using certification acceptance; therefore, assume responsibility for performance of all quality control testing and inspections required by Sections 346 and 400 for the precast component construction. Perform all Quality Control Testing using CTQP qualified testing personnel. Perform compressive strength testing in a laboratory inspected by CCRL or CMEC, with all deficiencies corrected.

Ensure that each Precast Concrete Sound Barrier Panel and Post is permanently and clearly marked by ink stamping the tongue and groove portion of the panel and post. Mark the panel with the panel type, date cast, project number, manufacturer's name or symbol and the post with the date cast, project number and manufacturer's name or symbol.

534-4 Approved Proprietary Sound Barrier Panels and Systems.

Use only approved proprietary panels or systems shown in Design Standards, Index Nos. 5200 thru 5206 that have been pre-determined by the Engineer to be in compliance with the project design and aesthetic criteria and are listed on the QPL.

Manufacturers seeking evaluation of products for inclusion on the QPL must submit an application in accordance with Section 6, independently certified test reports, and written certification that the product meets the requirements of this Section, Design Standards, Index Nos. 5200 thru 5206 and the Sound Barrier Evaluation Criteria contained in the State Structures Design Office's Structures Manual, which may be viewed at the following URL:
www.dot.state.fl.us/structures/StructuresManual/CurrentRelease/QualifiedProductsList/QPLChapter2SoundBarriers.htm .

534-5 Product Certification.

Provide written certification from the manufacturer of the panels that the product meets the requirements of this Section and is the same product listed on the QPL.

534-6 Shop Drawing Submittal.

Do not include shop drawings of the basic panel details, submit only the information requested. Submit shop drawings in accordance with Section 5, showing a plan and elevation of the sound walls with the following project specific information provided:

1. Begin and end wall stations with offsets
2. Horizontal and vertical alignments of the wall
3. Fire hose access hole locations
4. Drainage panel locations and type
5. Graphic details and graphic panel location
6. Panel locations
7. Post locations
8. Elevations of top of panel, bottom of panel, and panel joints
9. Existing and proposed ground elevations
10. Utility locations
11. Special post and panel details
12. Post and pile connection details
13. Lifting devices

534-7 Construction Methods.

A. Prior to beginning earthwork on the project, stake the wall location in the field, and establish the final ground line elevations at the barrier walls. Use these elevations to develop the shop plans, including a complete elevation view of each

wall indicating top and bottom elevations as well as the roadway grade. Protect the final ground elevations established in the field for the duration of the project, and do not adjust without prior approval of the Engineer. Keep to a minimum the clearing and grubbing, and trimming of trees as necessary to construct the walls.

B. Do not mix wall types or colors at any one site. Install the walls in accordance with the plans, and in accordance with shop drawings submitted to and approved by the Engineer. Secure joints and connections in such a manner as to be structurally sound with no visible openings for sound transmission. Ensure metal walls do not produce a secondary source of noise transmission due to vibration.

C. Repair marred, chipped, scratched, or spalled areas of walls at no expense to the Department in accordance with the manufacturer's recommendations or at the Engineer's direction.

D. The Contractor may substitute welded for fixed bolt connections or vice versa on metal walls, where applicable, provided load calculations are submitted for the specific modified connection and uses a minimum safety factor of 3.0.

E. Place trench backfill for wall construction in accordance with 125-8. Use select materials for the trench backfill.

If, in the opinion of the Engineer, the trench is too narrow to compact, backfill the trench excavation with concrete grout to the satisfaction of the Engineer at no expense to the Department.

F. Dispose of all excess excavation in a manner satisfactory to the Engineer.

G. Keep right-of-way fence that is scheduled to be salvaged in place until completing the wall or, in the opinion of the Engineer, as long as possible.

H. Stain concrete walls the color shown in the plans.

I. After erecting the wall, leave the disturbed area in a finished condition at the direction of the Engineer, and grass or sod the area as indicated in the plans.

J. Erection Tolerances:

1. Variation from plumb: ±1/4 inch
2. Panel alignment: ±1/4 inch
3. Top of panel elevation: ±3/4 inch
4. Elevation difference of adjacent panels: ±1/2 inch
5. Joint taper over panel length: ±1/2 inch
6. Top of collar elevation: ±3/4 inch
7. Post alignment: ±1 inch
8. Post placement:
    a. Variation from specified location ±1/2 inch
    b. variation from specified elevation ±1/4 inch
9. Continuity of graphics, fracture fins, etc across joints: 1/4 inch

K. When building sound barriers on top of earth berms, construct the berms of fill material compacted to 95% of the maximum density as determined by AASHTO T 99.

L. Provide the concrete wall (Precast or Cast-in-Place) with a uniform color, pattern, and texture.

534-8 Test Wall.

Erect a test wall section not less than 50 feet in length before starting general wall construction at the project site. The Engineer will use the erection of the test wall to determine if the Contractor's methods and equipment are sufficient to produce a sound barrier that meets the requirements of the Contract Documents. The Contractor may revise his methods and equipment as necessary, at any time during the positioning of the test wall, in order to satisfactorily meet all Contract requirements. Build the test wall at a permanent wall location, as directed by the Engineer. If the test wall does not meet the construction tolerances, remove and dispose of it at no expense to the Department. Include the cost of the test wall in the cost of the sound barrier.

534-9 Repairs or Rejection.

For precast concrete sound barrier components that have not been installed, evaluate cracks, spalls and other deficiencies in accordance with 450-12. Repair deficiencies in accordance with 450-13 or the plant's approved repair methods that are included as part of the QCP. Ensure that the original performance and durability of repaired sound barrier components are maintained. Use materials for concrete repair that will meet or exceed the strength requirement for the class of concrete used. Materials meeting the requirements of Section 930 may be substituted for non-shrink grout when required by 450-13. Precast concrete sound barrier components are subject to rejection if they fail to conform to any of the requirements after repair. For precast concrete sound barrier components that have been installed, the disposition of concrete cracks shall be in accordance with 400-21.

534-10 Method of Measurement.

The quantity to be paid for will be the plan quantity, in square feet, measured in place, completed and accepted, of the area bounded by the top of the top panel and the bottom of the bottom panel without deductions for openings in the panels, and the beginning to end limits shown in the control drawings. The pay area for anti-graffiti coating will be the plan quantity, in square feet, measured in place, completed and accepted, of the wall without allowances for striations or openings.

534-11 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including but not limited to: furnishing all materials, labor, panels, special panels, posts, collars, reinforcing steel, foundations, drain holes, fire hose access holes, grating, neoprene pads, equipment, alignment pins, etc. necessary to construct the sound barriers. Include in this price, the cost of any charges for power stoppages, sound barrier wall realignments, special erection methods, etc. required to construct the wall.

Payment will be made under:

Item No. 534- 72- Sound Barrier - per square foot.

SECTION 536
GUARDRAIL

536-1 Description.

Construct metal guardrail on posts of timber, steel, or as specified in accordance with the Contract Documents and the Design Standards.

Also, remove existing guardrail, construct guardrail anchorages, and replace guardrail posts, as specified in the plans.

536-2 Materials.

536-2.1 Guardrail: Construct guardrail of the standard W-beam or thrie beam type. Use materials for the rail and rail elements meeting the steel requirements of 967-1.

536-2.2 Posts:

536-2.2.1 General: Unless the Contract Documents designate a particular type of post, the Contractor may choose the type of post to use. Use posts of either timber, or steel, and of the sizes and dimensions shown in the plans. Use the particular type selected throughout a run of rail, except where special steel posts are required.

536-2.2.2 Timber Posts: Meet the requirements of the latest edition of the Southern Pine Inspection Bureau's Standard Grading Rules for Southern Pine Lumber, for No.1 grade timber, and treat the posts in accordance with the requirements for posts in 955-5.3. Ensure that penetration of preservative is in accordance with requirements for round piles and fence posts in 955-6.2. Shape and drill the posts prior to treatment, and ensure that they do not vary more than 1 inch from the specified length. Dress all timber posts on all four sides (S4S).

536-2.2.3 Steel Posts: Use steel posts meeting the requirements of ASTM A36 steel. Galvanize the posts in accordance with the requirements of ASTM A 123, with 2 oz/ft^2 of zinc coating. Drill the posts prior to galvanizing. Ensure that the manufacturer furnishes certification showing physical and chemical properties of each heat, the amount of spelter coating, and conformance to ASTM A 123.

The Contractor may use steel guardrail posts of either a rolled section or a welded structural shape with nominal dimensions as shown in the Design Standards.

For welded structural shapes, meet the following requirements:

(1) Ensure that the design properties of the shape meet or exceed the design properties for a W 6 x 9 shape as contained in the AISC Manual of Steel Construction.

(2) Weld in accordance with the requirements of ASTM A 769.

(3) After cutting posts to length, place a weld to seal the spaces between the web plate and flange plates.

(4) Galvanize as specified above after completing all drilling and welding.

536-2.3 Anchor Blocks: Use anchor blocks of Class I concrete, and construct and place them in accordance with the requirements shown in the plans or as directed by the Engineer.

536-2.4 Offset Blocks: Use guardrail offset blocks of either timber, steel, recycled plastic, or rubber, and of the sizes specified in the Design Standards.

Treat timber blocks in accordance with the requirements for posts in 955-5.3. Ensure that penetration of preservative is in accordance with requirements for round piles and fence posts in 955-6.2. For timber offset blocks, meet the requirements of the latest edition of the Southern Pine Inspection Bureau's Standard Grading Rules for Southern Pine Lumber, for No.1 grade timber. Dress all timber offset blocks on all four sides (S4S). Ensure that timber offset blocks do not vary more than 0.25 inch from the specified length.

Use rubber blocks that have a minimum Durometer hardness of 50 (ASTM D 2240), show no cracking at the end of an ozone exposure of 100 ±10 pphm for 15 hours at 100ºF (ASTM D 1149 mounting type A), do not exceed 15 points change in Durometer hardness in oven ageing for 70 hours at 158ºF (ASTM D 573), and show no cutting or tearing under a 6,500 lb load applied through a guardrail section. Ensure that the blocks present a neat appearance and have plane surfaces. Provide rubber blocks that are 6 inches wide, 8 inches deep and 14 inches high. Allow dimensional tolerances of ±5/8 inch in height, ±3/8 inch in width, and ±3/8 inch in depth.

For Recycled Plastic offset blocks, meet the requirements of Section 972.

536-2.5 Reflector Elements: Mount reflectors onto the guardrail in accordance with the details shown in the plans and the Design Standards. Provide reflectors that meet the requirements of 993-3.

536-2.6 Certification: Provide the Engineer a certification from the manufacturer confirming that all materials (timber or steel posts, anchor and offset blocks, reflector elements, and all other accessories) meet the requirements of this Section, Section 6 and the Design Standards. Provide the Engineer a copy of the certification at least ten days prior to guardrail construction.

Also furnish the Engineer a Certificate of Compliance certifying that the guardrail system, materials and construction practices comply with applicable Design Standards and Specifications.

Acceptance of furnished material will be based on the Certificate of Compliance, material certification and visual inspection by the Engineer.

536-3 Setting Posts.

Set standard length posts vertically to the depth shown in the Design Standards. Set special length posts vertically to the depth shown in the plans. Align and realign posts as necessary, until final acceptance. Where the posts are not set in concrete or mounted on structures, backfill the post holes with suitable thoroughly tamped material. As an alternate method, the Contractor may use a post-driving machine, meeting the approval of the Engineer and capable of driving the posts without damaging them.

For guardrail post replacement, backfill and compact the existing hole prior to setting the new post.

If driving timber posts, the Contractor may either block out holes in the asphalt for the posts during the asphalt paving operation or cut holes through the asphalt mat prior to the post installation. Blocked out holes or cut holes in the asphalt pavement shall be at least 50% larger than the sectional area of the timber

post. After completing driving of the posts patch the area of asphalt around each post with fresh hot bituminous mixture.

If driving steel posts, drive the post directly through the asphalt mat. Fill depressions or cracks with fresh, hot bituminous mixture in a manner meeting the approval of the Engineer.

For either timber or steel post locations, in which rock, concrete or asphalt thicker than 2 inches exist, remove such material and backfill with suitable material, thoroughly tamped as detailed in the Design Standards.

536-4 Erection of Rail.

Erect the guardrail panels, supports, anchors, etc., as shown in the Design Standards.

536-5 Existing Guardrail.

Stockpile guardrail, so specified, within the right-of-way at a location approved by the Engineer. Dispose of all remaining guardrail not specified for stockpiling.

536-6 Method of Measurement.

536-6.1 Guardrail: The quantity to be paid for will be the plan quantity, in feet, constructed, in place and accepted.

The plan length of a run of guardrail will be determined as a multiple of the nominal panel lengths plus the nominal lengths of terminal sections, unless payment for the terminal sections are included in the end anchorage or bridge anchorage assemblies.

536-6.2 End Anchorage Assemblies: The quantity to be paid for will be the number of each type as designated, constructed, in place and accepted.

536-6.3 Special Guardrail Posts: The quantity to be paid for will be the number of each, constructed, in place and accepted.

The designation “Special Guardrail Posts” will include only such posts as require special fabrication, for installation at locations where the normal setting would conflict with concrete structures, such as approach slabs, culvert slabs, footings, inlets, etc. Special posts, however, will not include posts for double-face median guardrail, regardless of whether they are embedded in or attached to concrete.

536-6.4 Bridge Anchorage Assemblies: -`The quantity to be paid for will be the number of each, constructed, in place and accepted.

536-6.5 Guardrail Anchorage (Concrete Barrier Wall): The quantity to be paid for will be the number of each, constructed, in place and accepted.

536-6.6 Guardrail Post Replacement: The quantity to be paid for will be the number of each, replaced.

536-6.7 Removal of Existing Guardrail: The quantity to be paid for will be the length, in feet, measured prior to removal.

536-6.8 Special Steel Guardrail Posts: The quantity to be paid for will be the number of each, constructed, in place and accepted.

536-7 Basis of Payment.

536-7.1 Guardrail: Price and payment will be full compensation for all work specified under this Section, including the furnishing and installing of the acrylic plastic reflectors and all other materials as specified. Payment will be made under the items as follows:

a. Where the Contractor furnishes all materials for the guardrail, and the Engineer does not require shop-bent rails, payment will be made under the basic item of Guardrail.

b. Where the radius of the guardrail installation is such as to require shop bending of the guardrail panels, payment will be made under the item of Guardrail (Shop-bent Panels).

All component parts of the complete guardrail installation will be included in the price per foot for the above items except for the separate payments to be made under the special items listed below.

536-7.2 End Anchorage Assemblies: Price and payment will include all components specified on the plans and Design Standards.

536-7.3 Special Guardrail Posts: Price and payment will include all costs for furnishing and installing the special posts that are over and above the costs for the normal posts, which are replaced by such special posts.

536-7.4 Bridge Anchorage Assemblies: When the plans provide for direct payment for Bridge Anchorage Assemblies, price and payment will include furnishing and installing the special End Shoes, Wood Blocks or Retrofit Wing Posts, Concrete Anchor Posts and necessary hardware.

When the plans do not provide for direct payment for Bridge Anchorage Assemblies, the Contractor shall include the cost for the assemblies in the Contract price per foot for the guardrail.

536-7.5 Guardrail Anchorage (Concrete Barrier Wall): Price and payment will include installing connections to concrete barrier walls, as shown on the Design Standards, Index Nos. 400 and 410.

536-7.6 Guardrail Post Replacement: Price and payment will include all labor, materials, and equipment required for removal and disposal of existing posts in areas provided by the Contractor, backfilling and compacting existing holes, and replacement with new posts.

536-7.7 Removal of Existing Guardrail: Price and payment will include all labor and equipment required for removal and disposition of the existing guardrail, as specified in the plans. No additional payment will be made for the removal of the back rail on double face guardrail, thrie beam guardrail, nested rail, safety pipe rail, rub rail or end anchorages.

536-7.8 Special Steel Guardrail Posts with Accessories: Price and payment will include all components specified on the plans and Design Standards.

536-7.9 Payment Items: Payment will be made under:

Item No. 536- 1-	Guardrail - per foot.
Item No. 536- 2-	Guardrail (Shop-Bent Panels) - per foot.
Item No. 536- 7-	Special Guardrail Post - each.
Item No. 536- 8-	Bridge Anchorage Assemblies - each.
Item No. 536- 73-	Removal of Existing Guardrail - per foot.

Item No. 536- 75-	Special Steel Guardrail Posts with Accessories - each.
Item No. 536- 76-	Special Length Guardrail Posts - each.
Item No. 536- 82-	Guardrail Anchorage (Concrete Barrier Wall)- each.
Item No. 536- 83-	Guardrail Post Replacement- each.
Item No. 536- 85-	Guardrail, End Anchorage Assembly - each.

SECTION 538
RESETTING GUARDRAIL

538-1 Description.

Remove the existing guardrail, and reset the salvaged guardrail with new materials. Reset the guardrail at locations shown in the plans in accordance with the design standards for guardrail construction or as modified by the plans.

538-2 Materials.

Prevent damage to reusable materials when removing existing guardrail. Furnish all new materials necessary to complete the reset guardrail installation. Provide only new offset blocks.

Meet the requirements specified in 536-2.

538-3 Construction Methods.

Set posts in accordance with the requirements of 536-3.

Erect guardrail panels, anchors, and hardware in accordance with the design standards for guardrail construction or as modified by the detailed plans.

Replace any salvageable materials damaged by operations at no expense to the Department.

Use a consistent type of post throughout a run of guardrail.

538-4 Method of Measurement.

The quantities to be paid for will be: (1) the length, in feet, of reset guardrail, (2) the number of end anchorage assemblies of each type as designated, (3) the number of special posts, and (4) the number of bridge anchorage assemblies; all as actually constructed and accepted.

The plan length of a run of reset guardrail will be determined as a multiple of the nominal panel lengths except that any panel which is cut off will be field-measured.

538-5 Basis of Payment.

Prices and payments for resetting guardrail will be full compensation for all work specified in this Section, including furnishing all required new hardware and additional posts, all new offset blocks, and replacement of any material damaged by the Contractor except as specified below.

Price and payment for end anchorage assemblies, special guardrail posts, and bridge anchorage assemblies will be as specified in Section 536.

Payment for new guardrail panels and posts furnished to replace such items determined to be non-salvageable, excluding any items damaged by the Contractor, will be paid for at the actual invoiced cost including transportation charges, to which cost will be added an amount equal to 25% of the total charges.

Payment will be made under:

Item No. 538- 1- Resetting Guardrail - per foot.

SECTION 544
VEHICULAR IMPACT ATTENUATORS

544-1 Description.

Install redirective and non-redirective vehicular impact attenuators (VIA) of the sizes and types designated in the plans. Redirective VIAs are safety devices with capabilities to redirect the impacting vehicle over the full length of the device. Non-redirective VIAs allow controlled penetration of the impacting vehicle over the full length of the device.

544-2 Qualified Products List.

Use Vehicle Impact Attenuators listed on the QPL. Manufacturers seeking evaluation of their VIAs shall furnish certified test reports showing that their products meet all test requirements of NCHRP 350.

544-3 Construction.

Handle and install manufactured materials or articles in accordance with the manufacturer's instructions and the Design Standards.

Use attenuators delineated with a Type I Object Marker specified in Section 705.

Perform repairs necessary due to defective material, work, or operations without additional cost to the Department.

Restore the attenuator damaged by the traveling public after the installation is completed, accepted and serving its intended purpose on an open section of bridge or roadway within 24 hours.

544-4 Compensation.

Price and payment will be full compensation for the complete system or module in place and accepted, including object marker. Payment for restoring damaged attenuators will be at the manufacturer's/distributor's invoice price for the new materials or parts plus 20% markup. The 20% markup is compensation for all necessary work, including but not limited to labor, equipment, supplies and profit, as authorized by the Engineer.

Relocation of an existing attenuator system to a permanent location called for in the plans shall be paid for at the Contract unit price for relocating existing systems. Price and payment will be full compensation for relocating and

reinstalling the system in accordance with the manufacturer's instructions and the Design Standards.

Payment will be made under:

Item No. 544- 74-	Vehicular Impact Attenuator, Relocate Existing - each.
Item No. 544- 75-	Vehicular Impact Attenuator - each.

SECTION 546
RUMBLE STRIPS

546-1 Description.

Construct Rumble Strips in accordance with the details shown in the plans and Design Standards.

546-2 Materials for Raised Rumble Strips.

Construct Raised Rumble Strips using one of the following:

(a) Thermoplastic materials listed on the Qualified Products List (QPL), meeting the requirements of 971-1 and 971-7. Ensure that the material used can be restored to its original dimensions by using a self bonding overlay meeting these requirements. Submit a certified test report to the Engineer indicating that the materials meet all requirements specified.

Before applying thermoplastic materials on portland cement concrete surfaces, apply a primer sealer recommended by the manufacturer.

(b) Any plant-mixed hot bituminous mixture meeting the requirements of a job-mix formula issued by the Department, except open-graded friction course.

Prior to the application of any plant-mixed hot bituminous material, apply a tack coat meeting the requirements of 300-2.3.

The mixture will be accepted on the basis of visual inspection by the Engineer with no further testing required.

546-3 Application.

546-3.1 Raised Rumble Strips: Notify the Engineer before the placement of raised rumble strips. Apply raised rumble strips having well defined edges. Remove and replace any raised rumble strips not meeting the requirements of the Contract Documents at no additional cost to the Department.

Before applying raised rumble strips, remove any material that would adversely affect the bond of the raised rumble strips by a method approved by the Engineer.

Apply raised rumble strips only to dry surfaces, and only when the ambient air and surface temperature is at least 55ºF and rising.

546-3.2 Ground-In Rumble Strips: Before the construction of any ground-in rumble strips, demonstrate to the Engineer that the equipment to be used can achieve a depression having well defined edges and a smooth interior finish without snagging or tearing the finished pavement.

Before opening the adjacent lane to traffic, ensure that all debris generated by the grinding process is removed and disposed of daily by vacuum or

a method approved by the Engineer. Do not dispose of the debris within the right-of-way. Do not use the debris generated by the grinding process in recycled asphalt.

Restore any pavement to the satisfaction of the Engineer at no additional cost to the Department, when ground-in rumble strips do not meet the requirements of the Contract Documents.

546-4 Method of Measurement.

The quantity of Raised Rumble Strips to be paid for under this Section will be the plan quantity per set, constructed and accepted.

The quantity of Ground-In Rumble Strips to be paid for under this Section will be the plan quantity in miles, constructed and accepted. The plan quantity will be determined based on the roadway length minus bridge lengths for each shoulder on which Rumble Strips are to be constructed.

546-5 Compensation.

Prices and payments will be full compensation for all work specified in this Section, including, all cleaning and preparing of surfaces, disposal of all debris, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment will be withheld until all deficiencies are corrected.

Payment will be made under:

Item No. 546- 71-	Rumble Strip Sets - per set.
Item No. 546- 72-	Rumble Strips - per mile.

SECTION 548
RETAINING WALL SYSTEMS

548-1 Description.

Construct permanent and temporary retaining wall systems in accordance with this Section and in conformance with the lines, grades, design, and dimensions shown in the Contract Documents or established by the Engineer. Unless otherwise noted in the plans, provide a wall system listed on the Qualified Products List (QPL) based on the FDOT Wall Type shown in the plans. Sheet pile walls and cast-in-place walls are not included in this Specification. All other wall systems used to cut back existing slopes are paid for under the same pay item numbers shown in the Basis of Payment Article of this Specification. Construct all walls of a specific type [MSE (Mechanically Stabilized Earth), counterfort, etc] using the same wall system and supplier. If different types of wall systems must be used in a manner that causes one wall to interact with or influence another wall, coordinate the detailing of these areas of interaction/influence with the assistance of the Contractor's Engineer of Record.

Obtain Precast Concrete Wall System from a manufacturing plant that is currently on the list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3.

Ensure that each Wall System Component is permanently and legibly marked by etching on the back of each panel, the panel number or type, project number (when applicable), date cast and manufacturer's name or symbol.

Ensure that each shipment of products to the job site includes a list of products shipped and the required written certification statement for each product. Provide this list and certification(s) to the Engineer.

548-2 Materials.

Purchase the precast components, soil reinforcement, attachment devices, joint filler, filter fabric, and all necessary incidentals from the wall supplier chosen.

548-2.1 Concrete: Ensure that concrete utilized for wall components is as specified in the Contract Documents and is consistent with the concrete class, environmental classification and admixture requirements for durability as stated in the Contract Documents. Produce and supply concrete for all wall components meeting the requirements of Section 346.

Produce and supply concrete for the leveling pad meeting the requirements of Section 347. Assume responsibility for performance of all testing required by Section 346. Use Department approved mix designs.

548-2.2 Reinforcing Steel: Meet the requirements of Section 931 utilizing Grade 60 (Black) steel.

548-2.3 Soil Reinforcement: For walls utilizing soil reinforcement, use reinforcement consisting of steel wire mesh, metal strips or structural geosynthetics as required for the wall system chosen.

Use steel wire mesh and embedded loops shop fabricated from cold drawn steel wire meeting the minimum requirements of ASTM A 82, and weld into the finished mesh fabric in accordance with ASTM A 185. Use steel strips hot rolled from bars to the required shape and dimensions with physical and mechanical properties meeting ASTM A 572 Grade 65 or as shown in the Contract Documents. Use shop-fabricated hot rolled steel tie straps meeting the minimum requirements of ASTM A 1011/A 1011 M, Grade 50, or as shown in the Contract Documents.

Ensure that steel reinforcing strips, tie strips, reinforcing mesh and connectors used in permanent walls are galvanized in accordance with ASTM A 123 or ASTM A 153, as applicable.

Use structural geosynthetics made of polypropylene, select high density polyethylene or high-tenacity polyester fibers having cross-sections sufficient to permit significant mechanical interlock with the soil/backfill. Use geosynthetics having a high tensile modulus in relation to the soil/backfill. Use geosynthetics having high resistance to deformation under sustained long term design load while in service and resistant to ultraviolet degradation, to damage under normal construction practices and to all forms of biological or chemical degradation normally encountered in the material being reinforced.

Store the geosynthetics in conditions above 20ºF and not greater than 140ºF. Prevent mud, wet cement, epoxy, and like materials from coming into contact with and affixing to the geosynthetic material. Rolled geosynthetic may

be laid flat or stood on end for storage. Cover the geosynthetic and protect from sunlight prior to placement in the wall system.

Carefully inspect all reinforcement, steel and geosynthetics to ensure they are the proper size and free from defects that may impair their strength and durability.

548-2.4 Attachment Devices: Use soil reinforcement attachment devices as required by the wall system chosen.

548-2.5 Joint Materials and Filter Fabrics:

548-2.5.1 Horizontal Joint Filler: Use elastomeric or polymeric pads/fillers in all horizontal joints between precast components as recommended by the wall manufacturer. Ensure that the pads are of sufficient size and hardness to limit vertical stresses on the pad and concrete surface and to prevent concrete to concrete contact at the joints.

548-2.5.2 Joint Covers: Cover joints and other wall openings with geotextile fabric meeting the requirements of Section 985 and Type D-5 of the Design Standards, Index No. 199. Apply an adhesive approved by the Engineer to the back of the precast component for attachment of the fabric material.

548-2.5.3 Alignment Pins: Ensure that pins used to align the precast components during construction are of the size, shape and material required for the wall system chosen.

548-2.6 Backfill Material: Meet the requirements of Sections 105, and 120 except as noted within this Section. Have the backfill material tested for every soil type for pH, resistivity, sulfate and chloride content by a Department approved independent testing laboratory prior to placement. Provide certification to the Engineer, that the results have met the requirements of this Section and are signed and sealed by a Professional Engineer, registered in the State of Florida. The retaining wall volume is defined to extend from the top of the leveling pad or footing, or bottom of walls which do not have footing or leveling pads, to the finish grade line and from the face of the wall to a vertical plane passing through the end of the extreme wall component (straps, counterforts, etc.) plus 1 foot.

For constructing the retaining wall volume, do not use backfill material containing more than 2.0% by weight of organic material, as determined by FM 1-T 267 and by averaging the test results for three randomly selected samples from each stratum or stockpile of a particular material. If an individual test value of the three samples exceeds 3%, the stratum or stockpile will not be suitable for constructing the retaining wall volume.

Ensure that the material is non-plastic as determined by AASHTO T 90 and the liquid limit as determined by AASHTO T 89 is less than 15. The pH, as determined by FM 5-550, shall not be lower than five and not higher than nine, unless approved otherwise by the Engineer, as follows: For walls utilizing non-metallic soil reinforcement, the Engineer may approve using a backfill with a pH value between three and ten, if no metallic structures, such as metallic pipes, are placed within the backfill. Do not use backfill with a pH lower than three or higher than ten.

Use backfill for walls using soil reinforcements that meets the following gradation limits determined in accordance with AASHTO T 27 and FM 1-T 011:

Sieve Size	Percent Passing
3 1/2 inches	100
3/4 inch	70-100
No. 4	30-100
No. 40	15-100
No. 100	0-65
No. 200	0-12

In addition, for permanent walls utilizing metallic soil reinforcement, use backfill that meets the following electro-chemical test criteria for determining corrosiveness:

Criteria	Test Method
Resistivity: > 30 Ω·m	FM 5-551
Sulfate content: < 200 PPM	FM 5-553
Soluble chloride content < 100 PPM	FM 5-552

For walls not using soil reinforcement, use backfill that meets the following gradation limits determined in accordance with AASHTO T 27 and FM 1-T 011:

Sieve Size	Percent Passing
3 1/2 inches	100
No. 200	0-12

548-3 Concrete Component Construction.

Construct concrete components in accordance with Section 400. Precast wall components are produced using certification acceptance; therefore, assume responsibility for performance of all quality control testing and inspections required by Sections 346 and 400 for the precast component construction. Perform all Quality Control inspection and testing using CTQP qualified personnel. Perform compressive strength testing in a laboratory inspected by CCRL or CMEC. The minimum time for form removal is 12 hours. Unless otherwise indicated in the Contract Documents, apply a Class 3 finish to the concrete surface for the front face, and roughly screed the rear face to eliminate open pockets of aggregate and surface distortions in excess of 1/4 inch.

548-3.1 Curing: Cure concrete components in accordance with Section 400.

548-3.2 Tolerances: Meet the following manufactured tolerances:

1. Precast Component Dimensions: Lateral position of soil reinforcement attachment devices-within 1 inch. All other dimensions-within 3/16 inch.

2. Precast Component Squareness: Angular distortion of the component shall not exceed 0.2 inches in 5 feet.

3. Precast Component Surface Finish: Surface defects on smooth formed surfaces measured on a length of 5 feet shall not exceed more than 0.1 inch. Surface defects on textured finished surfaces measured on a length of 5 feet shall not exceed 5/16 inch.

548-3.3 Marking of Precast Components: Clearly mark each precast components with the date of manufacture, the 346 concrete production LOT number and the piece-mark.

548-4 Repairs or Rejection of Precast Components.

For precast concrete wall components that have not been installed, evaluate cracks, spalls and other deficiencies in accordance with 450-12. Repair deficiencies in accordance with 450-13 or the plant's approved repair methods that are included as part of the QCP. Ensure that the original performance and durability of repaired wall components are maintained. Use materials for concrete repair that will meet or exceed the strength requirement for the class of concrete used. Materials meeting the requirements of Section 930 may be substituted for non shrink grout when required by 450-13.

For precast concrete wall components that have been installed, the disposition of concrete cracks shall be in accordance with 400-21.

The Department will reject all precast concrete wall components not meeting the quality standard of this Section and referenced Specifications. In addition, any of the following defects will be sufficient cause for rejection by the Department:

1. Defects that indicate unsatisfactory molding.
2. Defects indicating honeycombed or open texture concrete.
3. Defects in the physical characteristics such as:

Signs of aggregate segregation;

Broken or cracked corners;

Soil reinforcement attachment devices improperly installed/damaged;

Lifting inserts not useable;

Exposed reinforcing steel;

Insufficient cover over reinforcing steel;

Cracks at the alignment pipe or pin;

Insufficient concrete compressive strength;

Precast Component thickness in excess of ±3/16 inch from that shown in the Contract Documents; or

Stained front face, due to excess form oil or other reasons.

If the face of the precast component is stained or discolored to the point of rejection, the stain or discoloration may be removed or a Department approved stain or a Class 5 finish may be applied to attain a uniform appearance for the entire structure, to the satisfaction of the Engineer.

548-5 Handling Storage and Shipping.

Handle, store and ship all components in a manner that prevents chipping, cracks, fractures, excessive bending stresses, mud, dirt and debris. Support precast components in storage on firm blocking located immediately adjacent to the attachment device.

548-6 Construction Requirements.

548-6.1 General: Due to the unique nature of the structure and concept, procure from the Wall Supplier fully detailed shop drawings, technical instructions, guidance in preconstruction activities and on-site technical assistance during construction. Closely follow any instructions from the Wall Supplier, unless otherwise directed by the Engineer. Submit a copy of any instructions from the Wall Supplier to the Engineer. Verify all pertinent retaining wall information (soil parameters, wall alignment, utility locations, conflicting structures) prior to the Wall Supplier finalizing shop drawings. Bring any conflicts not shown in the Contract Documents to the Engineer's attention.

548-6.2 Wall Excavation: Excavate to the limits shown in the Contract Documents and in conformance with Section 125.

548-6.3 Foundation Preparation: Grade the foundation for the structure level for a width equal to or exceeding the limits of the retaining wall volume or as shown in the Contract Documents. Prepare the foundation in conformance with Section 125.

In addition to the compaction requirements of Section 125, compact the graded area with an appropriate vibratory roller weighing a minimum of 8 tons for at least five passes or as directed by the Department's District Geotechnical Engineer. Remove and replace any soft or loose foundation subsoils which, are incapable of sustaining the required compaction to the Engineer's satisfaction.

For permanent MSE wall systems, provide an unreinforced concrete leveling pad as shown in the Contract Documents. Cure the leveling pad a minimum of 12 hours before placement of precast wall components.

548-6.4 Wall Erection: Assemble, connect and support wall components as recommended by the Wall Supplier. As backfill material is placed behind the wall face, maintain the wall in the vertical position or slightly battered into the backfill to provide a final vertical alignment (by means of bracing, temporary wooden wedges placed in the joint at the junction of the two adjacent precast components on the external side of the wall or other alignment aids). Remove wooden wedges as soon as the precast component above the wedged precast component is completely erected and backfilled. External bracing is required for the initial lift of MSE systems.

Place soil reinforcement normal to the face of the wall, unless otherwise shown in the Contract Documents or directed by the Engineer. Prior to placement of the reinforcement, compact the backfill in accordance with 548-6.5.

548-6.4.1 Tolerances for Permanent Walls: Ensure that vertical tolerances (plumbness) and horizontal alignment tolerances do not exceed 3/4 inch when measured with a 10 foot straight edge. The maximum allowable offset in the joint between precast components is 3/4 inch. The final overall vertical tolerance of the completed wall (plumbness from top to bottom) shall not exceed 1/2 inch per 10 feet of wall height. Horizontal and vertical joints between precast components shall not be less than 1/2 inch or more than 1 1/4 inch. Walls which do not meet these tolerances will not be accepted by the Department and must be removed and reconstructed at no cost to the Department.

548-6.4.2 Tolerances for Temporary Walls: Ensure that vertical tolerances (plumbness) and horizontal alignment tolerances do not exceed

3 inches when measured with a 10 foot straight edge. The final overall vertical tolerance of the completed wall (plumbness from top to bottom) shall not exceed 1 inch per 3 feet of wall height, not to exceed a total of 6 inches. Walls which do not meet these tolerances will not be accepted by the Department and must be removed and reconstructed at no cost to the Department.

548-6.5 Backfill Placement: Perform work in accordance with an approved Quality Control Plan (QCP) meeting the requirements of 105-3. A LOT is defined as a single lift of finished embankment not to exceed 500 feet in length. Isolated compaction operations will be considered as separate LOTs. For multiple phase construction, a LOT will not extend beyond the limits of the phase.

Place the backfill closely following the erection of each course of precast components or soil reinforcement layers and spread by moving the machinery parallel to the wall face. Do not allow equipment heavier than 8 tons closer than 3 feet behind the wall face. Place backfill in a manner to avoid any damage or disturbance to the wall materials or misalignment of the facing materials. Remove and replace any wall materials which become damaged or disturbed during backfill placement at no cost to the Department, or correct as directed by the Engineer. Remove and reconstruct any misalignment or distortion of the wall facing due to placement of backfill outside the limits of this specification at no cost to the Department.

Sheepfoot, grid rollers or other types of equipment employing a foot are not allowed. Achieve compaction within 3 feet of the back of the wall face using a power operated roller or plate weighing less than 1,000 lbs. At a distance greater than 3 feet from the back of the wall, a vibratory roller may be used, provided that the frequency and amplitude combined with bulk weight of the roller has performed satisfactorily at a trial section of the same type of wall. A smooth wheel or rubber tire roller is considered adequate. Ensure that the maximum lift thickness after compaction does not exceed 6 inches. Decrease the lift thickness if necessary, to obtain specified density.

Perform backfill compaction in a way that the compactor moves in a direction parallel to the wall face and proceeds from a distance not less than 3 feet behind the wall face toward the end of the soil reinforcement element.

Ensure that the moisture content of the backfill material prior to and during compaction is uniformly distributed throughout each layer of material. Use backfill material having a placement moisture content at the dry side of the Optimum Moisture content. To achieve the required compaction moisture content, use water that meets the requirements of Section 923. Do not use saltwater. Do not transport excessively moist backfill materials to the site for any reason. The Engineer will determine the Optimum Moisture Content in accordance with FM 5-521.

At the end of each day's operation, shape the last level of backfill to permit runoff of rainwater away from the wall face or provide a positive means of controlling run off away from the wall such as temporary pipe, etc.

548-7 Acceptance Program.

548-7.1 General Requirements: Meet the requirements of 120-10 except delete the requirement of 120-10.1.4.1, 120-10.1.4.3, 120-10.2 and 120-10.3.

548-7.2 Maximum Density Determination: Obtain a minimum Quality Control (QC) density of 100% of the maximum density as determined by FM 1 T-180.

Perform gradation tests on the sample collected in accordance with AASHTO T 27 and FM 1-T 011. Classify soils in accordance with AASHTO M–145 in order to determine compliance with embankment utilization requirements.

548-7.3 Density Testing Requirements: Ensure compliance with the requirements of nuclear density testing in accordance with FM 1-T 238. Determine the in-place moisture content for each density test. Use FM 1-T 238, FM 5-507 (Determination of Moisture Content by Means of a Calcium Carbide Gas Pressure Moisture Tester), or FM 5-535 (Laboratory Determination of Moisture Content of Granular Soils by Use of a Microwave Oven) for moisture determination.

Perform these tests at a minimum frequency of one set of tests per LOT. One set of tests is defined as a density test for the fill within 3 ft behind the wall face and another density test for the fill beyond 3 feet behind the wall face.

Determine test locations including stations and offsets, using the random number generator provided by the Engineer. Do not use note pads or work sheets to record data for later transfer to the density log book. Notify the Engineer upon successful completion of QC testing on each LOT.

548-7.4 Acceptance Criteria: Obtain a minimum density of 90% of the maximum dry density as determined by FM 1 T-180within 3 ft behind the wall face and obtain a minimum density of 95% of the maximum dry density as determined by FM 1 T-180 from beyond 3 feet behind the wall face.

548-7.5 Frequency: Conduct sampling and testing at a minimum frequency listed in the table below. The Engineer will perform Verification sampling and tests at a minimum frequency listed in the table below.

Test Name	Quality Control	Verification
Maximum Density	One per soil type	One per soil type
Density	One set of tests per LOT	One set of tests per four LOTs for each type of QC test.
Gradation	One per Maximum Density	One per Maximum Density
LL&PI	One per Maximum Density	One per Maximum Density
Soil Classification	One per Maximum Density	One per Maximum Density
Organic Content	One per soil type	One per soil type

In addition, for permanent walls utilizing metallic soil reinforcement, test for corrosiveness at a minimum frequency of one test per soil type at point of placement according to the electro-chemical table in 548-2.6. The Engineer will collect enough material to split and create two separate samples and retain one for Resolution at point of placement until LOTs represented by the samples are accepted. The Engineer will perform Verification tests for corrosiveness at a minimum frequency of one test per soil type.

548-7.6 Verification Comparison Criteria and Resolution Procedures:

548-7.6.1 Maximum Density Determination: The Engineer will collect enough material to split and create two separate samples and retain one for Resolution until LOTs represented by the samples are accepted.

The Engineer will meet the requirements of 120-10.4.1 except replace "AASHTO T 99, Method C" with "FM 1-T 180, Method D".

548-7.6.2 Density Testing: Meet the requirements of 120-10.4.2.

548-7.6.3 Soil Classification: The Engineer will meet the requirements of 120-10.4.3 except test the sample retained in 548-7.6.1 instead of taking the additional one.

548-7.6.4 Gradation: The Engineer will verify the Quality Control results if the Verification result meets the gradation limits set forth in the gradation table of 548-2.6. Otherwise, the Engineer will test the sample retained in 548-7.6.1. The State Materials Office or an AASHTO accredited laboratory designated by the State Materials Office will perform Resolution testing. The material will be sampled and tested in accordance with AASHTO T 27 and FM 1-T 011.

If the Resolution Test result satisfies the required gradation limits, the LOTS will be verified. If the Resolution Test results do not meet the required gradation limits, reconstruct the LOTS with acceptable material. The Engineer will perform new verification testing.

548-7.6.5 LL&PI: The Engineer will verify the Quality Control results if the Verification result satisfies the plasticity index and liquid limit criteria set forth in 548-2.6. Otherwise, the Engineer will test the sample retained in 548-7.6.1. The State Materials Office or an AASHTO accredited laboratory designated by the State Materials Office will perform Resolution testing. The material will be sampled and tested in accordance with AASHTO T 90 and AASHTO T 89 respectively.

If the Resolution Test result satisfies the required criteria, LOTS of that soil type will be verified. If the Resolution Test results do not meet the required criteria, reconstruct the corresponding LOTS with acceptable material. The Engineer will perform new verification testing.

548-7.6.6 Corrosiveness: The Engineer will verify the Quality Control results if the Verification result satisfies the electro-chemical test criteria set forth in 548-2.6. Otherwise, the Engineer will test the sample retained in 548-7.5. The State Materials Office or an AASHTO accredited laboratory designated by the State Materials Office will perform Resolution testing. The material will be sampled and tested in accordance with FM 5-551, FM 5-552 and FM 5-553.

If the Resolution Test result satisfies the required criteria, material of that soil type will be verified and accepted. If the Resolution Test results do not

meet the required criteria, reject the material and reconstruct with acceptable material.

548-7.6.7 Organic Content: The Engineer will verify the Quality Control results if the Verification result satisfies the organic content test criteria set forth in 548-2.6. Otherwise, the Engineer will collect three additional samples. The material will be sampled and tested in accordance with FM 1-T 267 and by averaging the test results for three randomly selected samples from at least one lift per soil type. The State Materials Office or an AASHTO accredited laboratory designated by the State Materials Office will perform Resolution testing.

If the Resolution Test result satisfies the required criteria, material of that soil type will be verified and accepted. If the Resolution Test results do not meet the required criteria, reject the material and reconstruct with acceptable material.

548-8 Certification.

Furnish a copy of all test reports which are necessary to document compliance with the Specifications, at least ten days prior to wall construction.

Also furnish the Engineer a Certificate of Compliance certifying that the retaining wall materials, backfill and construction practices comply with this Specification.

Acceptance of furnished material will be based on the Certificate of Compliance, accompanying test reports, and visual inspection by the Engineer.

548-9 Method of Measurement.

The quantity to be paid for will be the plan quantity, in square feet, completed and accepted, of the area bounded by the top of the coping, the top of the leveling pad, top of structural footings, bottom of walls which do not have footings or leveling pads, and the beginning and end wall limits as shown on the wall control drawings.

548-10 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including the design of the wall system, excavation required specifically for wall construction below the normal roadway template, soil reinforcement, leveling pad, footings, copings, fabric material, horizontal joint materials, alignment pins, repairs, labor, equipment, and other materials necessary to complete the wall in an acceptable manner as shown on the Contract drawings. The cost of granular fill for the normal roadway template will be included in the cost of embankment or borrow excavation, as applicable.

Payment will be made under:

Item No. 548-12-	Retaining Wall System (Permanent) - per square foot.
Item No. 548-13-	Retaining Wall System (Temporary) - per square foot.

SECTION 550
FENCING

550-1 Description.

Furnish, erect and reset metal fence of the type and at the locations shown in the plans.

550-2 Types of Fence.

The types of fence are designated as follows:

Type A (Farm Fence).

Type B (Chain-Link Fence).

Type R (Chain-Link Fence for Pedestrian Overpass).

550-3 Materials.

550-3.1 Type A Fence (Farm Fence): Meet the requirements of Section 954 for timber posts and braces. For metal posts and braces, meet the requirements of the Design Standards. For recycled plastic fence posts, meet the requirements of Section 972.

For the fabric and all other accessories, meet the requirements of the Design Standards.

550-3.2 Type B Fence (Chain-Link): For the posts, braces, fabric and all accessories other than the concrete for bases, meet the requirements of the Design Standards.

Use concrete as specified in Section 347, or a premix approved by the Engineer for bases. The requirements contained in 347-2.2, and 347-3 will not apply.

550-3.3 Type R Fence (Chain-Link for Pedestrian Overpass): Use the fabric and accessories specified in the plans.

550-3.4 Resetting Fence: Use material from the existing fence. For any additional materials required, provide the same type of material as in the existing fence and as specified herein, including gates when applicable.

550-3.5 Optional Use of Materials: For Type A Fence, a combination of steel, aluminum, timber, recycled plastic or concrete posts may be used. Unless otherwise called for in the plans, line posts of one material may be used with corner, pull and end post assemblies of a different material. The Engineer will permit the use of line posts of only one optional material and pull posts assemblies of only one optional material between corner and end post assemblies. Within individual corner and end post assemblies, the Engineer will allow the use of only one optional material.

For Type B Fence, a combination of zinc-coated steel fence members, aluminum coated fence members and aluminum alloy fence members may be used. Unless otherwise indicated on the plans, the Engineer will allow the use of only one type of fabric material, one type of line post material and one type of pull assembly material between corner and end post assemblies.

550-3.6 Certification: Provide the Engineer certified test reports from the manufacturer confirming that all materials (posts, braces, fabric and all other accessories) conform to the requirements of this Section, Section 6 and the

Design Standards. Provide the Engineer a copy of the certification at least ten days prior to fence construction.

Also furnish the Engineer a Certificate of Compliance certifying that the fencing system, materials and construction practices comply with the applicable Design Standards and Specifications.

Acceptance of furnished material will be based on the Certificate of Compliance, accompanying test reports and visual inspection by the Engineer.

550-4 Construction Methods.

550-4.1 General: Install the fence in accordance with the specific requirements of this Article and with the details shown on the Design Standards for the particular type of fence called for, except for Type R Fence which shall be detailed in the plans. Construct the fence in close proximity to the right of way line except as otherwise detailed in the plans. Assume responsibility for obtaining satisfactory permits or permission from property owners for any encroachments required to perform the work, and for proper scheduling of the fence installation with the removal of existing fence where it is necessary to provide continuous security to adjacent areas already fenced. In order to meet this requirement, where necessary for maintaining security of livestock on adjacent property during construction of the new fence, the Engineer may require the erection and subsequent removal of temporary fencing.

550-4.2 Spacing of Posts: Space posts as shown in the Design Standards, within a tolerance of 12 inches, except where definite spotting of corner posts is required. Ensure that, in any line of fence, the over-spacings and the under-spacings shall approximately compensate. Set additional line posts at abrupt changes in grade.

550-4.3 Clearing: Where the clearing and grubbing for the project includes the area occupied by the fence, clear the area to the limits shown in the plans. If the limits are not shown in the plans, clear the area at least 2 feet wide on each side of the fence line. The Engineer may direct that desirable trees be left in place and may restrict clearing where permission from the property owners cannot be obtained.

550-4.4 Construction Over Irregular Terrain and Other Obstructions:

550-4.4.1 Clearance of Bottom of Fence: Install the fence such that the bottom of the fence, in general, follows the contour of the ground. The fence is detailed in the plans at approximately 3 inches above ground line. Over irregular ground, however, the Engineer will permit a minimum clearance of 1 inch and a maximum of 6 inches for a length not to exceed 8 feet, and, for Type A fence, with the barbed wire spaced midway between ground and bottom of fabric.

550-4.4.2 Grading: Where necessary to secure proper vertical alignment and to meet the clearance requirements, fill depressions (except where filling would obstruct proper drainage) and cut down knolls and ridges. Provide a substantial and permanent foundation for the fence.

550-4.4.3 Use of Extra-Length Posts. At locations where it is impracticable to adjust the ground level, the Engineer may require that posts of additional length be set and that the opening at the bottom be closed by additional barbed wire, stretched taut between poles, with no vertical distance between

wires greater than 3 inches. For all such posts requiring a concrete base, extend the concrete downward to the bottom of the extra-length post.

550-4.5 Setting Posts: If rock occurs within the required depth of the post hole, or pavement which is to remain in place exists at the location of a post, drill a hole of a diameter slightly larger than the greatest dimension of the post or footing and grout in the post or footing. Set timber posts either by digging or by driving. Set recycled plastic fence posts in accordance with the Design Standards.

550-4.6 Placing Fabric: Do not place fabric and barbed wire until the posts have been permanently positioned and concrete foundations have attained adequate strength. Place the fabric by securing one end and applying sufficient tension to remove all slack before making permanent attachments at intermediate points. Fasten the fabric to all end, corner and pull posts by approved means. Fasten the fabric using tools designed for the purpose, in accordance with the manufacturer's recommendations. Apply the tension for stretching by mechanical fence stretchers or with single-wire stretchers designed for the purpose.

550-4.7 Electrical Grounds: Wherever a power line passes over the fence, install a ground directly below the point of crossing. Install a ground rod consisting of a galvanized rod with connection of similar metal if required, or of other appropriate material, 8 feet in length and at least 5/8 inch in diameter. Drive the rod vertically until the top of the rod is approximately 6 inches below the ground surface. Use a No. 6 conductor to connect the rod and all fence elements. Connect the conductor to each fence element and the ground rod by means of non-corrosive electrical-type clamps.

550-5 Method of Measurement.

550-5.1 General: The quantities to be paid for will be plan quantity for the number of gates and the length of each type of fence constructed and accepted. In addition, extra payment will be made, in accordance with 550-6.2, for additional lengths of post approved by the Engineer for the crossing of depressions in accordance with 550-4.4.3, muck areas, or other areas of inadequate support for a post of standard length.

550-5.2 Measurement of Fence Length, and Payment: The length of fence to be paid for will be plan quantity completed and accepted. Measurement for Resetting Fence will be the actual length of existing fence reset, including gates when applicable.

550-6 Basis of Payment.

550-6.1 Basic Items of Fencing: The Contract unit price per foot for the Item of Fencing, will be full compensation for all work and materials necessary for the complete installation, including line posts, corner, end, and pull posts. Such price and payment will include, but not be limited to, the following specific incidental work.

(a) Any work required to level and prepare the terrain along the line of the fence.

(b) Any additional clearing incidental to construction of the fence.

(c) All preparation for post holes, in whatever type of material, as specified herein.

(d) Any furnishing and installing of electrical grounds.

(e) Any additional work or materials required for special construction over irregular terrain, or terrain of inadequate support for the posts, including the additional barbed wire, but not including the extra lengths of posts ordered by the Engineer.

(f) Any cost of erection and removal of any temporary fencing, which may be necessary for maintaining security of livestock, etc., on adjacent property during construction of the new fence.

550-6.2 Payment Rates for Extra-Length Posts: Any extra length posts added to complete installation of the fence will require an invoice. The Contractor will be compensated for invoice price plus 10% as payment for any extra length posts.

The standard length of steel, recycled plastic and aluminum posts will be the required length as indicated in the plans or Design Standards for each type and case.

The payment for additional length of post will include the cost of additional concrete to extend concrete bases, as applicable.

550-6.3 Gate Payment: The quantities to be paid for will be full compensation for all labor, materials, posts and associated hardware for the complete installation of the type gate specified in the plans, and accepted by the Engineer.

550-6.4 Payment Items: Payment shall be made under:

Item No. 550- 10-	Fencing - per foot.
Item No. 550- 60-	Gates - each.

SECTION 555
DIRECTIONAL BORE

555-1 Description.

555-1.1 Scope of Work: The work specified in this Section documents the approved construction methods, procedures and materials for Directional Boring, also commonly called Horizontal Directional Drilling (HDD).

555-1.2 General: HDD is a trenchless method for installing a product that serves as a conduit for liquids, gasses, or as a duct for pipe, cable, or wire line products. It is a multi-stage process consisting of site preparation and restoration, equipment setup, and drilling a pilot bore along a predetermined path and then pulling the product back through the drilled space. When necessary, enlargement of the pilot bore hole may be necessary to accommodate a product larger than the pilot bore hole size. This process is referred to as back reaming and is done at the same time the product is being pulled back through the pilot bore hole.

Accomplish alignment of the bore by proper orientation of the drill bit head as it is being pushed into the ground by a hydraulic jack. Determine orientation and tracking of the drill bit by an above ground radio detection device which picks up a radio signal generated from a transmitter located within the drill bit head. Then electronically translate the radio signal into depth and alignment.

In order to minimize friction and prevent collapse of the bore hole, introduce a soil stabilizing agent (drilling fluid) into the annular bore space from the trailing end of the drill bit. The rotation of the bit in the soil wetted by the drilling fluid creates a slurry. The slurry acts to stabilize the surrounding soil and prevent collapse of the bore hole as well as provides lubrication.

Select or design drilling fluids for the site specific soil and ground water conditions. Confine free flowing (escaping) slurry or drilling fluids at the ground surface during pull back or drilling. Accomplish this by creating sump areas or vacuum operations to prevent damage or hazardous conditions in surrounding areas. Remove all residual slurry from the surface and restore the site to preconstruction conditions.

555-2 Materials.

555-2.1 General: Materials are defined as pipe or conduit that becomes the installed product. Incidental materials that may or may not be used to install the product depending on field requirements are not paid for separately and will be included in the cost of the installed product.

555-2.2 Material Type: The following material standards are to be interpreted as the minimum in place standards. Use materials that are appropriate for the stresses generated by the selected equipment and field conditions. It is not intended to portray that the use of materials with these minimum material standards will retain their required properties if the stress limits are exceeded for which they were designed during installation. Ensure that the appropriate material is used to retain compliance once it is installed.

Material Standards for HDD Installation		
Material Type	Non-Pressure	Pressure
Polyethylene (PE)	ASTM D 2447	ASTM 2513 ASTM D 2447
High Density Polyethylene (HDPE)	ASTM D 2447 ASTM D 3350 ASTM F714	ASTM D 2447 ASTM D 3350 ASTM F714 ASTM 2513
Polyvinyl-Chloride (PVC)	ASTM F 789	N/A
Steel	ASTM A139 Grade B (1)	AWWA C200 API 2B(2)
(1) No hydrostatic test required (2)Dimensional tolerances only		

555-3 Construction Site Requirements.

555-3.1 The Americans with Disabilities Act: When and where installations temporarily disrupt pedestrian use of sidewalk areas for periods exceeding two consecutive work days, provide an alternate route that meets ADA requirements.

555-3.2 Site Conditions:

(a) Carry out excavation for entry, exit, recovery pits, slurry sump pits, or any other excavation as specified in Section 120. Sump pits are required to

contain drilling fluids if vacuum devices are not operated throughout the drilling operation, unless approved by the Engineer.

(b) Within 48 hours of completing installation of the boring product, clean the work site of all excess slurry or spoils. Take responsibility for the removal and final disposition of excess slurry or spoils. Ensure that the work site is restored to pre-construction conditions or as identified on the plans.

(c) Provide MOT in accordance with the Department Design Standards and the MUTCD when and where the former is silent.

(d) Exposure of product shall be limited to 3 feet and 14 consecutive days unless approved by the Engineer.

555-3.3 Damage Restoration: Take responsibility for restoration for any damage caused by heaving, settlement, separation of pavement, escaping drilling fluid (frac-out), or the directional drilling operation, at no cost to the Department.

555-3.3.1 Remediation Plans: When required by the Engineer, provide detailed plans which show how damage to any roadway facility will be remedied. These details will become part of the As-Built Plans Package. Remediation Plans must follow the same guidelines for development and presentation of the As-Built Plans. When remediation plans are required, they must be approved by the Engineer before any work proceeds.

555-4 Quality Control.

555-4.1 General: Take control of the operation at all times. Have a representative who is thoroughly knowledgeable of the equipment, boring and Department procedures, present at the job site during the entire installation and available to address immediate concerns and emergency operations. Notify the Engineer 48 hours in advance of starting work. Do not begin installation until the Engineer is present at the job site and agrees that proper preparations have been made.

555-4.1.1 Product Testing: When there is any indication that the installed product has sustained damage and may leak, stop all work, notify the Engineer and investigate damage. The Engineer may require a pressure test and reserves the right to be present during the test. Perform pressure test within 24 hours unless otherwise approved by the Engineer. Furnish a copy of test results to the Engineer for review and approval. The Engineer is allowed up to 72 hours to approve or determine if the product installation is not in compliance with the specifications. The Engineer may require non-compliant installations to be filled with excavatable flowable fill.

555-4.1.2 Testing Methods: Testing may consist of one of the following methods and must always meet or exceed the Department's testing requirements:

(a) Follow the product manufacturer's pressure testing recommendations.

(b) Ensure that product carrier pipes installed without a casing meet the pressure requirements set by the owner. If the owner does not require pressure testing, the Engineer may require at least one test.

(c) A water tight pipe and joint configuration where the product is installed beneath any pavement (including sidewalk) and front shoulders is required. The Engineer will determine when and where water tight joint

requirements will be applied to the ultimate roadway section for future widening. When a product is located elsewhere, the pipe and joint configuration must meet or exceed soil tight joint requirements. Conduct tests for joint integrity for one hour. The test for a soil tight joint allows up to 0.1 gallon of water leakage at a sustained pressure of 2 PSI. The water tight joint criteria allows no leakage at all for a sustained pressure of 5 PSI.

555-4.1.3 Failed Bore Path: If conditions warrant removal of any materials installed in a failed bore path, as determined by the Engineer, it will be at no cost to the Department. Promptly fill all voids by injecting all taken out of service products that have any annular space with excavatable flowable fill.

555-4.2 Product Locating and Tracking: The method of locating and tracking the drill head during the pilot bore will be shown in the plans. The Department recognizes walkover, wire line, and wire line with surface grid verification, or any other system as approved by the Engineer, as the accepted methods of tracking directional bores. Use a locating and tracking system capable of ensuring that the proposed installation is installed as intended. If an area of radio signal interference is expected to exceed 5 feet, the Engineer may specify the use of a suitable tracking system. The locating and tracking system must provide information on:

(a) Clock and pitch information

(b) Depth

(c) Transmitter temperature

(d) Battery status

(e) Position (x,y)

(f) Azimuth, where direct overhead readings (walkover) are not possible (i.e. subaqueous or limited access transportation facility)

(g) Ensure proper calibration of all equipment before commencing directional drilling operation.

(h) Take and record alignment readings or plot points such that elevations on top of and offset dimensions from the center of the product to a permanent fixed feature are provided. Such permanent fixed feature must have prior approval of the Engineer. Provide elevations and dimensions at all bore alignment corrections (vertical and horizontal) with a minimum distance between points of 100 feet. Provide a sufficient number of elevations and offset distances to accurately plot the vertical and horizontal alignment of the installed product. A minimum of three elevation and plot points are required.

Install all facilities such that their location can be readily determined by electronic designation after installation. For non-conductive installations, attach a minimum of two separate and continuous conductive tracking (tone wire) materials, either externally, internally or integral with the product. Use either a continuous green sheathed solid conductor copper wire line (minimum #12 AWG for external placement or minimum #14 AWG for internal placement in the conduit/casing) or a coated conductive tape. Conductors must be located on opposite sides when installed externally. Connect any break in the conductor line before construction with an electrical clamp, or solder, and coat the connection with a rubber or plastic insulator to maintain the integrity of the connection from corrosion. Clamp connections must be made of brass or copper and of the butt

end type with wires secured by compression. Soldered connections must be made by tight spiral winding of each wire around the other with a finished length minimum of 3 inches overlap. Tracking conductors must extend 2 feet beyond bore termini. Test conductors for continuity. Each conductor that passes must be identified as such by removing the last 6 inches of the sheath. No deductions are allowed for failed tracking conductors. Failed conductor ends must be wound into a small coil and left attached for future use.

555-4.3 Product Bore Hole Diameter: Minimize potential damage from soil displacement/settlement by limiting the ratio of the bore hole to the product size. The size of the back reamer bit or pilot bit, if no back reaming is required, will be limited relative to the product diameter to be installed as follows:

Maximum Pilot or Back-Reamer Bit Diameter When Rotated 360 Degrees	
Nominal Inside Pipe Diameter Inches	Bit Diameter Inches
2	4
3	6
4	8
6	10
8	12
10	14
12 and greater	Maximum Product OD plus 6

555-4.4 Drilling Fluids: Use a mixture of bentonite clay or other approved stabilizing agent mixed with potable water with a minimum pH of 6.0 to create the drilling fluid for lubrication and soil stabilization. Vary the fluid viscosity to best fit the soil conditions encountered. Do not use any other chemicals or polymer surfactants in the drilling fluid without written consent from the Engineer. Certify to the Engineer in writing that any chemicals to be added are environmentally safe and not harmful or corrosive to the facility. Identify the source of water for mixing the drilling fluid. Approvals and permits are required for obtaining water from such sources as streams, rivers, ponds or fire hydrants. Any water source used other than a potable water may require a pH test.

555-4.5 Equipment Requirements: Ensure that appropriate equipment is provided to facilitate the installation as follows:

HDD Equipment				
System Description	Pipe [1] Diameter Inches	Bore Length Feet	Torque Ft-Lbs	Trust/Pullback Lbs
Maxi-HDD	18 and greater	>1,000	>10,000	>70,000
Midi-HDD	Up to 16	Up to 1,000	1,900 to 9,999	20,001 to 69,999
Mini-HDD	Up to 6	Up to 600	Up to 1,899	Up to 20,000
(1) For the above, multiple pipe or conduit installations must not exceed the total outside pipe diameters stated above.				

Match equipment to the size of pipe being installed. Obtain the Engineer's approval for installations differing from the above chart. Ensure that the drill rod can meet the bend radius required for the proposed installation.

555-4.6 Thrust/Pullback Requirements: Unless approved by the Engineer, limit use of HDD equipment to installing the following product sizes and lengths based on the following product size, force and length relationships.

HDD Bore Equipment Thrust/Pullback Capacity						
Lbs	5,000 to 7,000	7,001 to 12,000	12,001 to 16,000	16,001 to 25,000	25,001 to 40,000	>40,000
Product Size [(1)] Inches	Maximum Pullback Distance In Feet					
4 or <	400 or <					
6 or <		600 or <				
8 or <			800 or <			
10 or <				1,000 or <		
12 [300] or <					2,000 or <	
> 12 [300]						Engineer's Discretion
(1) for the above, where a single pull of multiple conduits is to be attempted, the applicable product size must be determined by the diameter of a circle that will circumscribe the individual conduits as a group.						

555-5 Drilling Operations:

555-5.1 Installation Process: Ensure adequate removal of soil cuttings and stability of the bore hole by monitoring the drilling fluids such as the pumping rate, pressures, viscosity and density during the pilot bore, back reaming and pipe installation. Relief holes can be used as necessary to relieve excess pressure down hole. Obtain the Engineer's approval of the location and all conditions necessary to construct relief holes to ensure the proper disposition of drilling fluids is maintained and unnecessary inconvenience is minimized to other facility users.

To minimize heaving during pull back, the pull back rate is determined in order to maximize the removal of soil cuttings without building excess down hole pressure. Contain excess drilling fluids at entry and exit points until they are recycled or removed from the site or vacuumed during drilling operations. Ensure that entry and exit pits are of sufficient size to contain the expected return of drilling fluids and soil cuttings.

Ensure that all drilling fluids are disposed of or recycled in a manner acceptable to the appropriate local, state, or federal regulatory agencies. When drilling in suspected contaminated ground, test the drilling fluid for contamination and appropriately dispose of it. Remove any excess material upon completion of the bore. If in the drilling process it becomes evident that the soil is contaminated, contact the Engineer immediately. Do not continue drilling without the Engineer's approval.

The timing of all boring processes is critical. Install a product into a bore hole within the same day that the pre-bore is completed to ensure necessary support exists.

555-5.2 Boring Failure: If an obstruction is encountered during boring which prevents completion of the installation in accordance with the design location and specification, the pipe may be taken out of service and left in place at the discretion of the Engineer. Immediately fill the product left in place with excavatable flowable fill. Submit a new installation procedure and revised plans to the Engineer for approval before resuming work at another location. If, during construction, damage is observed to the FDOT facility, cease all work until resolution to minimize further damage and a plan of action for restoration is obtained and approved by the Engineer.

555-6 Documentation Requirements.

555-6.1 Boring Path Report: Furnish a Bore Path Report to the Engineer within seven days of the completion of each bore path. Include the following in the report:

(a) Location of project and financial project number including the Permit Number when assigned

(b) Name of person collecting data, including title, position and company name

(c) Investigation site location (Contract plans station number or reference to a permanent structure within the project right-of-way)

(d) Identification of the detection method used

(e) Elevations and offset dimensions as required in 555-4.2

555-6.2 As-Built Plans: Provide the Engineer a complete set of As-Built Plans showing all bores (successful and failed) within 30 calendar days of completing the work. Ensure that the plans are dimensionally correct copies of the Contract plans and include roadway plan and profile, cross-section, boring location and subsurface conditions as directed by the Engineer. The plans must show appropriate elevations and be referenced to a Department Bench Mark when associated with a Department project, otherwise to a USGS grid system and datum, or a specific location on top of an existing Department head wall. Plans must be same scale in black ink on white paper, of the same size and weight as the Contract plans. Submittal of electronic plans data in lieu of hard copy plans is preferred and may be approved by the Engineer if compatible with the Department software. Specific plans content requirements include but may not be limited to the following:

(a) The Contract plan view shows the center line location of each facility installed, or installed and placed out of service, to an accuracy of 1 inch at the ends and other points physically observed in accordance with the bore path report.

(b) As directed by the Engineer, provide either a profile plan for each bore path, or a cross-section of the roadway at a station specified by the Engineer, or a roadway centerline profile. Show the ground or pavement surface and crown elevation of each facility installed, or installed and placed out of service, to an accuracy within 1 inch at the ends and other exposed locations. On

profile plans for bore paths crossing the roadway show stationing of the crossing on the Contract plans. On the profile plans for the bore paths paralleling the roadway, show the Contract plans stationing. If the profile plan for the bore path is not made on a copy of one of the Contract profile or cross-section sheets, use a 10 to 1 vertical exaggeration.

(c) If, during boring, an obstruction is encountered which prevents completion of the installation in accordance with the design location and specification, and the product is left in place and taken out of service, show the failed bore path along with the final bore path on the plans. Note the failed bore path as "Failed Bore Path - Taken Out of Service". Also show the name of the Utility owner, location and length of the drill head and any drill stems not removed from the bore path.

(d) Show the top elevation, diameter and material type of all utilities encountered and physically observed during the subsoil investigation. For all other obstructions encountered during a subsoil investigation or the installation, show the type of material, horizontal and vertical location, top and lowest elevation observed, and note if the obstruction continues below the lowest point observed.

(e) Include bore notes on each plan stating the final bore path diameter, product diameter, drilling fluid composition, composition of any other materials used to fill the annular void between the bore path and the product, or facility placed out of service. Note if the product is a casing as well as the size and type of carrier pipe placed within the casing as part of the Contract work.

555-7 Method of Measurement.

The method of measurement will be based on the length of product measured in place along the surface of the ground, complete and accepted. No additions or deductions will be made for sweeps in either the vertical or horizontal direction to complete the installation.

555-8 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including furnishing and installing pipe or conduit, from plan point of beginning to plan point of ending at plan depth, removal of excavated materials and spoils, removal and disposal of drilling fluids, backfilling, and complete restoration of the site. Bundled product in a single bore will be paid for as a single bore based on the required drill bit head or back reamer head size. Separate payment shall not be made for individual products in a bundle.

The installation and attachment of tracking conductors (wire or tape) will be included in the cost of the bore and will not be paid for separately.

No payment will be made for failed bore paths, injection of flowable fill, products taken out of service or incomplete installations.

No payment will be made for directional boring until a Bore Path Report has been delivered to the Engineer. After the Engineer's acceptance of the Bore Path Report, payment will be made in the amount of 70% of the unit price bid, for Directional Boring. The remaining 30% of the unit price bid will be made after submittal of As-Built Plans, in accordance with 555-6.2.

Payment will be made under:

Item No. 555-	1-	Directional Bore - per foot of bore diameter.

SECTION 556
JACK AND BORE

556-1 Description.

556-1.1 Scope of Work: The work specified in this Section documents the approved construction methods, procedures and materials for Jack and Bore (J&B), also known as auger boring. Micro tunneling (MT) is also included in the category of J&B for purposes of specifications.

556-1.2 General: J&B is a method for installing a product (often called a casing) that may serve as a direct conduit for liquids or gases, or as a duct for carrier (Pipe, cable, or wire line products). It is a multi-stage process consisting of constructing a temporary horizontal jacking platform and a starting alignment track in an entrance pit at a desired elevation. The product is then jacked by manual control along the starting alignment track with simultaneous excavation of the soil being accomplished by a rotating cutting head in the leading edge of the product's annular space. The ground up soil (spoil) is transported back to the entrance pit by helical wound auger flights rotating inside the product. J&B typically provides limited tracking and steering as well as limited support to the excavation face.

Micro tunneling is conducted similar to J&B with the exception that it is remotely controlled, guided pipe jacking process that provides continuous support to the excavation face. The guidance system usually consists of a laser mounted in the tunneling drive shaft which communicates a reference line to a target mounted inside the MT machine's articulated steering head. The MT process provides the ability to control the excavation face stability by applying mechanical or fluid pressure to counterbalance the earth and hydrostatic pressures.

Removal and disposition of excess material varies, is the responsibility of the boring contractor and is not covered under this Specification. However, the cost of removal or final disposition is included in the cost of the J&B operation.

No J&B conduit may be left open ended without approval of the Engineer to prevent the conduit from acting as a drainage structure.

556-2 Materials.

Select materials approved for installation within the right-of-way based on their suitability for the construction method as defined in Table 556-2.1. After determining product suitability, individual material standards as contained in Table 556-2.2 apply.

Table 556-2.1
Product Suitability by Construction Method

Table 556-2.1 Product Suitability by Construction Method		
Type	Pipe/Casing Installation Mode	Suitable Pipe/Casing
Jack and Bore	Jacking	Steel, Plastic
Micro tunneling	Jacking	DI, FRPM, PC, PCCP, RCCP, RCP, Steel

Table 556-2.2 Material Standards Acceptable for J&B and MT Installations		
Material Type	Non-Pressure	Pressure
Ductile Iron (DI)	AWWA C150/C151 ASTM A-716, A-747	AWWA C150/C151
Fiberglass Reinforced Polymer Mortar (FRPM)	ASTM D-3262	ASTM D-3517 AWWA C950
Polymer Concrete (PC)	DIN 54815-1 & 2	N/A
Prestressed Concrete Cylinder Pipe (PCCP)	N/A	AWWA C300
Reinforced Concrete Cylinder Pipe (RCCP)	N/A	ASTM C-361
Reinforced Concrete Pipe (RCP)	ASTM C-76	ASTM C-361 AWWA C300/C302
Steel	ASTM A-139 Grade B(1) API 2B(2)	AWWA C200 API 2B(2)
Polyvinyl Chloride (PVC)	ASTM D-1785	N/A
Polyethylene (PE)	ASTM D-2447 ASTM D-2513 FOR GAS > 3 Inches	N/A
Polybutylene (PB)	ASTM D-2662	N/A
Cellulose Acetate Butyrate (CAB)	ASTM D-1503	N/A
Acrylonitrile Butadiene Styrene (ABS)	ASTM D-1527	N/A
Reinforced Thermosetting Resin Pipe (RTRP)	ASTM D-2296 OR ASTM D-2997	N/A
(1) No hydrostatic test required (2) Dimensional tolerances only		

Unless otherwise tested and approved by the Department, only use encasement pipe or uncased carrier pipe material that is new and has smooth interior and exterior walls.

556-2.1 Steel Pipe Casing and Welds: In addition to meeting or exceeding the conditions contained in Tables 556-2.1 and Table 556-2.2, meet the following requirements:

(a) The size of the steel casing must be at least 6 inches larger than the largest outside diameter of the carrier.

(b) The casing pipe must be straight seam pipe or seamless pipe.

(c) All steel pipe may be bare inside and out, with the manufacturer's recommended minimum nominal wall thicknesses to meet the greater of either installation, loading or carrier requirements.

(d) All steel casing pipe must be square cut and have dead-even lengths which are compatible with the J&B equipment.

Use steel pipe casings and welds meeting or exceeding the thickness requirements to achieve the service life requirements noted in the Department Drainage Manual Chapter 6. For purposes of determining service life, ensure that casings installed under roadways meet or exceed cross drain requirements and casings under driveways meet or exceed side drain pipe requirements. For purposes of material classification, consider steel pipe casing structural plate steel pipe. Ensure that steel pipe casing of insufficient length achieves the required length through fully welded joints. Ensure that joints are air-tight and continuous over the entire circumference of the pipe with a bead equal to or exceeding the minimum of either that required to meet the thickness criteria of the pipe wall for jacking and loading or service life. A qualified welder must perform all welding.

556-2.2 Reinforced Concrete Pipe Casing: In addition to meeting or exceeding the conditions contained in Tables 556-2.1 and Table 556-2.2, meet the following requirements:

Ensure that concrete pipe complies with the following minimum requirements:

(a) 5,000 psi concrete compressive strength

(b) Class III, IV, or V as required by load calculations, with a C-wall

(c) Full circular inner and/or outer reinforcing cage

(d) Multiple layers of steel reinforcing cages, wire splices, laps and spacers are permanently secured together by welding in place

(e) Straight outside pipe wall with no bell modification

(f) No elliptical reinforcing steel is allowed

(g) Single cage reinforcement with a 1 inch minimum cover from the inside wall

(h) Double cage reinforcement with a 1 inch minimum cover from each wall

(i) Joints are gasket type

(j) Additional joint reinforcement

Upon installation, the Engineer may, at his discretion, require the Contractor to perform concrete wiping or injection of the joints if it is believed the joints have not maintained their water tightness during the jacking operation. No additional payment will be made for this operation.

556-2.3 Plastic Pipe Casing: Plastic pipe may be jacked and bored if its physical properties are sufficient, and it is rigid such that when supported or suspended at mid point it maintains a straight alignment. If plastic pipe is Jacked and Bored it may not be used as a pressurized carrier. Plastic pipe casing installed by the jack and bore method requires the use of an auger. Open end jacking without the use of an auger for continuous cleanout of the bore as the pipe is advanced is not permitted. Closed end jacking is not permitted.

556-2.4 Pipe Couplings and Joints: In addition to meeting or exceeding the conditions contained in Tables 556-2.1 and 556-2.2, to minimize potential for bore failure, couplings must not project at right angles from the casing diameter by more than 3/4 inch.

(a) Steel Pipe Coupling and Joints:

1. Welds must comply with 556-2.1(d) when couplings are not used or when the coupling thickness is less than the casing thickness.

2. When couplings are used the casing joint needs only to be tack welded. Couplings must have a full bead weld such that the thickness, when measured at an angle of 45 degrees to the casing and coupling interface, must be no less than the casing thickness.

(b) Plastic Pipe Couplings and Joints:

1. Must meet or exceed all ASTM strength and composition standards established for the casing material to which they are being attached.

2. Joints must be made sufficiently strong to withstand the pressures of jacking. All chemical welds must be completely set and cured before any jacking is attempted.

556-3 Construction Site Requirements.

556-3.1 The Americans with Disabilities Act: When and where installations temporarily disrupt pedestrian use of sidewalk areas for periods exceeding two consecutive work days, provide an alternate route that meets ADA requirements.

556-3.2 Site Conditions:

(a) Carry out excavation for entry, exit, recovery pits, auger slurry sump pits, or any other excavation as specified in Section 120. Unless approved by the Engineer, sump pits are required to contain auger fluids if vacuum devices are not operated throughout the boring operation.

(b) Within 48 hours of completing installation of the boring product, ensure that the work site is cleaned of all excess auger fluids or spoils. Removal and final disposition of excess fluids or spoils is the responsibility of the boring Contractor and ensure that the work site is restored to pre-construction conditions or as identified on the plans.

(c) Restore excavated areas in accordance with the specifications and Design Standards.

(d) Provide MOT in accordance with the Department Design Standards and the MUTCD when and where the former is silent.

(e) Ensure that equipment does not impede visibility of the roadway user without taking the necessary precautions of proper signing and Maintenance of Traffic Operations.

556-3.3 Ground Water Control: Investigate all sites for possibility of having to manage groundwater problems that may occur due to seasonal changes or natural conditions.

(a) When ground water level must be controlled, use a system and equipment that is compatible with the properties, characteristics, and behavior of the soils as indicated by the soil investigation report.

556-3.4 Damage Restoration: Take responsibility for restoring any damage caused by heaving, settlement, separation of pavement, escaping boring fluid (fracout) of the J&B operation at no cost to the Department.

556-3.4.1 Remediation Plans: When required by the Engineer, provide detailed plans which show how damage to any roadway facility will be remedied. These details will become part of the As-Built Plans Package. Remediation Plans must follow the same guidelines for development and presentation of the As-Built Plans. When remediation plans are required, they must be approved by the Engineer before any work proceeds.

556-4 Quality Control.

556-4.1 General: Take control of the operation at all times. Have a representative who is thoroughly knowledgeable of the equipment, boring, and Department procedures present at the job site during the entire installation and available to address immediate concerns and emergency operations. Notify the Engineer 48 hours in advance of starting work. Do not begin the installation until the Engineer is present at the job site and agrees that proper preparations have been made.

556-4.2 Construction Process and Approval: For all installations, submit sufficient information to establish the proposed strategy for providing the following:

(a) An indication of where the leading edge of the casing is located with respect to line and grade and the intervals for checking line and grade. Indication may be provided by using a water gauge (Dutch level) or electronic transmitting and receiving devices. Other methods must have prior approval. Maintain a record of the progress at the job site.

(b) Equipment of adequate size and capability to install the product and including the equipment manufacturer's information for all power equipment used in the installation.

(c) A means for controlling line and grade.

(d) A means for centering the cutting head inside the borehole.

(e) Provide a means for preventing voids by assuring:

1. The rear of the cutting head from advancing in front of the leading edge of the casing by more than 1/3 times the casing diameter and in stable cohesive conditions not to exceed 8 inches.

2. In unstable conditions, such as granular soil, loose or flowable materials, the cutting head is retracted into the casing a distance that permits a balance between pushing pressure, pipe advancement and soil conditions.

3. Development of and maintaining a log of the volume of spoil material removal relative to the advancement of the casing.

(f) Adequate casing lubrication with a bentonite slurry or other approved technique.

(g) An adequate band around the leading edge of the casing to provide extra strength in loose unstable materials when the cutting head has been retracted into the casing to reduce skin friction as well as provides a method for the slurry lubricant to coat the outside of the casing.

(h) At least 20 feet of full diameter auger at the leading end of the casing. Subsequent auger size may be reduced, but the reduced auger diameter must be at least 75% of the full auger diameter.

(i) Water to be injected inside the casing to facilitate spoil removal. The point of injection shall be no closer than 2 feet from the leading edge of the casing.

556-4.3 Testing:

556-4.3.1 Product Testing: When there is any indication that the installed product has sustained damage and may leak, stop the work, notify the Engineer and investigate damage. The Engineer may require a pressure test and reserves the right to be present during the test. Perform pressure test within 24 hours unless otherwise approved by the Engineer. Furnish a copy of the test results to the Engineer for review and approval. The Engineer shall be allowed up to 72 hours to approve or determine if the product installation is not in compliance with specifications. The Engineer may require non-compliant installations to be filled with excavatable flowable fill.

556-4.3.2 Testing Methods: Testing may consist of one of the following methods but must always meet or exceed Department testing requirements.

(a) Follow the Product Manufacturer's pressure testing recommendations.

(b) Ensure that the product carrier pipes installed without a casing meet the pressure requirements set by the owner. If the owner does not require pressure testing, the Engineer may require at least one test.

1. The Department requires a water tight pipe and joint configuration where the product is installed beneath any pavement (including sidewalk) and front shoulders. The Engineer will determine when and where water tight joint requirements shall be applied to the ultimate roadway section for future widening. When under the pavement conduct an air pressure test for leaks in the presence of the Engineer at a minimum test pressure of 20 PSI by either of the following methods.

i. Standard 24 hour pressure test with a recording chart or,

ii. A dragnet type leak detector or equivalent device capable of detecting pressure drops of 1/2 PSI for a time period recommended by the manufacturer.

2. When a product is not located under the pavement, the pipe and joint configuration must meet or exceed soil tight joint requirements. The test for a soil tight joint allows up to 0.1 gallon of water leakage at a sustained pressure of 2 PSI. The water tight joint criteria allows no leakage at all for a sustained pressures of 5 PSI. Conduct test for joint integrity for one hour.

556-4.4 Product Locating and Tracking: Install all facilities such that their location can be readily determined by electronic designation after installation. For non-conductive installations, attach a minimum of two separate and continuous conductive tracking (tone wire) materials, either externally, internally, or integral with the product. Use either a continuous green sheathed solid conductor copper wire line (minimum #12 AWG for external placement or minimum #14 AWG for internal placement in the conduit/casing) or a coated conductive tape. Ensure that conductors are located on opposite sides when

installed externally. Connect any break in the conductor line before construction with an electrical clamp or solder, and coat the connection with a rubber or plastic insulator to maintain the integrity of the connection from corrosion. Clamp connections must be made of brass or copper and of the butt end type with wires secured by compression. Soldered connections must be made by tight spiral winding of each wire around the other with a finished length minimum of 3 inches overlap. Tracking conductors must extend 2 feet beyond bore termini. Conductors must be tested for continuity. Identify each conductor that passes by removing the last 6 inches of the sheath. No deductions are allowed for failed tracking conductors. Failed conductor ends must be wound into a small coil and left attached for future use.

556-4.5 Augering Fluids: Use a mixture of bentonite clay or other approved stabilizing agent mixed with potable water with a minimum pH of 6.0 to create the drilling fluid for lubrication and soil stabilization. Vary the fluid viscosity to best fit the soil conditions encountered. Do not use other chemicals or polymer surfactant in the drilling fluid without written consent of the Engineer. Certify in writing to the Engineer that any chemicals to be added are environmentally safe and not harmful or corrosive to the facility. Identify the source of water for mixing the drilling fluid. Approvals and permits are required for obtaining water from such sources as streams, rivers, ponds or fire hydrants. Any water source used other than potable water may require a pH Test.

556-4.6 Micro-Tunneling (MT) and Micro Tunnel Boring Machine (MTBM) Requirements:

556-4.6.1 Performance Requirements: The MTBM must meet the following minimum performance requirements:

(a) Capable of providing positive face support regardless of the MTBM type.

(b) Articulated to enable controlled steering in both the vertical and horizontal direction to a tolerance of plus or minus 1 inch from design alignment.

(c) All functions are controlled remotely from a surface control unit.

(d) Capable of controlling rotation, using a bi-directional drive on the cutter head or by using anti-roll fins or grippers. The Engineer must approve other methods.

(e) Capable of injecting lubricant around the exterior of the pipe being jacked.

(f) Indication of steering direction.

For slurry systems, the following is also required:

(g) The volume of slurry flow in both the supply and return side of the slurry loop.

(h) Indication of slurry bypass valve position.

(i) Indication of pressure of the slurry in the slurry chamber.

556-4.7 Failed Bore Path: If conditions warrant removal of any materials installed in a failed bore path, as determined by the Engineer, it will be at no cost to the Department. Promptly fill all voids by injecting all taken out of service products that have any annular space with excavatable flowable fill.

556-5 Jack and Bore and Micro-Tunneling Operations:

556-5.1 Installation Process: Provide continuous pressure to the face of the excavation to balance groundwater and earth pressures. Ensure that shafts are of sufficient size to accommodate equipment, the pipe selected and to allow for safe working practices. Provide entry and exit seals at shaft walls to prevent inflows of groundwater, soil, slurry and lubricants. Use thrust blocks designed to distribute loads in a uniform manner so that any deflection of the thrust block is uniform and does not impart excessive loads on the shaft itself or cause the jacking frame to become misaligned.

The jacking system must have the capability of pushing the pipe in J&B operations or MTBM and pipe for MT operations through the ground in a controlled manner and be compatible with the anticipated jacking loads and pipe capacity. Monitor the jacking force applied to the pipe and do not exceed the pipe manufacturer's recommendations.

Ensure that the pipe lubrication system is functional at all times and sufficient to reduce jacking loads. Use pipe lubrication systems that include a mixing tank, holding tank and pumps to convey lubricant from the holding tank to application points at the rear of the MTBM. Maintain sufficient fluids on site to avoid loss of lubrication.

Power Distribution System must be identified in the plans package or permit provisions as well as any noise constraints. Identity spoil removal capability and method to avoid creating hindrance to other activities which may be necessary in the area.

556-5.2 Excess Material and Fluids: Monitor the pumping rate, pressures, viscosity and density of the boring fluids to ensure adequate removal of soil cuttings and the stability of the borehole. Contain excess drilling fluids, slurry and soil cuttings at entry and exit points in pits until they are recycled or removed from the site.

Ensure that all boring fluids are disposed of or recycled in a manner acceptable to the appropriate local, state or federal regulatory agencies. When jacking and boring in suspected contaminated ground, test the boring fluid for contamination and dispose of appropriately. Remove any excess material upon completion of the bore. If it becomes evident that the soil is contaminated, contact the Engineer immediately. Do not continue boring without the Engineer's approval.

556-5.3 Boring Failure: If an obstruction is encountered which prevents completion of the installation in accordance with the design location and specifications; the pipe may be taken out of service and left in place at the discretion of the Engineer. Immediately fill the product left in place with excavatable flowable fill. Submit a new installation procedure and revised plans to the Engineer for approval before resuming work at another location. If damage is observed to any property, cease all work until a plan of action to minimize further damage and restore damaged property is submitted and approved by the Engineer.

556-6 Documentation Requirements.

556-6.1 Boring Path Report: Furnish a Bore Path Report to the Engineer within 14 days of the completion of each bore path. Submit the As-Built-Plans to the Engineer within 30 calendar days. No payment will be made for directional boring work until the Bore Path Report has been delivered to the Department. Include the following information in the report:

(a) Location of project and financial project number including the Permit Number when assigned.

(b) Name of person collecting data, including title, position and company name.

(c) Investigation site location (Contract plans station number or reference to a permanent structure within the project right-of-way).

(d) Identification of the detection method used.

(e) Spoils removal log.

(f) As-built placement plans showing roadway plan and profile, cross-section, boring location and subsurface conditions as defined in Bore Path Plans below. Reference the shown plan elevations to a Department Bench Mark when associated with a Department project, otherwise to a USGS grid system and datum or to the top of an existing Department head wall. These plans must be the same scale in black ink on white paper, of the same size and weight and as the Contract plans. Submittal of electronic plans data in lieu of hard copy plans may be approved by the Engineer if compatible with the Department software.

556-6.2 As-Built Plans: Provide the Engineer with a complete set of As-Built-Plans showing all bores (successful and failed) within 30 calendar days of completion of the work. Plans must be dimensionally correct copies of the Contract plans. Include notes on the plans stating the final bore path diameter, facility diameter, drilling fluid composition, composition of any other materials used to fill the annular void between the bore path and the facility or facility placed out of service. If the facility is a casing, note this, as well as the size and type of carrier pipes to be placed within the casing as part of the Contract work. Produce the plans as follows:

(a) On the Contract plan view, show the centerline location of each facility, installed or installed and placed out of service to an accuracy within 1 inch at the ends and other points physically observed. They show the remainder of the horizontal alignment of the centerline of each facility installed or installed and placed out of service and note the accuracy with which the installation was monitored.

(b) As directed by the Engineer, provide either a profile plan for each bore path, or a cross-section of the roadway at a station specified by the Engineer, or a roadway centerline profile. Also show the ground or pavement surface and the crown elevation of each facility installed, or installed and placed out of service, accurately to within 1 inch at the ends and other points physically observed. Show the remainder of the vertical alignment of the crown of each facility installed, or installed and placed out of service and note the accuracy with which the installation was monitored. On profile plans for bore paths crossing the roadway, show the contract plans stationing. On the profile plans for bore paths paralleling the roadway show the contract plans stationing. If the profile plan for

the bore path is not made on a copy of one of the contract profile or cross-section sheets, use a 10 to 1 vertical exaggeration.

(c) If a bore path is not completed, show on the plans the failed bore path along with the name of the utility owner and the final bore path. Note the failed bore path as "Failed Bore Path." Also show the location and length of the cutting head and any product not removed from the bore path.

(d) Show the crown elevation, diameter and material type of all utilities encountered and physically observed during the subsoil investigation. For all other obstructions encountered during subsoil investigation or the installation, show the type of material, horizontal and vertical location, top elevation and lowest elevation observed, and note if the obstruction continues below the lowest point observed.

556-7 Method of Measurement.

The method of measurement will be the actual length of the installation, measured in place along the surface of the ground, complete and accepted. No additions or deductions will be made for sweeps in either the vertical or horizontal direction to complete the installation.

556-8 Basis of Payment.

Price and payment will be full compensation for all work and materials required to complete the work specified in this Section, including furnishing and installing casings, from plan point of beginning to plan point of ending at plan depth, removal of excavated materials and spoils, removal and disposal of drilling fluids, backfilling, and complete restoration of the site.

The installation of tracking conductors (wire or tape) will be included in the cost of the bore and will not be paid for separately.

No payment will be made for failed bore paths, injection of excavatable flowable fill, products taken out of service or incomplete installations.

No payment will be made for jack and bore until a Bore Path Report has been delivered to the Engineer. After the Engineer's acceptance of the Bore Path Report, payment will be made in the amount of 70% of the unit price bid, for Jack and Bore. The remaining 30% of the unit price bid will be made after submittal of As-Built Plans, in accordance with 556-6.2.

Payment will be made under:

Item No. 556- 1-	Jack and Bore - per foot of bore diameter.

SECTION 557
VIBRATORY PLOWING

557-1 Description.

557-1.1 Scope of Work: The work specified in this Section documents the approved construction methods, procedures and materials for Vibratory Plowing, also known as cable plowing.

557-1.2 General: Vibratory Plowing is a trenchless method for installing a product which typically consists of a cable or small conduit for later insertion of wire line products. It is a multi-stage process consisting of positioning a vibrating plow equipped with a trailing product guide which feeds the cable or conduit to the depth setting of the plow as it moves forward. The product is inserted into the ground continuously along a predetermined path and depth. Reshape any disturbance of the ground surface such as localized residual mounding or grooves, by grading and compaction. If a conduit is installed, subsequent operations may involve pulling a desired product back through the conduit. The vertical depth of installation is controlled by two factors, hydraulic adjustment of the plow shear head and the surface contours. The depth of insertion must be continually adjusted to compensate for changes in terrain to ensure compliance with depth criteria. Horizontal profiles or steering the bore is accomplished by proper orientation of a tractor which pulls the vibratory plow. Alignments are generally limited to straight sections with minor deviation unless approved by the Engineer.

557-2 Construction Site Requirements.

557-2.1 Site Conditions: Consider vibratory plowing an excavation method and comply with all applicable provisions required of excavation methods.

(a) Ensure that subsequent excavation for manholes, hand pulls, or other service vaults, recovery pits or any other excavation is carried out as specified in Section 120.

(b) After completing installation of the product, restore the work site. Restore excavated or plowed areas in accordance with the Specifications and Design Standards.

(c) It is the plowing Contractor's responsibility for removal of excess material or debris created during the construction process as well as restoring the site to the condition which existed before construction.

(d) Exposure may be allowed for periods exceeding 14 consecutive days if the exposure is limited to 3 feet or less. Periods longer than described above may be approved by the Engineer if it will not affect maintenance or construction activities.

(e) Ensure that equipment does not impede visibility of the roadway user without taking the necessary precautions of proper signing and Maintenance of Traffic Operations.

557-2.2 Damage Restoration: Take responsibility for restoring any damage caused by cutting, heaving, settlement or separation of pavement at no cost to the Department.

557-2.2.1 Remediation Plans: When required by the Engineer, provide detailed plans which show how damage to any roadway facility will be remedied and include this as part of the As-Built Plans Package. Remediation Plans must follow the same guidelines for development and presentation of the As-Built Plans.

557-3 Quality Control.

557-3.1 General: Take control of the operation at all times, have a representative who is thoroughly knowledgeable of the equipment and procedures, present at the job site during the entire installation and available to address immediate concerns and emergency operations. Notify the Engineer 48 hours in advance of starting work. Do not begin installation until the Engineer is present at the job site and agrees that proper preparations have been made.

557-3.2 Alignment: Ensure that the plow operator maintains a true and consistent alignment. Deviation from the approved alignment more than 1 foot in either direction to avoid obstructions such as boulders, stumps or general vegetation will not be allowed unless approved by the Engineer. Document all approved deviations from the original permitted alignment.

557-3.3 Product Locating and Tracking: For all installations, submit sufficient information to establish the proposed strategy for compliance with the permit.

(a) Define what reference will be used to control and ensure alignment as permitted will be maintained with respect to line and grade. Also indicate the intervals for checking line and grade and maintain a record at the job site.

(b) Ensure the equipment is of adequate size and capability to install the project. This includes the equipment manufacturer's information for all power equipment used in the installation.

(c) Define the means for controlling line and grade.

Install all facilities in such a way that their location can be readily determined by electronic designation after installation. For non-conductive installations, accomplish this by attaching a minimum of two separate and continuous conductive wires (minimum 12 gauge) either externally, internally, or integrally with the product. Any break in the conductor must be connected by electrical clamp of brass or solder and coated with a rubber or plastic insulator to maintain the integrity of the connection from corrosion.

557-4 Documentation.

557-4.1 Plowing Path Report: Furnish a Plowing Path Report to the Engineer within 14 days of the completion of each installation. Include the following information on the report:

(a) Location of project and financial project number including the Permit Number when assigned.

(b) Name of person collecting data, including title, position and company name.

(c) Contract plans station number or reference to a permanent structure within the project right-of-way.

(d) As-built placement plans showing roadway plan and profile, cross-section and plowing location and elevations every 100 feet along the alignment. Reference shown plan elevations to a Department Bench Mark when associated with a Department project, otherwise to a USGS grid system and datum, or to the top of an existing Department head wall. These plans must be the same scale in black ink on white paper, of the same size and weight and as the Contract plans.

Submittal of electronic plans data in lieu of hard copy plans may be approved by the Engineer if compatible with the Department software.

557-4.2 As-Built Plans: Submit the completed As-Built Plans to the Engineer within 30 Calendar days. Ensure that the plans are dimensionally correct copies of the Contract plans. Include notes on each plan stating the final plow path, facility diameter and any facility placed out of service. If the facility is a duct, note this, as well as the size and type of product to be placed within the duct as part of the permitted work. Produce the plans as follows:

(a) On the Contract plan view, show the centerline location of each facility installed to an accuracy within 1 inch at the ends and other points physically observed. Show the remainder of the horizontal alignment of the centerline of each facility installed and note the accuracy with which the installation was monitored.

(b) As directed by the Engineer, provide either a profile plan for each path, or a cross-section of the roadway at a station specified by the Engineer, or a roadway centerline profile. Show the ground or pavement surface and the crown elevation of each facility installed to an accuracy within 1 inch at the ends and other points physically observed. Show the remainder of the vertical alignment of the crown of each facility installed and note the accuracy with which the installation was monitored. On profile plans for paths crossing the roadway show the Contract plans stationing of the crossing. On the profile plans for paths paralleling the roadway also show the Contract plans stationing. If the profile plan for the path is not made on a copy of one of the Contract profile or cross-section sheets, use a 10 to 1 vertical exaggeration.

(c) If, during installation, an obstruction is encountered which prevents installation of the product in accordance with this Specification, submit a new installation procedure and revised plans to the Engineer for approval before resuming work along a new alignment. If a section of a plowing path fails without installing a product or it has been removed, show the failed section of the plow path along with the final plow path on the plans. Note the failed path as "Failed Plow Path." Do not leave any products in a failed plow path. If breakage occurs or the plow path fails, remove all products from the broken or failed section of the plow path.

(d) On all of the plans, show the crown elevation, diameter and material type of all utilities encountered and physically observed during installation. For all other obstructions encountered during a subsoil investigation or the installation, show the type of material, horizontal and vertical location, top elevation and lowest elevation observed, and note if the obstruction continues below the lowest point observed.

557-5 Method of Measurement.

Payment will be based on the length of the installation, measured in place along with the surface of the ground, completed and accepted.

557-6 Basis of Payment.

Payment will be full compensation for all work specified in this Section, including all installations, from plan point of beginning to plan point of ending

(i.e. pull box) at plan depth, removal and disposal of excavated materials such as boulders, stumps, and debris, or grading and backfilling to complete restoration of the site. Bundled product in a single plow will be paid for as a single plow based on the required vibrating plow head size. Separate payment will not be made for individual products in a bundle.

The installation of tracking conductors will be included in the cost of the plow and will not be paid for separately.

No payment will be made for a failed plow path or incomplete installations. The removal of all materials installed in a failed plow path will be at no cost to the Department.

No payment will be made for installations until the Plowing Path Report has been delivered to the Department. After the Engineer's acceptance of the Plowing Path Report, payment will be made in the amount of 70% of the unit price bid, for Vibratory Plowing. The remaining 30% of the unit price bid will be made after submittal of As-Built Plans, in accordance with 557-6.2.

Payment will be made under:

Pay Item No. 557-	1-	Vibratory Plowing - per foot of aggregate product pull diameter.

SECTION 562
REPAIR OF GALVANIZED SURFACES

562-1 Description.

Apply a coating of galvanizing compound over welded areas of galvanized structural members and over areas of previously galvanized members on which the galvanizing has become damaged.

562-2 Materials.

Use a galvanizing compound as specified in 975-4 and listed on the Qualified Products List (QPL).

562-3 Construction Methods.

Prepare surfaces and apply the galvanizing compound according to ASTM A 780 and manufacturer's recommendations. Apply additional coats on rough or pitted surfaces, when in the opinion of the Engineer it is necessary to obtain acceptable cover. Follow the manufacturer's recommended dry time between coats.

Re-clean the areas not coated on the same day the cleaning is accomplished, or surfaces that have rusted, prior to coating.

Apply the galvanizing compound to attain a uniform appearance free from all defects or failures. Submit repair procedure(s) to the Engineer for approval. All deficiencies will be corrected at no cost to the Department.

562-4 Basis of Payment.

No direct payment will be made for galvanizing compound coating of welded surfaces or for field repair of damaged galvanized surfaces. Include the cost to perform these operations, in the Contract price for the item which includes the member being so treated.

SECTION 563
ANTI-GRAFFITI COATING SYSTEM

563-1 Description.

Apply anti-graffiti coating system to the areas shown in the plans. Perform the painting in accordance with this Section, using materials meeting the requirements of 975-9.

Use compatible anti-graffiti coating system components as recommended by the manufacturer which are currently listed on the Department's Qualified Products List (QPL).

563-2 Application.

563-2.1 General: Apply an anti-graffiti coating or coating system as specified in the Contract Documents in accordance with manufacturer's recommendations and as specified herein, when the ambient temperature is between 40º and 90ºF, and the surface temperature is between 50º and 85ºF and rising.

Ensure all concrete has cured a minimum of 30 days before applying anti graffiti coating.

Do not apply coating when precipitation is expected within 12 hours of the completion of application or the relative humidity is above 88%.

563-2.2 Protection of Adjacent Surfaces: Consider wind direction, velocity and geographic location as having a major impact on all cleaning and anti-graffiti coating operations. If conditions are such that material is dispersed to areas where vehicles or other property may be damaged, suspend operations until conditions improve enough to permit work without damage.

Protect all surfaces not intended to be coated, which are adjacent to, or in close proximity to the surfaces to be coated, during the application of anti-graffiti coating. Clean surfaces that are to be coated, as per manufacturer's recommendation. Use all necessary precautions to prevent materials from cleaning and anti-graffiti coating operations being dispersed outside the work site.

563-2.3 Surface Preparation: Prepare all surfaces to be coated in accordance with 560-15 and the manufacturer's recommendation for the following requirements:

Surface Cleaning Concrete Unit Masonry for Coating .....ASTM D 4261
or
Surface Cleaning Concrete for Coating.....ASTM D 4258
Testing pH of cleaned concrete surface.....ASTM D 4262
Moisture in concrete.....ASTM D 4263

When the anti-graffiti coating or coating system is to be applied over an existing coating, conduct a test patch in accordance with 560-15.

563-2.4 Base Coat: Apply the base coat, if part of the system, as recommended by the manufacturer.

Unless otherwise specified by the manufacturer, ensure the cured base coat has a minimum dry film thickness of 4.0-8.0 mils.

563-2.5 Finish Coat Non Sacrificial and Sacrificial: When applicable, ensure the base coat surface is clean and cured to a dry hard state according to the manufacturer's recommendation before applying the finish coat. Mix finish coat and apply in accordance with the manufacturer's recommendations.

Ensure the cured finish coat of the two coat system has a minimum dry film thickness of 2.5-5.0 mils.

Apply as many coats as necessary to provide a finish coat which is a uniform continuous film over the entire surface, free of pinholes, runs, sags, or any other deficiencies.

563-2.6 Correction of Deficiencies: Remove all coating identified by the Engineer as damaged or not meeting these Specifications, in accordance with the manufacturer's recommendations.

Prepare the surface and reapply the coating in accordance with the manufacturer's recommendations and as specified herein, at no additional cost to the Department.

563-2.7 Removal of Graffiti Before Acceptance: Remove all graffiti from areas receiving anti-graffiti coating, at no additional cost to the Department. Ensure all federal, state, and local environmental regulations are met when removing graffiti.

563-2.7.1 Finish Coat Non Sacrificial: Meet the manufacturer's recommendations for removal.

563-2.7.2 Finish Coat Sacrificial: Meet the manufacturer's recommendations for removal. Prepare the surface and reapply the sacrificial coating in accordance with the manufacturer's recommendations and as specified herein.

563-3 Method of Measurement.

The quantity to be paid for will be plan quantity, in square feet, of the area of anti-graffiti coating completed and accepted.

The area will be based on the surface area shown in the plans with no allowance for surface texture or variable depth surface profiles.

563-4 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including furnishing and applying all materials to complete the anti-graffiti coating.

Payment shall be made under:

Item No. 563- 3-	Anti-Graffiti Coating (Sacrificial) per square foot.
Item No. 563- 4-	Anti-Graffiti Coating (Non Sacrificial) per square foot.

SECTION 570
PERFORMANCE TURF

570-1 Description.

Establish a growing, healthy turf over all areas designated on the plans. Use sod in areas designated on the plans to be sodded. Use seed, hydroseed, bonded fiber matrix, or sod in all other areas. Maintain turf areas until final acceptance of all contract work in accordance with 5-11.

570-2 Materials.

Meet the following requirements:

Turf Materials	Section 981
Fertilizer	Section 982
Water	Section 983

570-3 Construction Methods.

570-3.1 General: Incorporate turf installation into the project at the earliest practical time.

Shape the areas to be planted to the plan typical sections and lines and grade shown in the Contract Documents.

Except in areas where the Contract Documents requires specific types of grass to match adjoining private property, any species of grass designated in Section 981 may be used. Use the methods and materials necessary to establish and maintain the initial grassing until acceptance of the Contract work in accordance with 5-11. All of the permanent grassing material shall be in place prior to final acceptance.

The Department will only pay for replanting as necessary due to factors determined by the Engineer to be beyond control of the Contractor.

Complete all grassing on shoulder areas prior to the placement of the friction course on adjacent pavement.

570-3.2 Seeding: At the Contractor's option, wildflower seed may be included in the turf seeding operation or performed separately from the turf seeding.

Use of compost meeting the requirements of Section 987 as mulch is acceptable unless otherwise specified.

570-3.3 Sod: Place the sod on the prepared surface, with edges in close contact. Do not use sod which has been cut for more than 48 hours.

Place the sod to the edge of all landscape areas as shown in the plans and as shown in the Design Standards.

Peg sod at locations where the sod may slide. Drive pegs through sod blocks into firm earth, flush with the sod soil surface, at intervals approved by the Engineer. The work and materials for pegging of sod as directed by the Engineer will be paid for as Unforeseeable Work.

Place rolled sod parallel with the roadway and cut any exposed netting even with the sod edge.

Monitor placed sod for growth of pest plants and noxious weeds. If pest plants and/or noxious weeds manifest themselves within 30 days of placement of the sod during the months April through October, within 60 days of placement of the sod during the months of November through March treat affected areas by means acceptable to the Department at no expense to the Department. If pest plants and/or noxious weeds manifest themselves after the time frames described above from date of placement of sod, the Engineer, at his sole option, will determine if treatment is required and whether or not the Contractor will be compensated for such treatment. If compensation is provided, payment will be made as Unforeseeable Work as described in 4-4.

Remove and replace any sod as directed by the Engineer.

570-3.4 Hydroseeding: Use equipment specifically designed for mixing the wood fiber, seed, fertilizer, tackifier and dye, and applying the slurry uniformly over the areas to be hydroseeded.

Use wood fiber that is made of 100% hardwood or softwood and does not contain reprocessed wood or paper fibers. Ensure that a minimum of 50% of the fibers are equal to or greater than 0.15 inch in length and a minimum of 50% of the fibers will be retained on a twenty-five mesh screen.

Mix fertilizer as required into the hydroseeding slurry.

Mix seed into the slurry at rates in accordance with Design Standards, Index 104.

Ensure that the dye does not contain growth or germination inhibiting chemicals.

When polyacrylamide is used as part of hydroseeding mix, only anionic polymer formulation with free acrylamide monomer residual content of less than 0.05% is allowed. Cationic polyacrylamide shall not be used in any concentration. Do not spray polyacrylamide containing mixtures onto pavement. These may include tackifiers, flocculants or moisture-holding compounds.

570-3.5 Bonded Fiber Matrix (BFM): Meet the minimum physical and performance criteria of this Specification for use of BFM in hydroseeding operations or temporary non-vegetative erosion and sediment control methods.

Provide evidence of product performance testing, manufacturer's certification of training and material samples to the Engineer at least seven calendar days prior to installation.

Ensure that the BFM is composed of long strand, thermally processed wood fibers held together by crosslinked hydro-colloid tackifier (>10%), which, upon drying becomes water-insoluble and non-dispersible. Ensure that the BFM contains biodegradable dye to aid in uniform application of the material and that the resulting matrix performs in a manner equal or superior to biodegradable erosion control blankets (ECBs). Provide documentation of manufacturer's testing at an independent laboratory to the Engineer, demonstrating superior performance of BFM as measured by reduced water runoff, reduced soil loss and faster seed germination in comparison to erosion control blankets.

Use only BFMs that contain all components pre-packaged by the manufacturer to assure material performance. Deliver materials in UV and weather resistant factory labeled packaging. Store and handle products in strict compliance with the manufacturer's directions.

When polyacrylamide is used as part of hydroseeding mix, only anionic polymer formulation with free acrylamide monomer residual content of less than 0.05% is allowed. Cationic polyacrylamide shall not be used in any concentration. Do not spray polyacrylamide containing mixtures onto pavement. These may include tackifiers, flocculants or moisture-holding compounds.

Meet the following requirements after application of the formed matrix:

Ensure that the tackifier does not dissolve or disperse upon re-wetting.

Ensure that the matrix has no gaps between the product and the soil and that it provides 100% coverage of all disturbed soil areas after application.

Ensure that the matrix has a minimum water holding capacity of 1.2 gal/lb.

Ensure that the matrix has no germination or growth inhibiting properties and does not form a water-repelling crust.

Ensure that the matrix is comprised of materials which are 100% biodegradable and 100% beneficial to plant growth.

Mix and apply the BFM in strict compliance with the manufacturer's recommendations.

Apply the BFM to geotechnically stable slopes at the manufacturer's recommended rates.

Degradation of BFM will occur naturally as a result of chemical and biological hydrolysis, UV exposure and temperature fluctuations. Re-application, as determined by the Engineer, will be required if BFM-treated soils are disturbed or water quality or turbidity tests show the need for an additional application. The work and materials for re-application, will be paid for as Unforeseeable Work.

570-3.6 Watering: Water all turf areas as necessary to produce a healthy and vigorous stand of turf. Ensure that the water used for turf irrigation meets the requirements of Section 983.

570-3.7 Fertilizing: Fertilize as necessary based on soil testing performed in accordance with Section 162. Refer to Section 982 for fertilizer rates.

For bid purposes, base estimated quantities on an initial application of 265 lbs/acre and one subsequent application of 135 lbs/acre of 16-0-8.

570-4 Turf Establishment.

Perform all work necessary, including watering and fertilizing, to sustain an established turf until final acceptance, at no additional expense to the Department. Provide the filling, leveling, and repairing of any washed or eroded areas, as may be necessary.

Established turf is defined as follows:

Established root system (leaf blades break before seedlings or sod can be pulled from the soil by hand).

No bare spots larger than one square foot.

No continuous streaks running perpendicular to the face of the slope.

No bare areas comprising more than 1% of any given 1,000 square foot area.

No deformation of the turf areas caused by mowing or other Contractor equipment.

Monitor turf areas and remove all competing vegetation, pest plants, and noxious weeds (as listed by the Florida Exotic Pest Plant Council, Category I "List of Invasive Species", Current Edition, www.fleppc.org). Remove such vegetation regularly by manual, mechanical, or chemical control means, as necessary. When selecting herbicides, pay particular attention to ensure use of chemicals that will not harm desired turf or wildflower species. Use herbicides in accordance with 7-1.7.

Take responsibility for litter removal and mowing turf (including undisturbed areas within the project limits) until final acceptance. Begin mowing new turf after establishment of a healthy root system. Mow all turf to the height of not less than 6 inches. Mow the sodded areas when competing vegetation height exceeds 20 inches in height. Do not mow wildflower areas until at least three weeks after the peak of the bloom period and do not mow lower than 6 inches. Do not use selective herbicides in wildflower areas.

If at the time that all other work on the project is completed, but all turf areas have not met the requirements for established turf set forth in 570-4, continuously maintain all turf areas until the requirements for established turf set forth in 570-4 have been met.

During the entire establishment period and until turf is established in accordance with this specification, continue inspection (once every seven days and after each 1/2 inch of rain) and maintenance of erosion and sedimentation control items in accordance with Section 104. Take responsibility for the proper removal and disposal of all erosion and sedimentation control items after turf has been established.

Notify the Engineer, with a minimum of seven calendar days advance notice, to conduct inspections of the turf at approximate 90-day intervals during the establishment period to determine establishment. Results of such inspections will be made available to the Contractor within seven calendar days of the date of inspection. Determination of an established turf will be based on the entire project and not in sections.

Upon the determination by the Engineer that the requirements of 570-4 have been met and an established turf has been achieved and all erosion and sedimentation control items have been removed, the Engineer will release the Contractor from any further responsibility provided for in this Specification.

The Contractor's establishment obligations of this specification will not apply to deficiencies due to the following factors, if found by the Engineer to be beyond the control of the Contractor, his Subcontractors, Vendors or Suppliers:

a. Determination that the deficiency was due to the failure of other features of the Contract.

b. Determination that the deficiency was the responsibility of a third party performing work not included in the Contract or its actions.

The Department will only pay for replanting as necessary due to factors determined by the Department to be beyond the control of the Contractor.

570-5 Responsible Party.

For the purposes of this Specification, the Contractor shall be the responsible party throughout construction and establishment periods.

Upon final acceptance of the Contract in accordance with 5-11, the Contractor's responsibility for maintenance of all the work or facilities within the project limits of the Contract will terminate in accordance with 5-11; with the sole exception that the facilities damaged due to lack of established turf and the obligations set forth in this Specification–for Performance Turf shall continue thereafter to be responsibility of the Contractor as otherwise provided in this Section.

570-6 Disputes Resolution.

The Contractor and the Department acknowledge that use of the Statewide Disputes Review Board is required and the determinations of the Statewide Disputes Review Board for disputes arising out of the Performance Turf Specification will be binding on both the Contractor and the Department, with no right of appeal by either party, for the purposes of this Specification.

Any and all Statewide Disputes Review Board meetings after final acceptance of the Contract in accordance with 5-11 shall be requested and paid for by the Contractor. The Department will reimburse the Contractor for all fees associated with meetings.

570-7 Failure to Perform.

Should the Contractor fail to timely submit any dispute to the Statewide Disputes Review Board, refuse to submit any dispute to the Statewide Disputes Review Board, fail to provide an established turf in accordance with 570-4 within one-year of final acceptance of the Contract in accordance with 5-11, or fail to compensate the Department for any remedial work performed by the Department in establishing a turf and other remedial work associated with lack of an established turf, including but not limited to, repair of shoulder or other areas due to erosion and removal of sediments deposited in roadside ditches and streams, as determined by the Statewide Disputes Review Board to be the Contractor's responsibility, the Department shall suspend, revoke or deny the Contractor's certificate of qualification under the terms of Section 337.16(d)(2), Florida Statutes, until the Contractor provides an established turf or full and complete payment for the remedial work made to the Department. In no case shall the period of suspension, revocation, or denial of the Contractor's certificate of qualification be less than six (6) months. Should the Contractor choose to challenge the Department's notification of intent for suspension, revocation or denial of qualification and the Department's action is upheld, the Contractor shall have its qualification suspended for a minimum of six (6) months or until the remedial action is satisfactorily performed, whichever is longer.

570-8 Method of Measurement.

The quantities to be paid for will be plan quantity in square yards based on the area shown in the plans, completed and accepted.

570-9 Basis of Payment.

Price and payment will be full compensation for all work and materials specified in this Section.

Payment will be made under:

Item No. 570- 1- Performance Turf - per square yard.

SECTION 571
PLASTIC EROSION MAT

571-1 Description.

Furnish and install plastic erosion mat on areas as shown in the plans. Conduct this work in conjunction with the Performance Turf work as specified in either Section 570.

571-2 Materials.

Use a plastic erosion mat consisting of continuous or fused synthetic polymer fibers, which are entangled to form a three dimensional matrix (netting or distorted netting may be included as part of the matrix). Ensure that the mat is capable of maintaining its shape throughout installation. Ensure that the mat is inert to chemicals encountered in a natural soil environment, and meets the requirement of Section 985 and the Design Standards, No. 199 according to its application.

571-3 Installation of Plastic Erosion Mat.

Before installing the plastic erosion mat furnish the Engineer two certified copies of the test report from the manufacturer certifying that the geotextile to be incorporated into this project meets the requirements of Section 985 and Index No. 199 of the Design Standards also, provide two copies of the manufacturer's written installation instructions.

Install a plastic erosion mat of uniform thickness, not less than 1/4 inch or more than 3/4 inch on the prepared soil surface in accordance with these Specifications, the manufacturer's recommendations and in conformity with the lines, grades and dimensions as shown in the plans. Ensure that all joints are shingle lapped such that the bottom of each section fits over the top of the section below to prevent uplift of the ends or edges by water flow. Overlap ends of adjacent rolls a minimum of 3 feet. Overlap edges of adjacent rolls a minimum of 4 inches. Stake all edges at 3 to 5 feet intervals with staples as recommended by the manufacturer unless otherwise directed by the Engineer. Ensure that overlaps and anchor trenches are in conformance with the plans and the manufacturer's installation recommendations.

Ensure that after installation there are no protrusions, projections or exposures of the plastic erosion mat. Do not compact the installed plastic erosion mat with any type of equipment employing a foot or grid.

The Engineer will reject any material having defects, tears, punctures, flaws, deterioration or other damage before, during or after installation. Remove and

replace all rejected plastic erosion mat at no additional expense to the Department.

Fill all voids in the mat with soil meeting the requirements of Section 987. Establish Performance Turf meeting the requirements of Section 570.

571-4 Method of Measurement.

The quantity to be paid for will be the surface area of Plastic Erosion Mat installed and accepted in square yards with no allowance for overlaps.

Performance Turf will be paid for separately in accordance with Section 570.

571-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including furnishing, handling, placement of Plastic Erosion Mat, all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

Payment will be made under:

Item No. 571- 1- Plastic Erosion Mat - per square yard.

SECTION 580
LANDSCAPE INSTALLATION

580-1 Description.

Install, establish and maintain landscaping as indicated in the Contract Documents.

580-2 Materials.

580-2.1 Plants:

580-2.1.1 Grade Standards and Conformity with Type and Species: Only use nursery grown plant materials purchased from Florida based Nurseryman Stock that comply with all required inspection, grading standards, and plant regulations in accordance with the latest edition of the Florida Department of Agriculture's "Grades and Standards for Nursery Plants."

Unless otherwise specified, minimum grade for all plants is Florida No. 1 or better. All plants must be the specified size and grade at the time of delivery to the site and the minimum grade maintained throughout the project construction period and plant establishment period.

Use only plants that are true to type and species and ensure that the plants not specifically covered by Florida Department of Agriculture's "Grades and Standards for Nursery Plants" conform in type and species with the standards and designations in general acceptance by Florida nurseries. Prior to planting, furnish certification to the Engineer that all plant materials have been purchased from Florida based Nurseryman Stock.

A minimum of two plants of each species on each shipment must be shipped with tags stating the botanical nomenclature and common name of the plant. Should discrepancies between botanical nomenclature and common name arise, the botanical name will take precedence.

580-2.1.2 Inspection and Transporting: Move nursery stock in accordance with all federal and state regulations and accompany each shipment with the required inspection certificates for filing with the Engineer.

580-2.2 Water: Meet the requirements of Section 983.

580-2.3 Mulching: Use of Cypress Mulch prohibited.

580-3 Planting Requirements.

580-3.1 Delivery: All materials must be available for inspection before installation and will be subject to approval or rejection.

580-3.2 Layout: Mark proposed planting beds and individual locations of trees and palms as shown in the Contract Documents for Engineer's review, prior to excavation or planting. The Engineer may request to review all proposed construction and maintenance practices before the start of the operations.

Make no changes to the layout, materials or any variations of plant materials from the Contract Documents without the Engineer's written approval.

580-3.3 Soil Drainage: All planting holes and beds must drain sufficiently prior to installing any plants. Immediately notify the Engineer of drainage or percolation problems before plant installation.

580-3.4 Installation of Plants: For installation of the plants as identified in the Contract Documents, comply with the requirements of the Design Standards, Index No. 544.

Personnel performing these services are under the sole responsibility and supervision of the Contractor and must be competent, experienced, and skilled in all aspects of the required landscape installation and establishment practices.

580-3.5 Contractor's Responsibility for Condition of the Plantings: Begin maintenance of all plants immediately after each planting.

Keep all plants watered, fertilized, mulched, pruned, and staked and guyed as necessary to assure specified minimum grade of Florida No. 1 throughout the duration of the project construction period and establishment period. During the establishment period, keep the individual planting locations and planting beds free of litter and undesirable vegetation. Ensure that the plants are maintained so that they are healthy, vigorous, and undamaged throughout the duration of the project construction period and establishment period. For the duration of the establishment period, operate and maintain in good operating condition, all components of any irrigation system installed in compliance with the Contract Documents.

During the establishment period, replace any plants that fall below specified minimum grade. Use replacement plants of the same species, size and planting medium as the plant being replaced and as specified in the Contract Documents.

580-3.6 Inspection Requirements. Certify monthly on a form provided by the Department that the plants have been installed and are being maintained per Contract Documents. A Registered Landscape Architect acting as the Contractor's Landscape Quality Control representative will oversee the establishment period.

The Contractor's Landscape Quality Control representative must perform quarterly inspections of planting areas and submit findings in report form to the

Department. Information to be included in inspection report from the Contractor's Quality Control representative must include as a minimum the following:

Date of inspection
Description of project
Location of inspection
Weather conditions
Condition of plants – identify by species, location, and number of plants that are no longer the specified minimum.
Condition of planting beds (including mulching, mowing, weeding, fertilizing, watering, and staking and guying), if applicable
Other comments
Signature and seal of Contractor's Landscape QC representative

Submit the certified inspection report to the Engineer within seven calendar days after performing the inspection. Any corrections to the inspection report must be revised/corrected and resubmitted within three calendar days after notification by the Engineer. Any deficiencies noted on the inspection report must be corrected within ten days of notification from the Department.

Periodic, random verifications will be performed by the Department to ensure the quality of the plants and correctness of the certified landscape inspection report. Any unresolved disputes that arise between the QC reporting and the verifications performed by the Department will be referred to the Statewide Disputes Review Board.

580-4 Disposal of Surplus Materials and Debris.

Remove from the jobsite any surplus excavated material from plant holes unless otherwise directed by the Engineer. Surplus is defined as material not needed after installation of plants per Contract Documents. Upon commencement of the plant installation, remove daily all landscape installation debris from the landscape locations described in the Contract Documents. Remove all excess staking and guying materials from the jobsite.

580-5 Plant Establishment Period and Contractor's Warranty.

Take responsibility for the proper maintenance, survival and condition of all plants for a period of one year after final acceptance in accordance with 5-11. Notify the Engineer upon completion of installation of all plants.

Mowing as part of the landscape work will be identified in the Contract Documents. Continue any mowing of the landscape areas specified in the Contract Documents throughout the establishment period.

Provide a Warranty/Maintenance Bond to the Department in the amount of the total sums bid for all landscape items as evidence of warranty during this plant establishment period. The cost of the bond will not be paid separately, but will be included in the costs of other bid items.

In addition to satisfying the provisions of Section 287.0935, Florida Statutes, the bonding company is required to have an A.M. Best rating of "A" or better. If the bonding company drops below the "A" rating during the Warranty/Maintenance Bond period, provide a new Warranty/Maintenance Bond

for the balance of the establishment period from a bonding company with an "A" or better rating. In such event, all costs of the premium for the new Warranty/Maintenance Bond will be at the Contractor's expense.

The Engineer may conduct interim inspections of all landscape items during the plant establishment period, as well as at the end of the plant establishment period. As part of the warranty to the Department, and at no cost to the Department, replace all plants found not to meet minimum specifications as shown in 580-2.1.1 and 580-3.5 within ten days after each inspection.

Prior to the end of the establishment period, remove all staking and guying from the project.

At the end of the establishment period, the Engineer will release the Contractor from further warranty work and responsibility provided all plants are established and all previous warranty and remedial work, if any, has been completed to the satisfaction of the Engineer.

580-6 Method of Measurement.

The quantities to be paid will be the items shown in the Contract Documents, completed and accepted.

580-7 Basis of Payment.

Prices and payments will be full compensation for all work and materials specified in this Section.

SECTION 603
GENERAL REQUIREMENTS FOR THE INSTALLATION AND EVALUATION OF TRAFFIC CONTROL SIGNAL EQUIPMENT AND MATERIALS

603-1 Description.

The provisions contained in this Section include general requirements for all traffic control signal equipment and materials used in the construction of signalized intersections.

603-2 Equipment and Materials.

603-2.1 General: Except as provided in 603-2.2, only use traffic control signal devices meeting the requirements of the Minimum Specifications for Traffic Control Signal Devices (MSTCSD) and listed on the Department's Approved Product List (APL).

Only use new equipment and materials, except as specified in the Contract Documents.

603-2.2 Exceptions: The Department may grant exceptions to the requirements of 603-2.1 by Temporary Permit to take advantage of "state of the art" equipment advances or other circumstances that are found to be in the public interest.

603-2.3 Uniformity: Only use compatible units of any one item of equipment, such as signal heads, detectors, controllers, cabinets, poles, signal system or interconnection equipment etc., for use at an intersection.

603-2.4 Hardware and Fittings: Ensure that all bolts and nuts less than 5/8 inch in diameter are passivated stainless steel, Type 316 or Type 304 and meet the requirements of ASTM F 593 and ASTM F 594 for corrosion resistance, unless otherwise specified in the Contract Documents. Provide documentation to the Engineer certifying that the materials meet all requirements specified.

Ensure that all bolts and nuts 5/8 inch and over in diameter are galvanized and meet the requirements of ASTM A 307.

Use high-strength steel anchor bolts and U-bolts, having a minimum yield strength of 55,000 psi and a minimum ultimate strength of 90,000 psi.

603-2.5 Galvanizing: Meet the requirements of Section 962 when galvanizing for fittings and appurtenances for all structural steel (including steel poles).

603-3 Definitions.

Traffic Control Signal Devices: Any device, either manually, electrically or mechanically operated, by which traffic is alternately directed to stop and permitted to proceed or controlled in any manner. These include, but are not limited to, controller assemblies (controller cabinets and their contents); signal heads including their hanging or mounting devices; vehicle detection systems (loops, sealant, amplifier, lead-in wire, or cable); and pedestrian detection systems (push button, push button housing, lead-in wires, and signal).

Minimum Specifications for Traffic Control Signal Devices: The current edition of the MSTCSD, maintained by the State Traffic Engineering Office, which provides standards and specific technical requirements for electronic equipment and materials for the evaluation of traffic control signal devices.

Approved Products List (APL): A listing of certified or approved traffic control signal devices or hardware, compiled and maintained by the State Traffic Engineering Office.

Temporary Permit: A permit issued by the State Traffic Engineering Office for a specified time period at a specific location for new products or technology introduced by manufacturers requiring approval by the Department. This permit allows for a trial use of such products and field evaluation before the Department issues a formal approval. The State Traffic Engineering Office maintains the list of temporarily permitted traffic control signal devices.

603-4 Systems Approval Requirement.

The Engineer will review and approve any system design plan of traffic control signal devices, that is controlled and/or operated from a remote location by electronic computers or similar devices, and which affects the movement of traffic on any portion of the State Highway System, prior to installation. Within such system, only use traffic control signal devices that meet all certification or approval requirements contained herein.

603-5 Device Approval Process.

The traffic control signal devices approval process is described in detail in Section A601 of the MSTCSD.

603-6 Marking of Approved Equipment.

603-6.1 Manufacturer's Identification: Ensure that all traffic control signal devices, furnished and/or installed, are marked by the manufacturer with a permanently affixed ID plate or stamp, bearing the name or trademark of the manufacturer and the part number.

603-6.2 Certification Number: Ensure that the Florida Department of Transportation certification number is permanently affixed.

1. For electrical/electronic devices such as controllers and accessories and vehicle detectors, the manufacturer, vendor, supplier, or Contractor shall permanently affix the certification number on the top front center of the electrical/electronic device with a tamper proof, water resistant label.

2. For vehicular and pedestrian traffic signals, electro-mechanical signs, disconnect hangers and pedestrian detectors, the certification number shall be permanently affixed inside the housing near the terminal block by the manufacturer, vendor, supplier, or Contractor.

3. For controller cabinets, the certification number shall be permanently affixed on the inside of the main cabinet door by the manufacturer, vendor, supplier, or Contractor.

603-7 Submittal Data Requirements.

Prior to the installation of signal equipment and within 30 days after the preconstruction conference, submit a completed listing of all traffic devices or

hardware with certification number(s) to the Engineer for approval on a form provided by the Department. On all non-structural equipment or materials that do not have a Florida Department of Transportation Certification Number, submit one copy of the manufacturer's descriptive literature and technical data fully describing the types of signal equipment that will be used to the Engineer.

Develop shop drawings for all structural support materials and other special designs, such as non-electrical, non-mechanical, or other fabricated items, which may not be specifically detailed in the plans. Have the Specialty Engineer approve all shop drawings. Do not submit shop drawings for those items that have been previously evaluated and approved. Meet the requirements of 5-1.4 for shop drawings. Send two copies of the shop drawings signed and sealed by the Specialty Engineer to the Engineer.

The Engineer will approve submittal data for devices having a Florida Department of Transportation Certification Number.

The Department is not liable for any equipment or material purchased, work done, or delay incurred prior to such approval.

Provide a complete operable signal installation as specified in the Contract regardless of any failure of the Department to discover or note any unsatisfactory material. Meet the requirements of Section 608.

603-8 Documentation for Electronic Equipment.

Prior to final acceptance, furnish the Engineer with two copies of the following documentary items obtained from the manufacturer for the electronic equipment listed below:

1. Manual describing the theory of operation
2. Manual for troubleshooting
3. Electronic schematics of circuit boards
4. Pictorial layout of components of circuit boards
5. Parts list, including the location
6. Diagram of the field installation wiring (not applicable to the detectors)

Furnish documentary items for the following equipment:

1. Controllers
2. Vehicle detectors
3. Coordinating units
4. Load switches
5. Flasher units
6. Preemption units
7. Conflict monitors
8. Special sequence relays
9. Any other equipment which has a logic, timing, or communications function
10. Other equipment documentation specified in the Contract Documents

603-9 Department-Furnished Equipment Installed By Contractor.

Where the Contract includes installation of Department-furnished equipment, the Department will turn over such equipment to the Contractor when the

construction progress allows or as designated in the Contract Documents. The Department will test and certify the equipment to be in proper condition and ready to use and will bear the costs of correcting any defects in the equipment prior to pick-up by the Contractor. The Engineer will coordinate the pick-up and installation of the equipment. Maintain the equipment in proper operational condition after pick-up at no cost to the Department, until either final acceptance or the equipment is returned to the Department.

SECTION 608
GUARANTIES

608-1 Description.

This Section sets forth traffic signal equipment guaranty requirements for Department contracts. The Department will consider manufacturer and Contractor costs associated with providing and delivering equipment guaranties, requirements, terms, and conditions incidental to the payment for equipment or construction feature utilizing the equipment.

608-2 Guaranty Provisions.

608-2.1 Contractor's Responsibility: Secure all guaranties that are customarily issued by the signal equipment manufacturers for the specific signal equipment included in the Contract. The Contractor shall ensure that the form in which such guaranties are delivered to the Contractor includes the provision that they are subject to transfer to the maintaining agency as named by the Department, and is accompanied by proper validation of such fact. Transfer guaranties at final acceptance of the work (or equipment) by the Department.

608-2.2 Terms: Ensure that the manufacturers of traffic signal equipment stipulate the terms of guaranties when submitting a request to the Department for certification and for equipment submittals for construction projects. Include terms for a specified service performance with provisions for repair parts and labor, or for replacement. Provisions shall define the equipment "installation date" as the date for such guaranty to be in effect. For construction projects, the "installation date" is the first day of equipment "burn-in". For warehouse purchases, the "installation date" is the date of visual inspection approval, not to exceed ten days after delivery date.

608-2.3 Conditions: When guaranty is available, ensure that a written and signed guaranty accompanies the manufacturer's billing invoice. The Engineer will sign and retain the original and provide a copy to the maintaining agency and to the manufacturer. If the Contractor does not comply with the terms of the guaranty, the Department may suspend the certification. Comply with additional terms and conditions as stated in purchasing agreements.

SECTION 611
SIGNAL INSTALLATION ACCEPTANCE PROCEDURES

611-1 Description.

This Section sets forth Contract acceptance procedures for signalization installations and for equipment purchase contracts.

611-2 Acceptance of Signal Installations.

611-2.1 Partial Acceptance: The Engineer may make inspection for partial acceptance under the Contract in accordance with 5-10 of a complete installation of a signalization control system upon its completion in accordance with the Contract Documents and at such time that other parts of the total Contract are at a stage of completion that either require or allow the installation to operate in a manner which is in accordance with the Contract Documents. Before inspection for partial acceptance, the Engineer will require the satisfactory completion of all field tests of completed installations in accordance with the requirements of 611-4. The Engineer will make inspection for partial acceptance in accordance with 5-10 in company with a Contractor's representative and, when applicable, a representative of the agency designated to accept maintenance responsibility.

611-2.2 Final Acceptance: The Engineer will make inspection for final acceptance of signal installations as part of all work under the Contract in accordance with 5-11, only after satisfactory completion of all field tests of completed installations in accordance with the requirements of 611-4 and on the basis of a comprehensive final field inspection of all traffic signal installations. The Engineer will make the final inspection of all signal installations with a Contractor's representative and, when applicable, a representative of the agency designated to accept maintenance responsibility. Transfer to the Department any guarantees on equipment or materials furnished by the manufacturer and ensure that the manufacturer includes with such guarantees the provision that they are subject to such transfer, and proper validation of such fact. In addition, as a condition precedent to final acceptance in accordance with 5-11, provide a Warranty/Maintenance Bond in accordance with the requirements of 611-5.

611-2.3 As-Built Drawings: As a condition precedent to acceptance under 611-2.1 or 611-2.2, furnish as-built drawings of all signal installations in accordance with the following requirements:

611-2.3.1 Submittal Requirements: Submit three sets of as-built plans for review by the Engineer on reproductions of the original 11 by 17 inch sheets. Record all as-built information using block lettering or typed text to ensure legibility. Signing and pavement marking plan sheets may be used instead of signalization plan sheets, if a substantial number of changes from the original signalization plans must be recorded. If, in the opinion of the Engineer, the changes can not be clearly delineated on reproductions of the original 11 by 17 inch sheets, clearly delineate all changes on 11 by 17 inch detail sheets, enlarged 200% from the reproductions. Make any corrections resulting from the Engineer’s review, and resubmit three sets of the completed as-built plans as a condition precedent to acceptance of the installation.

611-2.3.2 Components: Include as-built information for all components of the signal installation. As a minimum, identify the following components in the format indicated below.

611-2.3.2.1 Conduit and Cable: Identify all conduit and cable with unique linestyles for routing (overhead, conduit, saw cut, etc.) that are clearly identified in a legend on each sheet. Identify the type of cable (i.e., 7 conductor signal cable) and label the number of conductors, fiber strands or other identifying features of the cable. For conduit, clearly note conduit size and number of runs.

611-2.3.2.2 Loops: Identify the location of all installed loops (including the distance from the stop bar for the advance loops), the path of each loop to the pull box, the loop window and the path of the loop lead-in to the controller cabinet.

611-2.3.2.3 Pull Boxes: Label unused and out of service pull boxes clearly. Show dimensions for each pull box from the nearest edgeline and stop bar. If an edgeline is not near a pull box or would not clearly identify its location; a fixed monument may be used (i.e. signal pole).

611-2.3.2.4 Poles: Locate Poles from the nearest edgeline of both approaches. If an edgeline is not near a pole or would not clearly identify its location, a fixed monument may be used.

611-2.3.2.5 Signal Heads: Locate all signal heads with respect to the pavement markings. Each signal head shall be identified by its corresponding movement number.

611-2.3.2.6 Cabinet: Clearly locate the cabinet. The type of cabinet and controller manufacturer along with the model number shall be provided. A cabinet corner "blow up" shall be provided detailing pull box locations with all conduit and cable per 611-2.3.2.1 and 611-2.3.2.3.

611-2.3.2.7 Preemption: Clearly locate all preemption equipment. The type of preemption equipment and the manufacturer along with the model number shall be provided. Additionally, the type of communication medium (i.e. closed loop) shall be identified. Any underground conduit and cable as well as pull boxes shall be per 611-2.3.2.1 and 611-2.3.2.3.

611-2.3.3 Compensation: All costs involved with providing as-built plans are incidental to the other items of work associated with traffic signals. Payment for the work associated with traffic signals will be made at 85% of the unit price bid for signal installation. The remaining 15% of the unit price will be made after submittal and acceptance of the As-Built Plans.

611-2.4 Installation Inspection Requirements: Meet the requirements of Section 105.

611-3 Signal Timing.

Set the timing of a traffic signal or system of traffic control devices in accordance with the Contract Documents, unless approved otherwise in writing by the Engineer.

611-4 Field Tests of Signal Installations.

Perform the following tests on all traffic signal installations in the presence of the Engineer and, when applicable, a representative of the agency designated to accept maintenance responsibility.

Continuity: Test each signal head circuit, pedestrian detector circuit, vehicle detector loop circuit, and interconnect signal circuit for continuity.

Functional: Perform a functional test that demonstrates that each and every part of the signal installation functions as specified.

Induced Voltage: Measure the voltage between each signal head indication field terminal and the AC neutral circuit in the controller cabinet during the off (dark) state of each signal head indication. Ensure that the voltage does not exceed 2 $V_{AC, RMS}$. If this value is exceeded, take the following action to reduce the value to 2 $V_{AC, RMS}$:

(1) Check for loose or broken connections in the signal head circuit from the controller cabinet to the signal heads.

(2) If (1) above does not correct the problem, connect additional neutral circuits between the signal head and the controller cabinet.

Inductive Loop Assembly: An inductive loop assembly is defined as a loop plus the lead-in cable. Measure and record the series resistance of each inductive loop assembly. Ensure that the resistance does not exceed 10 Ω. Perform an insulation resistance megger test, at 500 V_{DC}, for each inductive loop assembly at the cabinet in which the inductive loop assembly is terminated. Do not connect the inductive loop assembly to the cabinet terminal strips during the test, except for the drain wire of a shielded lead-in cable. Insulation resistance is defined as the resistance between one wire of the lead-in cable and a ground rod or bussbar. Record the insulation resistance of each inductive loop assembly. Ensure that the resistance is equal to or greater than 100 MΩ.

Perform the 48 hour test only after achieving acceptable results from the other tests listed in 611-4.

Forty-Eight Hour Test:

(a) Before beginning the 48 hour test, place all new signal installations (no existing signals) in flash for 48 to 336 hours. The length of the flash period will be determined by the Engineer.

(b) Continuously operate each new or modified traffic signal installation or system for not less than 48 hours. If unsatisfactory performance of the system develops, correct the condition, and repeat the test until obtaining 48 hours of satisfactory continuous operation.

(c) During the 48 hour test period, the Contractor is fully responsible for the signal or signal systems. Provide a responsible representative (technically qualified) who can monitor signal operation and troubleshoot any malfunctions within a one hour period.

When coordination is specified in the Contract Documents, provide a two hour training session on the operation and programming of the coordination features of the controller units during the 48 hour test. Arrange the time and place of the training session with the Engineer.

(d) Perform a 48 hour test for flashing beacon installations in the same manner as for traffic signal installations.

(e) Start the 48 hour test on a Monday, Tuesday, or Wednesday. However, do not start the 48 hour test on the day preceding a holiday.

(f) Start the 48 hour test between 9:00 AM and 2:00 PM.

(g) Before the 48 hour test, install and have standing by all equipment specified in the Contract Documents.

611-5 Contractor's Warranty Period for Signal Installations.

611-5.1 General Requirements: After satisfactory completion of all field tests in accordance with 611-4 and as a condition precedent to final acceptance of all work under the Contract in accordance with 5-11, provide a Warranty/Maintenance Bond for the repair or replacement of any defective components of the signal installations which shall be in effect for a 90 day period after final acceptance in accordance with 5-11. Include the costs of the bond in the costs of other bid items.

In addition to satisfying the provisions of Section 287.0935, Florida Statutes, the bonding company is required to have a A.M. Best rating of "A" or better. If the bonding company drops below the "A" rating during the 90 day Warranty/Maintenance Bond period, provide a new Warranty/Maintenance Bond for the balance of the 90 day period from a bonding company with an "A" or better rating. In such event, all costs of the premium for the new Maintenance Bond will be at the Contractor's expense.

The Warranty/Maintenance Bond shall be written and issued in the amount of the total sums bid for all electrical or electronic equipment furnished and installed as part of any traffic signal installation or system of traffic control devices.

At the end of the 90 day warranty period, the Contractor will be released by the Engineer from further warranty work and responsibility, provided all previous warranty work and remedial work, if any, has been completed satisfactorily.

611-5.2 Contractor's Responsibilities: During the warranty period, the Contractor is responsible for the following:

(a) Repair or replacement of equipment that fails to function properly due to defective materials or workmanship.

(b) Upon notification by the Engineer of a malfunction, restore the equipment to proper operating condition within 12 hours after notification by the Engineer.

If the Contractor fails to restore the equipment to proper operating condition within 12 hours after notification, the Engineer has the authority to have the remedial work performed by other forces. The Contractor is responsible for all incurred costs of the work performed by other forces. Remedial work performed by other forces does not alter any of the requirements, responsibilities or obligations of this warranty.

(c) In the event that the equipment does not function or malfunctions due to defective materials or workmanship, the Contractor is liable for any impairment to the safety of pedestrian and vehicular traffic resulting from such malfunction.

611-5.3 Department's Responsibilities: During the warranty period, the Department is responsible for the following:

(a) Electrical energy costs which are paid for by the local maintaining agency.

(b) All adjustments, such as timing, necessary for the normal operations of equipment.

(c) Documentation of the individuals involved and the time of Contractor notification upon failure or malfunction of equipment.

(d) Repair or replacement of any part of the installation damaged as a result of natural causes or those resulting from vehicular or pedestrian traffic not associated with Contractor activities.

611-6 Manufacturer's Tests and Certifications.

For materials which may not require formal testing, the Engineer reserves the right to require certifications from the manufacturer of such equipment and material, to the effect that they meet all Specification requirements, and, in the event of questionable equipment or material, to require that such material or equipment be tested at no expense to the Department.

The Engineer reserves the right to withhold any payments which may be due, if the Engineer determines that the equipment does not meet the Specifications or evaluation criteria.

611-7 Contracts for Purchase of Equipment.

611-7.1 Acceptance Tests Required: For each unit of equipment furnished under purchase contracts (furnish only), the Engineer will perform the following tests:

(a) Visual inspection within five days after delivery.

(b) Operational tests which determine whether the equipment performs in accordance with the requirements of the Contract Documents. The Engineer will complete such tests within 15 days after delivery.

611-7.2 Eligibility for Payment:

(a) The Department will base payment for equipment furnished under purchase contracts on satisfactory completion of the visual inspection and operational tests required by 611-7.1.

(b) Before any payment will be made for each functional group, deliver to the Engineer and receive from the Engineer acceptance of all units of each functional group of equipment required to be furnished by the Contract Documents. The Department will make separate payment for a staged delivery of each functional group of equipment only when staged delivery is specified in the Contract Documents.

611-7.3 Equipment Failing to Pass Acceptance Tests:

(a) When any unit of equipment fails to pass the acceptance tests, correct the deficiencies (by repair or replacement), at no expense (including all freight costs) to the Department, to attain compliance. If the original Contract Time has expired, the Department will charge and continue to assess liquidated damages in accordance with 8-10 until final acceptance of the equipment. Upon compliance

with such correction requirements, the Engineer will perform tests on the equipment as specified above and will determine their eligibility for payment.

(b) The Department will not assess liquidated damages during the acceptance test period in 611-7.1. The Department will allow only one acceptance test exclusion with regard to liquidated damages assessment per lot of units required to be delivered.

SECTION 620
SIGNAL INSTALLATION GROUNDING

620-1 Description.

Install grounding for traffic signal installations to provide personnel and equipment protection against faults, surge currents and lightning transients.

620-2 Materials.

Use materials meeting the requirements of Section A620 of the current Minimum Specifications for Traffic Control Signal Devices (MSTCSD), except as provided in 603-2.2.

620-3 Requirements for Grounding.

620-3.1 General: Meet all local electrical codes which exceed these Specifications. Install all grounding conductors, which bond grounding electrode assemblies, 18 inches below finished grade. Accomplish grounding for any element of a traffic signal installation by installing either a grounding electrode assembly or a grounding electrode array, unless otherwise specified in the Contract Documents.

Use solid No. 6 AWG copper insulated (green) conductor for electrical or lightning protection ground from the system ground bus or barrier plate(s) to the grounding electrodes and from grounding electrode to grounding electrode. Use either solid or stranded No. 6 AWG copper insulated (green) conductor for all other applications.

Bond all grounding electrode assemblies and arrays together and place in a location that minimizes the length of the grounding conductor between the assembly or array and the element being grounded.

Install 40 feet of ground assembly or array for each of the following elements:

(a) Electric power service
(b) Pole with electrical power service installed
(c) Pole mounted cabinet with electrical power service installed
(d) Controller or detector cabinet

Install 20 feet of ground assembly or array for each of the following elements:

(a) Pole
(b) Pedestals for pedestrian signals
(c) Metal cover used with pull boxes with AC power

Ensure that all separately grounded elements at an intersection are bonded together to form an intersection grounding network.

For span wire assemblies, use the span wire to connect the grounding electrode assemblies or arrays of the poles.

Do not install a grounding electrode assembly or array for a base mounted cabinet within 6 feet of a grounding electrode assembly or array installed for a pole.

Make all bonds between ground wires and grounding electrode assemblies or arrays with an exothermic bond with the following exception: do not exothermically bond grounding electrode to grounding electrode connections or the system ground bussbar or barrier plate connections located within a cabinet. Use exothermic materials from the same source to make all the exothermic bonds at an intersection, meeting the requirements of the IEEE standards 80 and 837.

620-3.2 Grounding Electrode Assembly: Provide a grounding electrode assembly consisting of one or more grounding electrodes coupled together, such that the total length of the electrodes in the assembly is a minimum of 20 feet, driven into the earth at a single point, without disrupting the electrical continuity of the assembly.

Use a coupling device for grounding electrode to grounding electrode connections approved by the Engineer.

Install the grounding electrode assembly so that the final elevation at the top is 6 inches below finished earth grade. Mark the location of the assembly with a stake and keep uncovered until the Engineer performs a final inspection of the installation.

620-3.3 Grounding Electrode Array: Provide a grounding electrode array consisting of two or more grounding electrode assemblies, bonded together and spaced a minimum of 6 feet apart.

620-3.4 Grounding Poles: Ground all metal poles, including pedestals for pedestrian signals, in accordance with the details for grounding and connections shown in the Design Standards, Index No. 17727.

For non-metallic poles, including pedestals for pedestrian signals, accommodate the ground connection from signal heads and span wires to the ground electrode assembly or array located at the pole base in accordance with the details in the Design Standards, Index No. 17727.

When erecting new metal poles within 10 feet of existing metal poles or structures, bond the new and existing poles or structures together.

620-3.5 Grounding Electric Power Service: Ground all electric power services in accordance with the details for grounding and connections shown in the Design Standards, Index No. 17736.

620-3.6 Grounding Controller or Detector Cabinets: Ground controller or detector cabinets to the bussbar located in the cabinet. Place the grounding electrode assembly or array as close to the cabinet as possible.

620-3.7 Grounding Span Wire Mounted Signal Heads and Electrically Powered Signs: Ground span wire mounted signal heads and electrically powered signs through the span wire assembly in accordance with the details shown in the Design Standards, Index No. 17727.

Do not use guy wires for grounding purposes, however bond any guy wire to the span wire as part of the intersection grounding network.

620-4 Basis of Payment.

The work specified in this Section will not be paid for directly, but will be considered as incidental work.

SECTION 630
CONDUIT

630-1 Description.

Install conduit for traffic signals and other electrically powered or operated traffic control devices as shown in the plans and Design Standards, Index No. 17721.

630-2 Materials.

Use materials meeting the requirements of Section A630 of the current Minimum Specifications for Traffic Control Signal Devices (MSTCSD), except as provided in 603-2.2.

630-3 Installation Requirements.

630-3.1 General: Consider the locations of conduit as shown on the plans as approximate. Construct conduit runs as straight as possible, and obtain the Engineer's approval of all major deviations in conduit locations from those shown on the plans.

Do not place more than the equivalent of four quarter bends or 360 degree of bends, including the termination bends, between the two points of termination in the conduit, without a pullbox. Obtain the Engineer's approval to use corrugated flexible conduits for short runs 6 feet or less.

Use only intermediate metal conduit, rigid galvanized conduit, rigid aluminum conduit or PVC coated intermediate metal conduit for above-ground or underground electrical power service installations. Meet the requirements of Section 562 for coating all field cut and threaded galvanized pipe.

Use either schedule 80 PVC or fiberglass reinforced epoxy conduit for installations on bridge decks.

Use either schedule 40 PVC or fiberglass reinforced epoxy, conduit for underground and under pavement installations, except for electrical power service.

When the installation of a conduit requires jacking under paved surfaces, railroads, etc., use an intermediate metal conduit as the sleeve for the underground conduit. Install the underground conduit as shown in the Design Standards, Index No. 17721.

When a conduit installation changes from underground to above-ground, make the change a minimum of 6 inches below finished grade.

Install a No. 12 AWG pull wire or polypropylene cord the full length of all conduits that are designated for future use. Ensure that a minimum of 24 inches of pull line approved by the Engineer is accessible at each conduit termination.

Install an expansion fitting when conduit crosses an expansion joint of a structure.

Use couplings and expansion joints made of the same material as the conduit.

Ensure that all joints are made as specified by the manufacturer and are waterproof.

For installations not specifically shown, install the conduit in accordance with NEC and/or National Electrical Safety Code requirements.

When earth backfill and tamping is required, place backfill material as per Section 120 in layers approximately 12 inches thick, and tamp each layer to a density equal to or greater than the adjacent soil.

When trenching, saw cut and repair all pavement and sidewalks encountered.

When backfilling trenches in existing pavement, use a commercially available sand-cement (approximately 10:1 mix ratio).

Provide a standard clearance between underground control cable and electrical service cable or another parallel underground electrical service cable that meets National Electrical Safety Code requirements.

630-3.1.1 Fiber Optic Cable Conduit: Prevent the ingress of water, dirt, sand, and other foreign materials into the conduit prior to, during and after construction. Exclude water and debris from buried conduit and from the top riser assembly of aboveground conduit using a foam-sealing material, rubber plug, or other device designed for this application and approved by the Engineer. Use a UV-rated flexible conduit to protect the cable from the top of the conduit riser to the span messenger where the cable is to be lashed.

Ensure that the conduit fill ratio (outer cable diameter to inner conduit/duct diameter) does not exceed 50%.

Install the conduit system so the fiber optic cable maintains a minimum bend radius of 20 times the cable diameter.

Install the conduit as shown in the plans. Provide all fittings and incidental materials necessary to construct a complete installation. Use approved methods for connecting inner duct or conduit within or between plowed portions, trenched portions, and bored portions. Submit the conduit manufacturer's coupling method and material to the Department's Project Manager for approval.

630-3.1.2 Fiber Optic Cable Locate Wire: Bury locate wire along the centerline of the top outer surface of installed conduit, as shown in the plans, or as directed by the Engineer. Install locate wire in the trench or bore with all underground conduits to provide end-to-end electrical continuity for electronically locating the underground conduit system. Do not install locate wire in a conduit with fiber optic cable.

Do not run locate wires into field cabinets. Terminate locate wires at the first and last pull boxes in the conduit run or as shown in the plans. Ensure that wire termination occurs only at the top of a pull box.

In a trenching operation, install the locate wire no more than 3 inches above the conduit. Ensure that the locate wire enters all pull boxes and splice boxes, and that a minimum of 10 feet of slack locate wire is coiled and neatly stored in each box.

In a boring operation, install the locate wire in an encasement.

Drill a hole in the pull box or splice box for wire entry as shown in the plans. Fill any gaps between the locate wire and the hole it passes through with nonshrink grout or a similar sealant suitable for the application and approved by the Engineer.

Perform continuity tests and insulation resistance tests on all locate wires. Provide the Engineer with all test results. Replace or repair defective locate wire at no additional cost.

Make locate wire splices in a flush grade-level box. Ensure that locate wire splices are waterproof and suitable for direct burial. Ensure that locate wire splices at the pull box meet NEC requirements. Ensure that locate wire splices include a mechanical crimp connection with a butt sleeve, an oxide-preventing aerosol lacquer, mastic electrical splicing tape, and standard electrical tape using methods and materials approved by the Engineer. At the completion of the installation, provide the Engineer with as-built drawings that document all splice locations.

630-3.2 Conduit Sizes: Size the conduit to be used on all installations, unless otherwise shown in the Contract Documents. Use conduit of sufficient size to allow the conductor to be installed without any damage and meeting NEC requirements. Use conduit that is at least 1 inch in diameter, except for the conduit protecting the ground wire on the side of a pole, use conduit that is at least 1/2 inch in diameter.

630-3.3 Conduit Joints: Make conduit joints using materials as specified by the manufacturer. As an exception to the threaded coupling for intermediate metal conduit, at locations where it is not possible to screw the threaded coupling properly, the Contractor may use a waterproof slip-joint coupling approved by the Engineer. Secure the joint, and tighten threaded connections.

Prior to insertion into the coupling, clean, prime and coat the ends of PVC conduit with a solvent-type cement as specified by the manufacturer.

630-3.4 PVC Coating: Apply the PVC coating to the entire surface of the conduit, except for the threads, to attain a nominal thickness of 40 mils. Ensure that the coating is free of sags and/or drips. Ensure that the bond between the PVC coating and the conduit is greater than the tensile strength of the PVC coating.

Attach the coupling to the conduit prior to the application of the coating for conduit of 1 inch diameter or less.

Use a coupling with sleeve extensions on conduit larger than 1 inch. Ensure that the sleeve extensions on all threaded female openings have a length equal to the diameter of the conduit up to and including size number 53.

630-3.5 Conduit Terminations: Fit the terminating ends of all metal conduit and metal conduit sleeves with an appropriate bushing.

For conduit to be encased in concrete, wrap with tape or otherwise protect all terminations to prevent the entrance of concrete.

Connect new underground conduit(s) to existing underground conduit(s) with a pull box.

Install conduit terminating in a concrete strain pole through the cable entry hole and up the center of the pole to a location approximately 6 inches below the handhole.

Seal conduits terminating in a controller base, pole, pull box, junction box, or pedestal base with Appleton Duct Seal, Permagum Duct Seal, GB Duct Seal, or an equivalent moisture resistant sealant approved by the Engineer.

For a controller base, pole or pedestal base, and junction boxes, terminate conduit runs into the center of the base or box at least 2 inches above the surface of the base.

630-3.6 Existing Underground Facilities: Coordinate with any potential conflicting underground utilities prior to starting all excavating or jacking operations at the project site.

630-3.7 Restoration of Trench Areas: Restore the conduit trench construction area to an acceptable condition. Such work includes replacement of all pavement areas, sidewalks, curbs, structures, or grass areas disturbed by the conduit trench.

630-3.8 Jacking Conduit: Use either intermediate metal conduit or rigid galvanized conduit as the sleeve when installation of a conduit requires jacking under paved surfaces, railroads, etc., with either polyvinyl chloride or fiberglass reinforced epoxy conduit installed in the jacked sleeve. Do not disturb any pavement without the approval of the Engineer.

630-3.9 Above-Ground Installation: Securely attach above-ground conduit installations to the surface of the supporting structure using conduit straps. As a minimum, use conduit straps located on 5 feet centers. Use galvanized metal conduit straps when installing intermediate metal conduit, fiberglass reinforced epoxy conduit, rigid galvanized conduit, rigid aluminum conduit or PVC coated intermediate metal conduit above ground.

Use the same PVC coating for the metal straps as the conduit, when using PVC coated intermediate metal conduit.

630-3.10 Elbows: Use only preformed or field constructed conduit elbows. The radius of curvature of the inner edge of any bend shall not be less than shown below:

Size	Standard Radius
1/2 inch	4 inches
3/4 inch	4 1/2 inches
1 inch	5 1/2 inches
1 1/4 inches	7 1/4 inches
1 1/2 inches	8 1/4 inches
2 inches	9 1/2 inches
2 1/2 inches	10 1/2 inches
3 inches	13 inches
3 1/2 inches	15 inches
4 inches	16 inches
5 inches	24 inches
6 inches	30 inches

630-4 Method of Measurement.

630-4.1 General: Measurement for payment will be in accordance with the following work tasks.

630-4.2 Furnish and Install: The Contract unit price per foot of conduit, furnished and installed, will include furnishing all hardware and materials as specified in the Contract Documents, and all labor, trenching, backfilling, and restoration materials necessary for a complete and accepted installation.

Payment for conduit placed in the ground or used on bridge decks will be based on the horizontal path of the installed conduit as measured in a straight line between the centers of pull boxes, cabinets, poles, etc. No allowance will be made for sweeps or vertical distances above or below the ground or the bridge deck.

Due to conditions which may exist on the project site, the Contractor may furnish conduit in variable lengths.

Furnishing and installing the locate wire is included in the cost of the conduit.

Conduit used for fiber optic cable includes the cost of furnishing and installing the locate wire and the cost of conducting the continuity test and the insulation resistance test.

630-4.3 Furnish: The Contract unit price per foot of Conduit, furnished, will include the cost of materials, and hardware as specified in the Contract Documents, plus all shipping and handling cost involved in delivery as specified in the Contract Documents.

The Contractor shall furnish conduit in 20 foot sections with one coupling per section.

630-4.4 Install: The Contract unit price per foot of conduit, installed, will include all miscellaneous hardware and materials, labor, trenching, backfilling, and restoration materials necessary for a complete and accepted installation.

The Engineer will supply conduit in sections with one coupling per section and elbows as required.

Payment for conduit placed in the ground or used on bridge decks will be based on the horizontal path of the installed conduit as measured in a straight line between the centers of pull boxes, cabinets, poles, etc. No allowance will be made for sweeps or vertical distances above or below the ground or the bridge deck.

Installing the locate wire is included in the cost of the conduit. Conduit used for fiber optic cable includes the cost of installing the locate wire and the cost of conducting the continuity test and the insulation resistance test.

630-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 630- 1- Conduit - per foot.

SECTION 632
SIGNAL AND INTERCONNECT CABLE

632-1 Description.

Install underground and aerial signal and interconnect cable.

632-2 Materials.

Use materials meeting the requirements of Section A632 of the current Minimum Specifications for Traffic Control Signal Devices (MSTCSD), except as provided in 603-2.2.

632-3 Installation Requirements.

632-3.1 Number of Conductors: Determine the number of conductors required for each signal and interconnect cable unless specified in the Contract Documents.

Provide two spare conductors within the interconnect cable. Terminate conductors within controller cabinets as specified below.

Provide three spare conductors for each signal cable used at all signal installations. Install the three spare conductors from the controller cabinet through each signal head disconnect hanger to the furthermost disconnect hanger.

For non-span wire installations, install the three spare conductors from the controller cabinet through each signal to the furthermost signal.

Ground spare signal cable conductors in the controller cabinet. In the disconnect hanger, terminate spare wires at the terminal strip. Individually cap or tape any additional spares in the disconnect hanger.

Identify all spare conductors in a controller cabinet as spare signal conductors or spare interconnect conductors, and ground them to the controller cabinet ground bus bar. Provide spare conductors within the controller cabinet of sufficient length to reach the furthermost field wiring terminals in the cabinet.

632-3.2 Number of Cables: Do not install more than four separate cables at any point on a single support wire.

632-3.3 Protection of Cable: Ensure cable drawn through conduit, ducts, drilled holes protected by a rubber grommet, or support structures is installed in such a manner as to prevent damage to conductors or insulation.

632-3.4 Cabling for Mast Arm Assembly: Continuous lengths of cable between the traffic signal controller cabinet, signal heads (or disconnect hangers), pedestrian signal heads and pedestrian detectors will be allowed only when specified in Contract Documents.

Attach strain relief approved by the Engineer to the “J” hook inside the mast arm pole.

632-3.5 Cable Terminations: Terminate signal cable in the terminal by inserting the bared conductors into a compression type terminal block and tightening the appropriate screws.

When barrier terminal blocks are specified in the Contract Documents, crimp insulated forks or ring terminals to the bared conductors using a calibrated ratchet-crimping tool and connect the forks or ring terminals to the barrier terminal block by tightening the appropriate screws.

Neatly form and tie wrap all cable terminations.

Ground spare signal cable conductors in the controller cabinet. If disconnect hangers are specified in the Contract Documents, terminate spare wires at the terminal strip located inside the disconnect hangers. Individually cap or tape any additional spares in the disconnect hanger.

Ensure all cable terminations for a mast arm assembly are terminated in the terminal compartment at the base of the mast arm pole.

632-4 Signal Cable.

Install underground and aerial signal cable in accordance with the Design Standards, Index No. 17727.

Except for mast arm assemblies, install signal cable in continuous lengths between the traffic signal controller cabinets, disconnect hangers (or signal heads for non-span wire installations), pedestrian signal heads, and pedestrian detectors.

Do not use the neutral return conductor for pedestrian detectors as a neutral return for any other device.

632-5 Interconnect Cable.

Install underground and aerial interconnect cable in accordance with the Design Standards, Index Nos. 17733 and 17841.

Install aerial interconnect cable in continuous lengths to and between traffic signal controller cabinets and aerial junction boxes.

Except for mast arm assemblies, install underground interconnect cable in continuous lengths to and between traffic signal controller cabinets and above-ground junction boxes.

Install terminations between controller cabinets at above-ground interconnect junction boxes. The Contractor may install terminations at intervals less than shown on the plans; however, the Contractor must provide the above-ground junction box, materials, and labor for these terminations at no expense to the Department. Obtain the Engineer's approval of the location of additional junction boxes.

632-6 Method of Measurement.

632-6.1 General: Measurement for payment will be in accordance with the following work tasks.

632-6.2 Furnish and Install: The Contract unit price per intersection for Cable (Signal) and per foot for Cable (Interconnect), furnished and installed, will include furnishing all material, hardware, support wire, cable ties, cable clamps, lashing wire, terminal connectors, cable grounding and labor necessary for a complete and accepted installation.

Payment for Cable (Signal) will be based on the number of intersections at which signal cable is furnished and installed.

Payment for Cable (Interconnect) will be based upon the length installed between cable terminations, as determined by the manufacturer's sequential markings printed on the cable jacket, recorded to the nearest foot.

632-6.3 Furnish: The Contract unit price of Cable, furnished, will include the cost of the required cable as specified in the Contract Documents, plus all

shipping and handling costs involved in delivery as specified in the Contract Documents.

632-6.4 Install: The Contract unit price per intersection for Cable (Signal) and per foot for Cable (Interconnect), installed, will include all labor, cable ties, cable clamps, lashing wire, and cable grounding necessary for a complete and accepted installation. The Engineer will supply all cable.

Payment for Cable (Signal) will be based on the number of intersections at which signal cable is installed.

Payment for Cable (Interconnect) will be based upon the length installed between cable terminations, as determined by the manufacturer's sequential markings printed on the cable jacket, recorded to the nearest foot.

632-7 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 632- 7-	Cable (Signal) - per intersection.
Item No. 632- 8-	Cable (Interconnect) - per foot.

SECTION 634
SPAN WIRE ASSEMBLY

634-1 Description.

Install a span wire assembly for supporting traffic signals, signs, and/or other traffic control devices. Provide fiberglass insulators when required.

634-2 Materials.

634-2.1 General Requirements: For a single point attachment, only a catenary wire is used to support the imposed dead and wind load from the attached signs and traffic signals. The catenary wire, for a single point attachment, also supports the signal conductor cables and interconnect cables.

For a two point attachment, the catenary wire is used to support the imposed dead load and a portion of the imposed wind load from the attached signs and traffic signals. The two point attachment also includes a messenger wire to resist a significant portion of the imposed wind load and to support the signal conductor cables and interconnection cables.

Use a tether wire for maintaining the alignment of signal heads when specified in the plans.

634-2.2 Wires: For span wire assemblies, only use wire cables of seven wire strands manufactured and provided with a Class A zinc coating in accordance with ASTM A 475.

Provide Utility Grade catenary or messenger wires. The Contractor may use Siemens-Martin Grade tether wires. Meet the following additional requirements for span wire assembly strands:

Span Wire Assembly Strand Type	Nominal Diameter Inch	Required Minimum Breaking Strength Pounds
Catenary Wire or Messenger Wire *	3/8 7/16 1/2	11,500 18,000 25,000
Tether Wire	3/16	1,900
*Supply catenary or messenger wire of the nominal diameter as specified in the contract documents.		

634-2.3 Hardware and Fittings: For Utility or Siemens-Martin Grade wires, use the connection hardware as specified herein. For installations that use other grades of wire, provide the hardware and fittings indicated on the plans. Provide only hardware and fittings made of galvanized steel or non-corrosive metal unless the fiberglass insulators specified in 634-2.4 are also required. Provide hardware and fittings of sufficient strength to resist the breaking strength of the wire with which they are used.

Use an alloy steel eyebolt (ASTM F 541, Type 2) and a matching heavy hex nut (ASTM A 563, Grade C or D), both zinc coated in accordance with ASTM A 153, Class C, to connect the automatic compression dead-end clamp of the catenary wire or messenger wire to the wood or concrete strain poles. Sizes of eyebolts, supplied with nuts and washers, are as following: Use a 3/4 inch diameter bolt for maximum of one 7/16 inch diameter catenary (or messenger) wire, or maximum of two 3/8 inch diameter catenary (or messenger) wires. Use a 1 inch diameter bolt for maximum of one 1/2 inch diameter catenary (or messenger) wire, or maximum of two 7/16 inch diameter catenary (or messenger) wires. Use 1-1/4 inch diameter bolt for maximum of two 1/2 inch diameter catenary (or messenger) wires. For two point attachments, connect the messenger wire at the lower attachment location. Do not use thimbleye bolts for these connections.

Only use thimbleye and eye bolts, 3/4 inch in diameter, minimum, to connect the automatic compression dead-end clamps of tether wires to wood or concrete strain poles.

Only use “S” hooks, 5/16 inch in diameter, minimum, when connecting the tether wire to all poles.

Ensure that other hardware and fittings, as required for the attachment of a span wire assembly to support poles or structures, are in accordance with the details shown in the Design Standards.

634-2.4 Fiberglass Insulators: Install fiberglass insulators of the length specified in the plans on span wire assemblies located within 6 feet of overhead electric power lines.

Use a fiberglass insulator of a cylindrical shape, fabricated from epoxy-resin impregnated fiberglass strands and having a breaking strength 50% greater than that of the structural support wire to which it is to be attached. Equip the insulator with thimbleye fittings on each end for attachment of the wire. Furnish all fittings and hardware necessary for the complete installation with the

insulator and ensure that such fittings and hardware are of at least equal strength to the insulator.

634-3 Installation Requirements.

634-3.1 Span Wire Assembly Types: Use either of the following span wire assemblies as shown in the contract documents:

(a) Single Point Attachment Assembly: This type of assembly requires a catenary wire with an optional tether wire (if specified in the plans).

(b) Two Point Attachment Assembly: This type of assembly requires a catenary wire, a messenger wire and an optional tether wire (if specified in the plans).

634-3.2 Span Types: Install span wire assemblies on the following span types:

(a) Perpendicular Span: Use this type span at an intersection to support a single span wire assembly upon which traffic signals, signs, and/or other traffic control devices are attached. Attach the span wire assembly to two support poles or structures, located on opposite sides of the roadway, and extend the assembly across the roadway at an angle of approximately 90 degrees to the roadway approach.

(b) Diagonal Span: Use this span type at an intersection to support a single span wire assembly upon which traffic signals, signs, and/or other traffic control devices are attached. Attach the span wire assembly to two poles, located in opposite quadrants of the intersection, and extend the assembly across the intersection at an angle of approximately 45 degrees to the approach lanes of the intersection. Locate traffic control devices for all approaches at appropriate locations on the span wire assembly.

(c) Box Span: Use this span type at an intersection to support a perimeter system of four span wire assembly upon which traffic signals, signs and/or other traffic control devices for each approach to the intersection are attached. Attach the span wire assembly to four poles, one located in each quadrant of the intersection, and extend each span wire between two poles at an angle of approximately 90 degrees to the roadway approaches. Place traffic control devices for an approach on the span wire on the far side of the intersection.

(d) Special Design Span: Use this span type to support two or more span wire assembly upon which traffic signals, signs and other traffic control devices for one or more roadway approaches are attached. Attach the span wire assembly to three or more poles.

634-3.3 General Requirements:

(a) Provide a span wire assembly with catenary, messenger and tether wires of one continuous length of wire cable with no splices except when an insulator is required by 634-2.4. Connect the insulator, if required, to the cable with automatic compression dead-end clamps.

(b) Attach the span wire assemblies to the support poles or structures by means of automatic compression clamps and accessory hardware.

(c) Assemble the washer and nut on the oval eye bolt with the flat washer next to the pole. Tighten the nut sufficiently to prevent the oval eye bolt from rotating.

(d) For two point attachments, install the messenger wire with the following tensions per 100 feet. Linearly prorate cable tensions for other lengths from these values:

Cable Size Inch	Wire Tension Lbs.
3/8	340.0
7/16	500.0
1/2	645.0

(e) The catenary wire shall be tensioned to provide a 5% ± 0.5% sag.

(f) Install the span wire assemblies in accordance with the Design Standards, Index No. 17727, and at a height on the support poles which will provide a clearance from the roadway to the bottom of the signal head assemblies as shown in Index 17727.

(g) Connect all span wires to the pole grounding system in accordance with Section 620.

(h) Obtain and meet all provisions of the National Electric Safety Code (ANSI-C2) regarding clearance from electric lines, contacting of utility owners, and safety requirements prior to span wire installation.

(i) Prior to installation of the two point attachment span wire assembly, submit the method of providing the required tension in the messenger wire to the Engineer for approval.

634-4 Method of Measurement.

634-4.1 General: Measurement for payment will be in accordance with the following work tasks.

634-4.2 Furnish and Install: The Contract unit price per intersection for Span Wire Assembly and per foot of Fiberglass Insulator, furnished and installed, between supporting poles and structures will include furnishing all materials and hardware as required in 634-2, and all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

634-4.3 Furnish: The Contract unit price per intersection for Span Wire Assembly and per foot of Fiberglass Insulator, furnished, will include the cost of the required materials and hardware as required in 634-2, and all handling and delivery of these items to the site designated by the Department in the Contract Documents.

634-4.4 Install: The Contract unit price per intersection for Span Wire Assembly and per foot of Fiberglass Insulator, installed, will include all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

The Engineer will supply all materials and hardware as required in 634-2 for the span wire assembly.

634-5 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section. When a tether wire is specified in the plans, the payment of the tether wire shall be included in the compensation for the span wire assembly.

Payment will be made under:

Item No. 634- 4-	Span Wire Assembly - per intersection.
Item No. 634- 5-	Fiberglass Insulator - per foot.

SECTION 635
PULL AND JUNCTION BOXES

635-1 Description.

Install pull and junction boxes for traffic signals.

635-2 Materials.

Use Pull and Junction Boxes listed on the Department's Approved Product List (APL). Ensure that all Pull and Junction Boxes are marked in accordance with Section 603 and the markings are visible after installation.

635-3 Pull Boxes Installation.

Install pull boxes in accordance with the Design Standards, Index No. 17721. Ensure that the pull box cover is flush with the finished grade or sidewalk. Do not install pull boxes in roadways, driveways, parking areas, ditches or public sidewalk curb ramps.

635-4 Junction Boxes Installation.

635-4.1 Aerial Junction Boxes: Install aerial junction boxes in accordance with the Design Standards, Index No. 17733.

635-4.2 Mounted Junction Boxes: Install mounted junction boxes in accordance with the Design Standards, Index No. 17841. Ensure that the bottom surface of pole mounted junction boxes is a minimum of 4 feet above the finished grade.

635-4.3 Cable Terminations: Make cable terminations in junction boxes in accordance with Section 632. Rout and form the cable to allow access to the terminal screws. Do not cover the terminal identification numbers with the cable.

635-5 General Requirements.

Do not pull signal or interconnect cable through a pull box used for loop termination. Use separate pull boxes for signal and interconnect cables.

Use embedded junction boxes that include junction boxes, conduit, conduit expansion couplings, and miscellaneous hardware to make a complete and accepted installation.

Ground all metal covers in accordance with Section 620.

When specified in the Contract Documents, disregard the grounding requirements for metal covers for pull and junction boxes powered strictly by battery or a combination of battery and solar energy or used exclusively for vehicle loop wires where signal or 120V interconnect power is not present.

635-6 Method of Measurement.

635-6.1 General: Measurement for payment will be in accordance with the following work tasks:

635-6.2 Furnish and Install: The Contract unit price each for Pull and Junction Boxes, furnished and installed, will consist of the pull and junction boxes including all required hardware for the type of box and location as specified in the Contract Documents, and all labor and materials necessary for a complete and accepted installation.

635-6.3 Furnish: The Contract unit price each for Pull and Junction Box, furnished, will include the cost of the pull and junction box including covers, doors, locks and keys, and any necessary miscellaneous hardware specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents

635-6.4 Install: The Contract unit price each for Pull and Junction Box, installed, will include the cost of all labor, equipment, miscellaneous hardware and materials necessary to make a complete and accepted installation of the type box and at locations as shown on the plans. The Engineer will supply a complete box as specified in the Contract Documents.

635-7 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, except grounding. Payment for embedded junction boxes will not be made separately.

The Contractor shall include the cost of embedded junction boxes in the Contract unit price for the concrete substructure or superstructure items.

Payment will be made under:

Item No. 635- 1- Pull and Junction Boxes - each.

SECTION 639
ELECTRICAL POWER SERVICE ASSEMBLIES

639-1 Description.

Install electrical power service assemblies for either overhead service or underground service in accordance with the details shown in the Design Standards, Index No. 17736.

639-2 Definitions.

(a) Overhead Service: A service assembly which is supplied electrical power from an overhead power company source. Include with an overhead electrical power service assembly the following components:

(1) Weatherhead
(2) Conduit
(3) Service wire
(4) Meter base (when required)
(5) Service disconnect assembly
(6) Transient Protection Device

(b) Underground Service: A service assembly which is supplied electrical power from an underground power company source. Include with an underground electrical power service assembly the following components:

(1) Conduit
(2) Service wire
(3) Meter base (when required)
(4) Service disconnect assembly
(5) Transient Protection Device

639-3 Materials.

Use materials meeting the requirements of Section A639 of the current Minimum Specifications for Traffic Control Signal Devices (MSTCSD), except as provided in 603-2.2.

639-4 Installation Requirements.

639-4.1 General: Meet the following requirements for the installation of individual components of the electrical power service assembly:

Use extreme care and caution in the installation of all components of the electrical power service assembly.

Follow installation procedures recommended by NEC and National Electrical Safety Code (NESC).

Consider the location of electrical power service assemblies as shown in the plans to be approximate, and coordinate with the appropriate electrical power company authority to determine the exact locations of each assembly.

639-4.2 Weatherhead: Securely attach the weatherhead to the upper end of the conduit which extends upward from the meter base (or service disconnect if a meter base is not required) to a minimum height of 22 feet above grade.

639-4.3 Conduit: Securely attach all conduit to the pole or cabinet with a maximum distance of 5 feet between conduit attachment hardware.

639-4.4 Electrical Service Wire: Install the electrical service wire in a manner which will ensure that damage to the installation will not occur.

Ensure that the service wire is of sufficient length after installation in the conduit to provide for attachment to the power company service and for termination within the cabinet for which power is required.

639-4.5 Meter Base: When a meter base is required, securely fasten the meter base to the pole or cabinet. Install pole mounted meter bases at a minimum height of 5 1/2 feet above grade when measured from the center of the meter base or meet the local electric power company requirement, whichever is greater.

639-4.6 Service Disconnect: Securely fasten the service disconnect to the pole (or cabinet with the Engineers approval), and electrically position the service disconnect between the service meter and the traffic control device cabinet to which electrical service is being supplied. Install pole mounted service disconnects a minimum of 4 feet above grade when measured from the bottom of the disconnect. For cabinet installations, mount the service disconnect at a height approved by the Engineer or as shown in the plans.

639-5 Method of Measurement.

639-5.1 General: Measurement for payment will be in accordance with the following work tasks.

639-5.2 Furnish and Install: The Contract unit price per foot of Electrical Service Wire, or the Contract unit price each for Electrical Service Disconnect, furnished and installed, will include furnishing all materials and hardware as specified in the Contract Documents, and all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

639-5.3 Furnish: The Contract unit price per foot of Electrical Service Wire, or the Contract unit price each, for Electrical Service Disconnect, furnished, will include the cost of the required materials and hardware as specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

639-5.4 Install: The Contract unit price per foot of Electrical Service Wire, or the Contract unit price each, for Electrical Service Disconnect, installed, will include all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation. The Engineer will supply electrical service wire or electrical service disconnect.

639-5.5 Electrical Power Service: The Contract unit price per assembly for Electrical Power Service will include furnishing and installing all material and hardware as specified in the Contract Documents, and all labor and equipment necessary to make a complete and accepted installation.

Payment for conduit and electrical service wire as part of the electrical power service assembly will include only the conduit and service wire which is vertically attached to the assembly. Horizontal lengths of conduit and conductors required beyond the electrical power service assembly will be paid for under another pay item.

639-6 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 639- 1-	Electrical Power Service - per assembly.
Item No. 639- 2-	Electrical Service Wire - per foot.
Item No. 639- 3-	Electrical Service Disconnect - each.

SECTION 641
PRESTRESSED CONCRETE POLES

641-1 Description.

Furnish and install prestressed concrete poles for service pole applications, luminaire support, and strain poles for span wire support of traffic signals, signs, and other devices (multiple types). Obtain precast, prestressed concrete poles from a manufacturing plant that is currently on the Department's list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list

shall meet the requirements of 105-3. Provide poles that are listed on the Department's Qualified Products List (QPL).

Ensure that each pole is constructed and permanently and legibly marked in accordance with Design Standards, Index No. 17725, including the date cast. The marking shall be visible after installation.

Ensure that the shipment of the products to the job site meets the requirements of 450-16.3 and Section 8.2 of the Materials Manual.

641-2 Materials.

Meet the following requirements:

Portland Cement Concrete	Section 346 Class V Special or Class VI
Reinforcing Steel	931-1
Prestressed Strands	933-1

641-3 Concrete Pole Construction.

Construct concrete poles in accordance with Section 450. Assume responsibility for performance of all quality control testing and inspections required by Sections 346 and 450, however; the PCI personnel and plant certifications are not required.

641-4 Installation Requirements.

641-4.1 General: Furnish poles of the type and length shown on the plans. Provide catenary cable of the size shown on the plans. Ground poles in accordance with Section 620. Install span wire assemblies in accordance with Section 634.

Do not consider the poles acceptable for use if the camber of the pole, measured as the maximum deviation between the centerline of the pole and a straight line connecting the centroids of the cross-sections at each end of the pole, is greater than the total pole length in inches divided by 140.

641-4.2 Footings: Provide footings 3 feet 6 inches in diameter and of the depth specified in the plans for strain poles used for span wire support of traffic signals. Provide footings for all other pole applications as specified in the plans. Construct the footings with concrete as specified in Section 347.

For the excavation and backfill of the footing, meet the requirements specified in 125-4 and 125-8.2 with the exception of the backfill density. In lieu of the requirements for obtaining the specified density, the Contractor may hand tamp the backfill in 4 inch maximum layers or machine tamp the backfill in 6 inch maximum layers. When performing such operations, ensure that the material is neither dry nor saturated. The Contractor may backfill with concrete.

Use forms, when required, meeting the requirements of 700-7.3. If the footing is cast in an oversize hole, place the concrete in the top 6 inches in a form. Trowel all exposed surfaces to a smooth finish.

641-4.3 Orientation of Poles: For poles supporting one catenary wire, orient the pole so that the load face is perpendicular to the catenary wire. For poles supporting two catenary wires, orient the pole so that the load face is perpendicular to a line bisecting the angle between the two catenary wires.

641-5 Method of Measurement.

641-5.1 General: Measurement for payment will be in accordance with the following work tasks.

641-5.2 Furnish and Install: The Contract unit price for Prestressed Concrete Poles, Furnish and Install, will consist of the pole plus all labor, concrete for the foundation and other materials necessary for a complete and accepted installation as specified in the Contract Documents.

641-5.3 Furnish: The Contract unit price for Prestressed Concrete Poles, Furnish, will include the cost of the pole and shipping, handling, and delivery of the pole to the site designated in the Contract Documents.

641-5.4 Install: The Contract unit price for Prestressed Concrete Poles, Install, will include all labor, concrete for the foundation and other materials necessary for a complete and accepted installation as specified in the Contract Documents. The Engineer will supply the poles.

641-6 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 641-	Prestressed Concrete Poles - each.

SECTION 649
GALVANIZED STEEL STRAIN POLES, MAST ARMS AND MONOTUBE ASSEMBLIES

649-1 Description.

The work in this Section consists of furnishing and installing galvanized steel strain poles, galvanized steel mast arm(s) and galvanized steel monotube assemblies in accordance with the details shown in the Contract Documents, subject to a five year warranty period as defined herein. The warranty period will apply only when strain poles, mast arms or steel monotube assemblies are painted as called for in the Contract Documents.

649-2 Materials.

Use strain poles and mast arm assemblies listed on the Department's Qualified Products List (QPL) for all standard configurations shown in the Design Standards.

Obtain strain poles, mast arm and monotube assemblies from a fabrication facility that is listed on the Department's list of metal producers with accepted quality control program, meeting the requirements of 105-3.

Provide shop drawings and signed and sealed calculations, as needed, in accordance with Section 5 for configurations shown in the plans and denoted as special.

Use coating products meeting the requirements of Section 975.

Use grouts listed on the QPL meeting the requirements of Section 934.

Use water meeting the requirements of Section 923.

Use membrane curing compounds meeting the requirements of Section 925.

649-3 Fabrication.

Fabricate strain poles, mast arm and monotube assemblies and miscellaneous hardware in accordance with the Contract Documents. Cut all materials to the final dimensions and complete all welding prior to galvanizing. Obtain all components for individual strain poles, mast arm and monotube assemblies from the same fabricator. Obtain the luminaire and bracket from other sources, when necessary.

Affix an aluminum identification tag which will be visible from the handhold or located inside the terminal box containing the information described in the Design Standards.

Before shipping, assemble mast arm and monotube assemblies including luminaire and bracket to assure proper fit. The mast arm and monotube assemblies may be separated for shipment.

Ensure all components are protected from damage during shipping and handling by wrapping or other effective methods. Replace any component, which the Engineer determines is damaged beyond repair, at no additional cost to the Department. If components are wrapped for shipment, remove wrappings no later than five days after receipt of components or immediately if the wrappings become saturated. Post these instructions in brightly colored wording on the wrapper. Failure to comply with these instructions may lead to damage of the coating system and will be cause for the rejection of the component.

649-4 Coatings.

649-4.1 Galvanizing: Galvanize all components in accordance with ASTM A 123, except galvanize all fastener assemblies in accordance with ASTM A 153. Use galvanizing methods which provide surfaces suitable for painting.

649-4.2 Surface Preparation: Prepare all galvanized surfaces to be painted in accordance with ASTM D 6386 and the manufacturer of the coating system's specifications. Provide a clean and suitable galvanized surface that maximizes coating system adhesion.

Measure the thickness of the zinc coating after completion of surface preparation using a magnetic thickness gage in accordance with ASTM A 123. Ensure sufficient galvanizing remains on the substrate to meet the requirements of ASTM A 123 and the Contract Documents. Correct any deficient areas to the satisfaction of the Engineer at no additional cost to the Department.

649-4.3 Painting:

649-4.3.1 General: When required by the Contract Documents, provide painted strain poles, mast arms and monotube assemblies. Provide products from a fabricator on the Department's list of Prequalified Fabricators of Painted Galvanized Steel Strain Poles, Mast Arms and Monotube Assemblies. Provide products that will meet specification requirements throughout the warranty period. Meet the color requirement as specified in the Contract Documents. Provide the Engineer with two metal sample coupons, a minimum of 2 x 4 inches, painted concurrently and with the same paint as was used on the first lot

of any strain poles, mast arms and monotube assemblies delivered to the jobsite. Provide sample coupons and manufacturer product data sheets to the Engineer along with the delivery of the first shipment of any painted strain poles, mast arms or monotube assemblies delivered to the jobsite. At the time of their delivery, the sample coupons described in this paragraph shall match the color of the strain poles, mast arms and monotube assemblies to within 1ΔE measured as specified in 975-7. If the delivered sample coupons exhibit a difference in color from the strain poles, mast arms and monotube assemblies greater than 1ΔE then the sample coupons will be considered unacceptable and no payment shall be made for the materials which the sample coupons represent. Those materials shall not be accepted by the Department until acceptable representative sample coupons in accordance with the requirements of this Section have been delivered to the Engineer.

649-4.3.2 Responsible Party Warranty: When the Contract Documents call for painted galvanized steel strain poles, mast arms or monotube assemblies, the Contractor shall designate a Responsible Party to accept responsibility. The Responsible party designated by the Contractor must execute and deliver to the Department a form, provided by the Department, prior to the first delivery to the jobsite of any painted strain poles, mast arms or monotube assemblies, stipulating that the Responsible Party accepts responsibility for ensuring the coating system adhesion and color retention requirements as specified in 975-7 are met for a period of five years after final acceptance in accordance with 5-11. The Responsible Party shall also bear the continued responsibility for performing all remedial work associated with repairs of any adhesion or color retention failure as defined in Section 975, as to which notice was provided to the Responsible Party within the five year warranty period. Failure to timely designate the Responsible Party will result in the Contractor being the Responsible Party unless otherwise agreed to in writing by the Department. The responsible Party shall be either the Contractor or the Fabricator. When the Responsible Party is the Fabricator, the Responsible Party shall be one of the Fabricators listed on the "Prequalified Fabricators of Painted Galvanized Steel Strain Poles, Mast Arms and Monotube Assemblies." This list may be viewed on the Department's website at the following URL: www.dot.state.fl.us/construction/ .

Upon final acceptance of the Contract in accordance with 5-11, the Contractor's responsibility to ensure that the coating system adhesion and color retention requirements specified in 975-7 will terminate. The obligations of the Responsible Party set forth in this Section shall start at final acceptance of the Contract in accordance with 5-11 and continue thereafter until expiration of the five year warranty period.

649-5 Installation.

Install foundations for strain poles, mast arm and monotube assemblies in accordance with Section 455. Do not install the mast arm pole, strain poles or monotube pole until the foundation has achieved 70% of the specified 28-day concrete strength and verifying test results have been provided to the Engineer. Determine concrete strength from tests on a minimum of two test cylinders prepared and tested in accordance with ASTM C 31 and ASTM C 39. Before

erecting the pole clean the top of the foundation of any laitance, oils, grease or any other deleterious materials. Erect strain poles in an orientation which considering the rake and the application, cable forces will produce a plumb pole. Erect monotubes plumb at the time of installation. Plumb the pole supporting mast arms after the mast arms, traffic signals or sign panels have been placed.

If the traffic signals and/or sign panels are not in place within two working days after the mast arm is erected, furnish and install a 3 by 2 foot blank sign panel on the bottom of each mast arm within 6 feet of the mast arm tip and plumb the pole. Re-plumb the pole supporting mast arms after installation of traffic signals and sign panels.

Install ASTM A 325 bolt, nut and washer assemblies in accordance with the following. Use bolt, nut and washer assemblies that are free of rust and corrosion and that are lubricated properly as demonstrated by being able to easily hand turn the nut on the bolt thread for its entire length. Tighten nuts to the full effort of an ironworker using an ordinary spud wrench to bring the faying surfaces of the assembly into full contact which is referred to as "snug tight." After bringing the faying surfaces to a snug tight condition, tighten nuts in accordance with the turn-of-nut method in Table 460-7 of Specification 460-5. Maintain uniform contact pressure on the faying surfaces during snugging and turn-of-nut process, by using a bolt tightening pattern that balances the clamping force of each bolt, as closely as possible, with the equal clamping force of a companion bolt.

Use ASTM F 1554 anchor bolt assemblies that are free of rust and corrosion, and lubricate these assemblies prior to installation so that the nut turns easily by hand the entire length of the bolt thread. Install nuts on anchor bolts in accordance with the sequence that follows. Ensure that the base plate is level by incrementally adjusting the leveling nuts all of which must be in direct contact with the bottom surface of the base plate at the conclusion of the leveling process. The distance from the bottom of leveling nuts to the top of the concrete foundation must not exceed one anchor bolt diameter. Tighten all the anchor bolt nuts so they are in direct contact with the top surface of the base plate and are "snug tight." Snug tight is attained by applying the full tightening effort of an ironworker using an ordinary spud wrench. If the top surface of the base plate has a slope that exceeds 1:40, use a beveled washer under the anchor bolt nut. Tighten the leveling nuts until they are snug tight. Match mark the anchor bolt nut relative to the anchor bolt to ensure that the anchor bolt nut is rotated by the fraction of a turn specified in Table A and apply the turn to the nut. Do not exceed the Table A value by more than 20 degrees. Tighten each "retainer" or "jam" nut until it is in firm contact with the top surface of the anchor bolt nut then while preventing the anchor bolt nut from rotating, tighten the jam nut until it is snug tight. During each stage of leveling nut, anchor bolt nut and jam nut tightening, use a pattern of tightening that, as nearly as possible, produces a balanced distribution of clamping forces on the base plate as tightening progresses.

Table A	
Anchor Bolt Diameter (in.)	Nut Rotation from Snug Tight Condition
≤ 1 1/2	1/3 turn
> 1 1/2	1/6 turn

649-6 Screen Installation.

Install a screen that will prevent vermin and debris from entering the gap between the bottom of the base plate and the top of the concrete foundation. Cover the entire gap with a wire screen, the bottom horizontal wire of which shall be in full contact with the surface of the concrete foundation and the top horizontal wire of which shall not extend beyond the top surface of the base plate. For the screen, use standard grade plain weave galvanized steel wire cloth with 1/2 inch x 1/2 inch mesh and 0.063 inch diameter wires. Vertical screen wires shall not extend beyond the top and bottom horizontal wires of the screen. Use one continuous section of screen with only one overlapping splice where the ends come together and overlap the layers 3 inches minimum. Attach the screen to the vertical side of the base plate with self-tapping stainless steel screws (#8-1/2 inch long) with stainless steel washers (1/4 inch inside diameter). Drill pilot holes into the base plate to facilitate screw installation. Install screws on 9 inch centers maximum and at least one screw shall be installed through the overlapping splice to clamp the layers together. Also clamp the overlapping splice layers together just above the concrete foundation with an all stainless steel fastener assembly consisting of a machine screw (#8-5/8 inch long), nut and 2 flat washers (1/4 inch inside diameter) and lock washer. Tightly clamp the screen layers between the flat washers.

649-7 Remedial Work.

During the warranty period, the Responsible Party shall perform all remedial work necessary to meet the requirements of this Specification at no cost to the Department. Such remedial work shall be performed within 180 days of notification of a failure by the Department. Failure to perform such remedial work within the time frame specified will result in the work being performed by other forces at the Responsible Party's cost.

If the Responsible Party is the Fabricator, the Fabricator will be removed from the list of "Prequalified Fabricators of Painted Galvanized Steel Strain Poles, Mast Arms and Monotube Assemblies" for a minimum of six months or until payment in full for the correction of the deficiencies or defects has been made, whichever is longer.

If the Responsible Party is the Contractor, the Department will suspend, revoke or deny the Responsible Party's certificate of qualification under the terms of Section 337.16(d)(2), Florida Statutes, for a minimum of six months or until payment in full for the correction of the deficiencies or defects has been made, whichever is longer.

649-8 Statewide Disputes Review Board.

A Statewide Disputes Review Board will resolve any and all disputes that may arise involving administration and enforcement of this Specification. The Responsible Party and the Department acknowledge that use of the Statewide Disputes Review Board is required, and the determinations of the Statewide Disputes Review Board for disputes arising out of this Specification will be binding on both the Responsible Party and the Department, with no right of appeal by either party.

649-9 Method of Measurement.

649-9.1 General: Measurement for payment will be in accordance with the following work tasks.

649-9.2 Furnish and Install: The Contract unit price each for strain poles, mast arm and monotube assemblies, furnished and installed, will include all materials specified in the Contract Documents, including the foundation, cover plates, caps, clamps, blank sign panel, luminaire bracket, all labor, equipment, miscellaneous materials and hardware necessary for a complete and acceptable installation.

649-9.3 Furnish: The Contract unit price each for strain poles, mast arm and monotube assemblies, furnished, will include all materials, all shipping and handling costs involved in delivery as specified in the Contract Documents.

649-9.4 Install: The Contract unit price each for strain poles, mast arm and monotube assemblies, installed, will include the foundation, blank sign panel, all labor, equipment, miscellaneous materials and hardware necessary for a complete and acceptable installation. The Engineer will supply materials as specified in the Contract Documents.

649-10 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section. Sign panels and/or signal assemblies will be paid for separately.

Payment will be made under:

Item No.	649-	Steel Mast Arm Assembly - each.
Item No.	649-	Steel Monotube Assembly - each.
Item No.	649-	Steel Strain Pole - each.

SECTION 650
VEHICULAR SIGNAL ASSEMBLIES

650-1 Description.

Install vehicular traffic signal assemblies. For additional requirements related to the installation of the signals, refer to the appropriate Sections for the installation of related elements of the overall traffic signal system.

650-2 Materials.

Use signal and signal lamps currently listed on the Department's Approved Product List (APL). Ensure that all equipment is marked in accordance with Section 603.

650-3 Installation.

650-3.1 Preassembly: Pre-assemble the signal heads when more than one signal section is required prior to installation at the site. Furnish signal heads with the signal lamps firmly seated in the lamp receptacle. Rotate the lamp receptacle (or the reflector holder) so that the opening between the filament ends is up.

650-3.2 Positioning of Signals: Consider the locations of the installed signals as shown on the plans as sufficiently flexible as to allow for unanticipated field conditions at the site. The Engineer will direct any variations from the locations shown. Position adjacent signal faces no closer than 8 feet apart measured horizontally at 90 degrees to the traffic flow between centers of faces.

Regardless of the results of any scaled dimensions, consider the location shown on the plans to be approximate. Position a signal face mounted on a span wire or mast arm as near as practical to the line of the driver's normal view.

Ensure that all sections are of the same manufacturer and the section assemblies are uniform in appearance and alignment.

650-3.3 Clearances: Unless directed otherwise by the Engineer for unusual circumstances at the site, provide a vertical clearance of not less than 17 1/2 feet and not more than 19 feet for traffic signals placed over the roadway. Measure such clearance for each span directly under the most critical signal assembly (in regards to clearance) for that span. Place signal assemblies on each span as near as practical to the same elevation as the critical signal assembly.

Ensure that the lowest point on pedestal-mounted and side-mounted signal heads is 12 feet above finished grade at the point of their installation.

650-3.4 Aiming of Signal Indication: For proper lateral orientation, aim signals after installing and before locking them in position.

650-3.5 Wiring Connections: Do not splice signal cable. Connect the proper signal cable to the terminals in each signal head in order to provide the proper signal indication display when the cables are connected to the controllers. Wire a separate neutral circuit and return it to the controller cabinet from each vehicular movement as shown in the Contract Documents.

650-3.6 Special Installation Requirements for Optically Programmed Signals: Install, direct (aim), and conceal optically programmed signals in strict accordance with the instructions of the manufacturer, using the materials furnished by the signal manufacturer with the signals, and with the directions of the Engineer.

Position the signals for maximum performance in accordance with the requirements shown on the plans, and install them with rigidly firm mounts, using elbows and plumbizers of such type as will provide for stability of the position of the signals. Do not use clevises in the supporting attachments.

Seal the cable routing to the signals to provide permanent water tightness.

650-3.7 Vertically Mounted Polycarbonate (Light-Weight) Signal Head Assemblies: Ensure that when mounted in a vertical position and suspended from the top section all polycarbonate signal head assemblies have a die cast aluminum top section. Ensure that all sections of the assembly are from the same manufacturer. Single section polycarbonate assemblies may be used without a die cast aluminum top section.

650-3.8 Sealing Installed Signal Head Assembly: Ensure that the installed signal head assembly is sealed to exclude dust and moisture. Drill two 1/4 inch drain holes in the bottom of the installed signal head assembly.

650-3.9 Concealing Signals Not in Use: Where traffic signals are installed and not put into service immediately, conceal the signal head assembly by placing burlap bags or other covering approved by the Engineer over a weather resistant covering of non-transparent material open at the bottom to prevent condensation buildup.

650-3.10 Installation Sequence: Install all traffic signal assemblies at any intersection as a single operation unless a staged operation is approved by the Engineer.

650-4 Method of Measurement.

650-4.1 General: Measurement for payment will be in accordance with the following work tasks.

650-4.2 Furnish and Install: The Contract unit price per assembly for Traffic Signal, furnished and installed, will consist of the traffic signal assembly, including all hardware, labor, and materials necessary for a complete and accepted installation.

650-4.3 Furnish: The Contract unit price per assembly for Traffic Signal, furnished, will include the cost of all components of a traffic signal assembly plus all shipping and handling cost involved in delivery as specified in the Contract Documents.

The Contractor shall deliver the assembly in an unassembled state, with the following exception, deliver signal sections assembled in the required number of sections for one direction so that with minimum effort they may be combined into a multiple direction assembly as specified in the Contract Documents. The Contractor shall include all hardware specified in this Section in the components of the assembly which are to be furnished and used in the installation of the assembly. The Contractor shall package and ship component parts of the assembly in accordance with manufacturer's instructions in order to minimize the potential for damage during shipment.

650-4.4 Install: The Contract unit price per assembly for Traffic Signal, installed, will consist of all labor necessary to assemble all traffic signal components for a complete and accepted installation.

The Engineer will supply all traffic signal assembly components. The Contractor shall furnish any required minor miscellaneous standard hardware items, such as nuts and bolts, as part of the installation task.

650-4.5 Relocate: The Contract unit price per assembly for Traffic Signal, relocate, will include the removal of the signal head and installation at the

location shown in the plans. This includes signal cable and all other materials necessary for a complete and accepted relocation.

650-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including all hardware necessary to make a complete unit with proper lens indications, mounting hardware, brackets, drop-pipe, disconnect hangers, bulbs, and any other materials or equipment to make a complete installation.

Payment will be made under:

Item No. 650- 5- Traffic Signal–per assembly.

SECTION 653
PEDESTRIAN SIGNAL ASSEMBLIES

653-1 Description.

Install pedestrian signal assemblies as shown in the plans and Design Standards, Index No. 17764.

653-2 Materials.

Use only pedestrian signals currently listed on the Department's Approved Product List (APL). Ensure that all equipment is marked in accordance with Section 603.

653-3 Installation.

653-3.1 General: Use pedestrian signal assemblies capable of being maintained, adjusted, or disassembled with ordinary hand tools. Pre-assemble the pedestrian signal (not mounting hardware) prior to installation at the site. Connect the proper signal cable wires to the proper connections in the pedestrian housing in order to provide the proper signal indication display. Conceal all conductors. Construct the pedestrian signal assembly (including the mounting hardware) to be a weathertight unit.

653-3.2 Placement: Install the pedestrian signals at a location and mount them in the manner as shown on the plans. Consider the plans to be sufficiently flexible as to allow for unanticipated field conditions at the site. The Engineer will direct all variation from the locations shown. Mount pedestrian signals with bottom of housing not less than 8 feet (standard) or more than 10 feet above the sidewalk level. Position pedestrian signals and all mounting assembly members as either plumb or level, and symmetrically arranged. Properly aim the signals in the line of the pedestrian's vision for the crosswalk being used.

653-3.3 Installation Sequence: Install all pedestrian signal assemblies at any intersection as a single operation unless a staged operation is approved by the Engineer. Do not install signals at any intersection until all other signal equipment, including the controller, and pedestrian detectors, are in place and ready for operation, unless completely covered, in accordance with 650-3.8. Ensure that the cover remains in place until the pedestrian signal is placed into operation.

653-4 Method of Measurement.

653-4.1 General: Pedestrian signal assemblies will include any hardware necessary to make a complete installation and may include one or more pedestrian signals, as specified in the Contract Documents, including the appropriate mounting hardware.

Measurement for payment will be in accordance with the following work tasks.

653-4.2 Furnish and Install: The Contract unit price per assembly for Pedestrian Signal, furnished and installed, (including mounting hardware but not including pedestals) will include all materials and equipment as specified in the Contract Documents, and all labor and materials necessary for a complete and accepted installation.

653-4.3 Furnish: The Contract unit price per assembly for Pedestrian Signal, furnished, will include the cost of the assembly including all mounting hardware as specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

The Contractor shall deliver the pedestrian signal assembly in a pre-assembled state. The Contractor shall package and ship component parts of the assembly in accordance with the manufacturer's instructions to minimize the potential for damage during shipment.

653-4.4 Install: The Contract unit price per assembly for Pedestrian Signal, installed, will consist of all labor necessary to assemble all components for complete and accepted installation. The Engineer will supply pedestrian signal assembly (including all mounting hardware) as specified in the Contract Documents. The Contractor shall furnish all conduit, risers, lead-in-wires, posts or miscellaneous materials needed to complete the installation as specified in the Contract Documents.

653-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 653-	Pedestrian Signals - per assembly.

SECTION 660
INDUCTIVE LOOP DETECTORS

660-1 Description.

Install inductive loop detectors, harnesses, and loop assemblies.

660-2 Materials.

Use inductive loop detectors, pre-formed loop assemblies and loop sealant currently listed on the Department’s Approved Products List (APL). Ensure that all loop detectors are marked in accordance with Section 603 and the markings are visible after installation.

660-3 Installation Requirements.

660-3.1 Inductive Loop-Detector Units: Install inductive loop detector units and cable harnesses in accordance with the manufacturer's instructions and the Design Standards, Index No. 17781. Adjust the operating frequency of each detector unit, if required, to prevent crosstalk of the units.

660-3.2 Saw Cuts: Use a chalk line or equivalent method to outline the perimeter of the loop on the pavement and routes for lead-in cables. Do not allow the saw cut in the pavement to deviate by more than 1 inch from the chalked line. Ensure that all saw cuts are free of any dust, dirt or other debris and completely dry prior to the installation of the loop wire, loop wire twisted pair lead or lead-in cable.

Make saw cuts in accordance with the Design Standards, Index No. 17781. Ensure that the top conductor of the loop wire or lead-in cable is a minimum of 1 inch below the final surface of the roadway.

660-3.3 Loop Wire: Ensure that all loops are wound in a clockwise manner and the first turn of the loop wire is placed in the bottom of the saw cut, with each subsequent turn placed on top of the preceding turn. Push the loop wire to the bottom of the saw cut with a non-metallic tool which will not damage the insulation.

Tag and identify the clockwise "lead" of each loop.

Use alternate polarity on adjacent loops.

Ensure that the hold down material is non-metallic and is not longer than 1 inch and that the distance from the top of the hold down material to the final surface of the roadway is not less than 3/4 inch.

Twist the loop wire a minimum of five turns per 1 foot to form a loop wire twisted pair lead from the edge of the loop to the pull box.

Splice the loop wire twisted pair lead to the lead-in cable in the pull box. Place only one loop wire twisted pair lead in a saw cut.

Ensure that the distance between a twisted loop wire pair lead within the roadway is a minimum of 6 inches from any other twisted loop wire pair lead or loop, until they are within 1 foot of the edge of pavement or curb, at which point they may be placed closer together.

Prepare and apply the loop sealant in accordance with the manufacturer's instructions. Ensure that the loop sealant has cured completely before allowing vehicular traffic to travel over the sealant.

660-3.4 Lead-In Cable: Place the lead-in cable in the bottom of the saw cut. Do not damage the insulation.

Install no more than four lead-in cables in a saw cut. Ensure that the hold down material is not longer than 1 inch and that the distance from the top of the hold down material to the final surface of the roadway is not less than 3/4 inch.

Prepare and apply the loop sealant in accordance with the manufacturer's instructions. Ensure that the loop sealant has cured completely before allowing vehicular traffic to travel over the sealant.

660-4 Splicing and Termination Requirements.

660-4.1 Splicing: Splice lead-in cable to the loop wire in accordance with Design Standards, Index No. 17781. Perform the splicing in a pull box located off the roadway, not in the roadway itself.

Splice the black conductor of the lead-in cable to the clockwise "lead" of the loop.

Ensure that the ends of the cable jackets, twisted pair and lead-in, are encased in the loop splice material.

Ensure that each loop has an individual return to the cabinet and series splicing is performed on a separate terminal block in the cabinet.

660-4.2 Terminations: Using insulated terminal lugs, terminate lead-in cables or twisted pair loop wire on a terminal strip which is located in the controller or detector cabinet. Use a calibrated ratchet type crimping tool to attach the lugs to the conductors of the lead-in cable or twisted loop wire.

660-5 Loop Assembly Identification.

Identify and tag each loop assembly in the controller or detector cabinet by lane and movement number.

Example:

Outside lane- Movement 6
Center lane- Movement 6
Inside lane- Movement 6

660-6 Testing Requirements.

660-6.1 Series Resistance: Obtain Department of Transportation Traffic Signal Resistance Measurement Data Sheets from the Engineer. Measure and record the series resistance of each loop assembly on these Data Sheets. Leave a copy in the controller cabinet.

If the series resistance of a loop assembly is greater than 10 Ω, inspect the loop assembly to find the cause of the excessive resistance. Correct the cause of the excessive resistance at no additional cost to the Department.

660-6.2 Insulation Resistance: Measure and record the insulation resistance of each loop assembly, and verify that the resistance is greater than 100 MΩ. Use a 500 V_{DC} insulation megger to measure the resistance. Reference all measurements to a good earth ground (ground rod, metallic water pipe, etc.). Disconnect the transient suppression devices from the loop assemblies before taking any measurements. If the insulation resistance is less than 100 MΩ, determine if the lead-in cable or the loop wire is causing the problem, and replace the defective cable or loop wire at no additional cost to the Department.

660-7 Turn On Requirements.

Connect the loop assemblies to the appropriate inductive loop vehicle detectors and tune the detectors in accordance with the manufacturer's instructions. Separate the operating frequencies of vehicle detectors, in adjacent lanes, by at least 2 kHz.

660-8 Method of Measurement.

660-8.1 General: Measurement for payment will be in accordance with the following tasks.

660-8.2 Furnish and Install: The Contract unit price each for Inductive Loop Detector and per assembly for Loop Assembly, furnished and installed, will include all equipment, materials as specified in the Contract Documents and all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

660-8.3 Furnish: The Contract unit price each for Inductive Loop Detector, per assembly for Loop Assembly, per gallon for Loop Sealant, per foot for Loop Material and for each Inductive Loop Detector Accessories, furnished, will include all equipment and materials as specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

660-8.4 Install: The Contract unit price each for Inductive Loop Detector and per assembly for Loop Assembly, installed, will include all loop sealant, miscellaneous materials, labor, and equipment necessary for a complete and accepted installation.

The Engineer will supply the inductive loop detector, harness, lead-in cable, and loop wire.

660-8.5 Modify: The Contract unit price per assembly for Loop Assembly, modified, will include all lead-in cable, saw cuts, miscellaneous materials as specified in the Contract Documents, connecting new lead-in cable to an existing loop and installing and terminating the lead-in cable to the location designated in the Contract Documents, and all labor and equipment necessary for a complete and accepted installation.

660-9 Basis of Payment.

660-9.1 Inductive Loop Detector: Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 660- 1- Inductive Loop Detector - each.

660-9.2 Loop Assembly: Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 660- 2- Loop Assembly - per assembly.

SECTION 665
PEDESTRIAN DETECTOR ASSEMBLY

665-1 Description.

Install pedestrian detector assembly.

665-2 Materials.

Use only an ADA (Americans with Disabilities Act) compliant pedestrian detector assembly listed on the Department's Approved Product List (APL).

Ensure that all pedestrian detectors are marked in accordance with Section 603 and the markings are visible after installation.

665-3 Installation.

Meet the requirements of 653-3.1, except as follows. Connect the lead-in wires to the detector in order to provide proper operation when connected to the controller.

Install the pedestrian detector assembly at the location and mounted in a manner as shown on the plans and Design Standards, Index No. 17784 (Pedestrian Detector Assembly). Ensure that all detectors used are of the same manufacturer and model.

Consider the plans to be sufficiently flexible as to allow for unanticipated field conditions at the site. The Engineer will direct any variation from the locations shown. Mount the pedestrian detector assembly at the height (center of push-button) of 3 1/2 to 4 feet above the sidewalk. When mounting, place the detector housing or saddle in complete contact with the pole or controller cabinet. Orient the pedestrian detector assembly and sign to point in the same direction as the corresponding crosswalk. When a post is required in the installation of the pedestrian detector assembly, restore the area around the post to its original condition or as required by the plans.

665-4 Method of Measurement.

665-4.1 General: Measurement for payment will be in accordance with the following tasks.

665-4.2 Furnish and Install: The Contract unit price each for Pedestrian Detector Assembly, furnished and installed, will include all mounting hardware, lead-in wires, materials and equipment, as specified in the Contract Documents, and all labor and miscellaneous materials necessary for a complete and accepted installation.

665-4.3 Furnish: The Contract unit price each for Pedestrian Detector Assembly, furnished, will include the cost of the assembly (including all mounting hardware) plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

Risers, lead-in wires, or posts are not included in furnish items.

The Contractor shall deliver the pedestrian detector assembly in a pre-assembled state. The Contractor shall package and ship component parts of the assembly in accordance with the manufacturer's instructions in order to minimize the potential for damage during shipment.

665-4.4 Install: The Contract unit price each for Pedestrian Detector Assembly, installed, will include all materials, equipment, labor and miscellaneous materials necessary to assemble and install all components for a complete and accepted installation. The Engineer will supply the pedestrian detector assembly, including mounting hardware.

665-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 665- Pedestrian Detector - each.

SECTION 670
TRAFFIC CONTROLLER ASSEMBLY

670-1 Description.

Install traffic controller assembly or flashing beacon controller assembly.

670-2 Materials.

Use a traffic controller assembly or flashing beacon controller assembly listed on the Department's Approved Product List (APL). Ensure that the traffic controller assembly or flashing beacon controller assembly is marked in accordance with Section 603 and the markings are visible after installation.

670-3 Installation Requirements.

670-3.1 Controller Cabinets: Meet the requirements of Section 676.

670-3.2 Field Wiring: Meet the requirements of Sections 632 and 676.

670-3.3 Grounding: Meet the requirements of Sections 620 and 676.

670-3.4 Equipment Placement: Install all equipment in the cabinet in accordance with the manufacturer's recommendations.

670-4 Method of Measurement.

670-4.1 General: Measurement for payment will be in accordance with the following work tasks.

670-4.2 Furnish and Install: The Contract unit price per assembly for Traffic Controller Assembly or Flashing Beacon Controller Assembly, furnished and installed, will include all equipment specified in the Contract Documents, and all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

670-4.3 Furnish: The Contract unit price per assembly for Traffic Controller Assembly or Flashing Beacon Controller Assembly, furnished, will include all equipment specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

670-4.4 Install: The Contract unit price per assembly for Traffic Controller Assembly or Flashing Beacon Controller Assembly, installed, will include all labor, equipment, and miscellaneous materials necessary for a complete and acceptable installation. The Engineer will supply the equipment specified in the Contract Documents.

670-5 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 670- 5- Traffic Controller Assembly - per assembly.

SECTION 671
TRAFFIC CONTROLLERS

671-1 Description.

This Section specifies the provisions for the measurement and payment for NEMA Types D4-4, and D8 and Model 170 controller units.

671-2 Materials.

Use Traffic Controllers listed on the Department's Approved Product List (APL). Ensure that all Traffic Controllers are marked in accordance with Section 603 and the markings are visible after installation.

671-3 Method of Measurement.

671-3.1 General: Measurement for payment will be in accordance with the following work tasks.

671-3.2 Furnish and Install: The Contract unit price each for Traffic Controller Unit, furnished and installed, will include furnishing a controller unit and harness cable as specified in the Contract Documents, and all labor and miscellaneous materials necessary for a complete and accepted installation.

671-3.3 Furnish: The Contract unit price each for Traffic Controller Unit, furnished, will include the controller unit and harness cable as specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

671-3.4 Install: The Contract unit price each for Traffic Controller Units, installed, will include all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation. The Engineer will supply all materials as specified in the Contract Documents.

671-3.5 Modify: The Contract unit price each for Traffic Controller Units, modified, as specified in the Contract Documents, will include all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

671-4 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 671- 2- Traffic Controller - each.

SECTION 676
CONTROLLER CABINETS

676-1 Description.

Install NEMA cabinets types 1, 2, 3, 4, 5, and cabinets types used for Model 170 controller assemblies.

676-2 Materials.

Use Controller Cabinets listed on the Department's Approved Product List (APL). Ensure that all Controller Cabinets are marked in accordance with Section 603 and the markings are visible after installation.

676-3 Installation Requirements.

676-3.1 General: Install controller cabinets in accordance with the Design Standards, Index No. 17841. Ensure that all conduit entrance holes or other holes which are field drilled are reamed and free of burrs. Make all conduit connections to the cabinet watertight by the use of clear silicone rubber sealant.

676-3.2 Pole Mounted Cabinets (Types 1, 2, 3, and 4):

(a) Fasten the pole mounted hardware which is furnished with the cabinet to the cabinet, making all connections watertight.

(b) Use stainless steel bands for mounting cabinets onto steel strain poles.

(c) Use stainless steel bands or lead anchors (or equivalent) for mounting cabinets onto concrete strain poles.

(d) Use stainless steel bands or lag bolts for mounting cabinets onto wood poles.

676-3.3 Base Mounted Cabinets (Types 4, 5, and types used for Model 170 Controller Assemblies):

(a) Use anchor bolts to fasten base mounted cabinets to the concrete base.

(b) Seal the joint between the bottom of the cabinet and the concrete base (inside and outside of cabinet) with a clear silicone rubber sealant.

(c) Construct the base for the cabinets with concrete in accordance with Section 347. Make the concrete base for the cabinet level, free of honeycombs and as smooth as possible. Temporarily seal the end of conduit risers located in the base before placing the concrete. Position the end of the conduit risers a minimum of 2 inches above the finished surface of the concrete base.

676-3.4 Field Wiring:

(a) Terminate signal cable, interconnect cable, and loop lead-in wires on the appropriate terminal strips in the controller cabinet with insulated terminal lugs. Use a calibrated ratchet type crimping tool to install the insulated terminal lugs onto the field wires.

(b) Label spare circuits of the signal and interconnect cables and connect them to the cabinet ground bussbar.

(c) Neatly bundle and identify all field wiring cables in the controller cabinet.

676-3.5 Grounding: Ground all controller cabinets in accordance with the requirements of Section 620. Keep the ground wire from the controller cabinet ground bussbar to the ground rod assembly or array as short as possible. Ensure the ground wire is not in contact with any other part of the cabinet.

676-4 Method of Measurement.

676-4.1 General: Measurement for payment will be in accordance with the following work tasks.

676-4.2 Furnish and Install: The Contract unit price each for Controller Cabinet, furnished and installed, will include all materials specified in the Contract Documents, and all labor, equipment, and miscellaneous materials necessary for a complete and acceptable installation.

676-4.3 Furnish: The Contract unit price each for Controller Cabinet, furnished, will include all materials and all shipping and handling costs involved in delivery as specified in the Contract Documents.

676-4.4 Install: The Contract unit price each for Controller Cabinet, installed, will include all labor, equipment, and miscellaneous materials necessary for a complete and acceptable installation. The Engineer will supply all materials as specified in the Contract Documents.

676-4.5 Modify: The Contract unit price each for Controller Cabinet, modified, as specified in the Contract Documents, will include all labor, equipment, and miscellaneous materials necessary for a complete and acceptable installation.

676-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 676- 1- Controller Cabinet - each.

SECTION 678
CONTROLLER ACCESSORIES

678-1 Description.

Install Controller Accessories.

678-2 Materials.

Use Traffic Controller Accessories listed on the Department's Approved Product List (APL). Ensure that all Traffic Controller Accessories are marked in accordance with Section 603 and the markings are visible after installation.

678-3 Time Switch.

Mount time switches on the inside wall of the controller cabinet in such a manner as to allow easy access for programming the switch. Ensure that the load current on the output circuit(s) of the time switch does not exceed 3 A at 115 $V_{AC.}$ Whenever time switches are used for transferring a controller assembly to and from flashing operation, wire the controller cabinet for uniform code flashing as specified in the Contract Documents.

678-4 Method of Measurement.

678-4.1 General: Measurement for payment will be in accordance with the following work tasks.

678-4.2 Furnish and Install: The Contract unit price each for Controller Accessory, furnished and installed, will include furnishing all materials,

equipment, and hardware specified in the Contract Documents, and all labor and miscellaneous materials necessary for a complete and acceptable installation.

678-4.3 Furnish: The Contract unit price each for Controller Accessory, furnished, will include the cost of the equipment and materials and all shipping and handling costs involved in delivery as specified in the Contract Documents.

678-4.4 Install: The Contract unit price each for Controller Accessory, installed, will include all labor, equipment, and miscellaneous materials necessary for a complete and acceptable installation. The Engineer will supply all materials as specified in the Contract Documents.

678-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 678- 1- Controller Accessories - each.

SECTION 690
REMOVAL OF EXISTING TRAFFIC SIGNAL EQUIPMENT

690-1 Description.

Remove existing traffic signal equipment including electrical and electronic equipment, supporting hardware and structures, electrical wiring conduit, and all other elements specified and required to clear the areas of concern for new installations.

When removing existing traffic signal equipment, salvage and protect all equipment and materials designated for removal in the Contract Documents.

690-2 Ownership.

The Department retains ownership of the equipment removed unless otherwise stated in the Contract Documents.

690-3 General Removal Operations.

Remove and salvage all equipment, appurtenances, and materials designated on the plans to remain the property of the Department or other owner.

Where the removals require excavation, backfill, compact, and level the excavated areas (unless to be used as areas for other installations) so as to form a smooth contour, uniform in density with adjacent ground areas.

Where the removal operations require the removal or disturbance of overlying pavement, curb, grass, or sidewalk, remove such pavement and subsequently replace it in kind (or equivalent).

Remove, handle, and transport electronic equipment to be removed with all due care. Correct any damage to such equipment caused by negligence at no expense to the Department regardless of whether the damage occurs before or after removal of the equipment.

When removing all electronic equipment, also remove all attaching devices and all other devices and auxiliaries related to the electronic unit which the Department does not require to remain in place for use with replacing equipment.

Perform all removals in such a manner as to not damage or disturb adjacent property, utilities, or other equipment.

Where replacing existing functioning installations by new installations, do not remove the existing installations until the new installations are in place and operating or until temporary traffic control approved by the Engineer is in place.

Notify the proper authorities or the owners of affected adjacent installations at least 24 hours in advance of any removal operations which might endanger or otherwise affect the operations of their facilities.

Where the Contract Documents indicate that owners will remove their own poles (or others), carefully remove and handle all signal equipment from such poles prior to such removal of the poles.

690-4 Specific Removal Operations.

690-4.1 Removal of Poles: Remove direct burial, strain poles, steel strain poles, mast arm and monotube assemblies and associated foundations as specified in the plans. Obtain the Engineer's approval for the removal process before beginning any removal work. These requirements do not apply to poles used for highway lighting, unless they are jointly used to support traffic signal mast arm or span wire assembly.

Accomplish the removal process of each pole/foundation in such a manner as not to result in a safety hazard to motorists or adjacent property or damage to existing utilities. Ensure that all utilities have been located prior to removal.

When shallow pole removal is specified in the plans, ensure the remaining pole/foundation and any protrusions, such as pole keys, dead men, guying apparatus, conduit, anchor bolts, or reinforcing steel, are removed to a minimum depth of 4 feet below existing grade.

When deep pole removal is specified in the plans completely remove each pole including the foundation and all accessories or attachments, such as pole keys, dead men, guying apparatus, conduit, anchor bolts, and reinforcing steel.

Do not remove or disturb utility poles located within the right-of-way.

690-4.2 Removal of Signal Pedestal: Remove each signal pedestal and associated foundations as specified in the plans. Obtain the Engineer's approval for the removal process before beginning any removal work.

Accomplish the removal process of each pedestal/foundation in such a manner as not to result in a safety hazard to motorists, pedestrians or adjacent property or damage to existing utilities. Ensure that all utilities have been located prior to removal.

Completely remove each pedestal including the foundation and all accessories or attachments, such as pole keys, conduit, anchor bolts, and reinforcing steel.

690-4.3 Controller Assembly: When removing controller assemblies, also remove the cabinet. For base mounted cabinets, completely remove the concrete base and technician pad.

Prior to removal, conduct an inventory of all controller assembly parts, cabinets, and related equipment using an appropriate list, as determined by the Engineer, including identification of the model number and serial numbers of each item. Turn over the controller assembly inventory list to the Engineer for retention by the Department or transfer the list to the equipment owner.

690-4.4 Signal Head Assembly (Vehicular and Pedestrian): Remove all signal head assemblies in such a manner as to avoid unnecessary damage. Also remove the signal head, disconnect hanger and adjustable hanger, saddle clamp, drop pipe, and all miscellaneous attachment hardware before dropping span wire.

690-4.5 Detector Assembly (Vehicular and Pedestrian): Divide the removal of detector assemblies into the following categories:

(a) Vehicular Detector Assemblies: When the removal of vehicular detector assemblies is specified in the Contract Documents, remove the amplifier from the controller cabinet, the loop, and the lead-in wiring that is in the conduit and pull boxes.

When removing pressure type vehicular detector assemblies, remove the amplifier and the detector pad and its framework from the roadway pavement. After removing such detector assemblies, repair the roadway areas by backfilling and tamping with an approved asphalt concrete mix or concrete pavement mix so as to restore the roadway to the satisfaction of the Engineer.

(b) Pedestrian Detector Assemblies: Include in the removal of pedestrian detector assemblies the removal of the push button detector, sign, and all mounting hardware, including the supporting post and foundation.

690-4.6 Mast Arm Assembly: Disconnect the mast arms carefully at the pole, and salvage all usable hardware and attachment devices as determined by the Engineer. Remove all devices supported by the mast arm and the wiring in the mast arm prior to the removal of the mast arm.

For integrally installed mast arms and mast arm poles, remove the pole and mast arm combination as a unit after removing the devices supported by the mast arms.

690-4.7 Cabling and Conduit: After removing the conductor cable and conduit, carefully stub, or protect with other appropriate procedures, the remaining conductor cable and conduit at the point of removal.

If the removal of any cables and conduit requires excavation, restore disturbed areas compatible with adjacent ground areas.

690-5 Transporting and Storing Removed Signal Equipment.

When the Contract Documents specify special handling, deliver equipment and materials that are not stipulated to be reused in the new installations to the location(s) designated in the Contract. When the Contract Documents note no special handling, stockpile or dispose of the removed materials as approved by the Engineer. The Engineer will determine ownership of removed equipment and will approve of the removal of any salvaged equipment from the project in advance.

Provide disposal areas, and dispose of removed concrete strain poles in such areas.

690-6 Method of Measurement.

690-6.1 General: The quantities to be paid for will be measured in accordance with the different work tasks required in this Section. The Contract unit price for each different work task as specified in the Contract Documents will include all labor and equipment required to remove the specified items specified by the Pay Item Numbers.

690-6.2 Remove Poles:

690-6.2.1 Pole Removal Shallow: The quantity to be paid for will be the removal of each pole including the foundation and all accessories or attachments to a depth not less than 4 feet below existing grade.

690-6.2.2 Pole Removal Deep: The quantity to be paid for will be the depth in foot below existing grade required for complete removal of the pole and foundation including all accessories or attachments.

690-6.3 Remove Signal Pedestal: The quantity to be paid for will be the complete removal of each pedestal including the foundation and all accessories or attachments.

690-7 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 690- 10-	Remove Traffic Signal Head Assembly - each.
Item No. 690- 20-	Remove Pedestrian Signal Assembly - each.
Item No. 690- 31-	Remove Signal Pedestal - each.
Item No. 690- 32-	Pole Removal Shallow - each.
Item No. 690- 33-	Pole Removal Deep - per foot.
Item No. 690- 50-	Remove Controller Assembly - each.
Item No. 690- 60-	Remove Vehicular Detector Assembly - each.
Item No. 690- 70-	Remove Pedestrian Detector Assembly - each.
Item No. 690- 80-	Remove Span Wire Assembly - each.
Item No. 690- 90-	Remove Cabling and Conduit - per intersection.
Item No. 690-100-	Remove Miscellaneous Signal Equipment - per intersection.

SECTION 699
INTERNALLY ILLUMINATED SIGNS

699-1 Description.

The work in this Section consists of furnishing and installing an Internally Illuminated Street Name Sign in accordance with the details specified in the Contract Documents.

699-2 Materials.

699-2.1 General: Use internally illuminated street name sign assemblies and associated mounting hardware meeting the requirements of the Minimum Specifications for Traffic Control Signal Devices (MSTCSD) and listed on the Department's Approved Product List (APL). Ensure all internally illuminated street name signs are marked in accordance with Section 603 and the markings are visible after installation.

Replace any component which the Engineer determines is damaged beyond repair at no additional cost to the Department.

699-2.2 Hardware: Meet the requirements of 603-2.4.

699-2.3 Clamp-On Cantilever Arm: Use only clamp-on cantilever arms which meet all design and wind loading requirements as specified in the Contract Documents. Ensure the clamp is adjustable to accommodate various size poles.

699-3 Submittal Requirements.

699-3.1 General: Free-swinging, internally illuminated signs and clamp-on cantilever arms mounted on the upright poles of mast arm assemblies or monotube signal structures may be accepted either by certification or by shop drawing submittal and approval as stipulated in this Section.

699-3.2 Acceptance of signs by Certification: Meet all of the following requirements:

1. Article 699-2,
2. Are not more than 12.0 sq. ft. in area, and
3. Weigh no more than 75 lbs.

699-3.3 Acceptance of signs by Shop Drawing Approval: Submit Shop Drawing in accordance with Section 5, for internally illuminated street name signs not meeting all of the requirements of 699-3.2.

699-3.4 Acceptance of Clamp-On Cantilever Arms: For Cantilever arms supporting signs meeting the requirements of 699-3.2, certify to the Engineer that the arm meets the criteria in this Section. For Cantilever Arms supporting signs which do not meet the requirements of 699-3.2, submit shop drawings and design calculations for the arm design in accordance with Section 5.

699-4 Installation.

699-4.1 General: Secure the brackets to the street name sign housing in accordance with the manufacturers instructions.

699-4.2 Single Sided Sign Assembly: Install as specified in the Contract Documents.

699-4.3 Double Sided Sign Assembly: Use a free swinging mounting method.

699-4.3.1 Two Point Support Assembly: Use a two point support assembly when the street name sign assembly is attached to a mast arm that is perpendicular to the street on which the sign is viewed.

Use a two point mast arm mounting assembly consisting of the following:

1. Stainless steel band or cable type clamp,
2. Clevis,
3. Span wire adapter,
4. Tri-stud hanger body.

Ensure one of the hangers has a mechanism for the horizontal adjustment of the sign.

699-4.3.2 One Point Support Assembly: Use a one point support assembly consisting of an articulated horizontal stainless steel band or cable type mast arm clamp, sign bracket and mounting hardware, when the street name sign assembly is attached to a mast arm that is diagonal to the street on which the sign is viewed. Do not use a one point support assembly for internally illuminated street name sign assemblies exceeding 4 feet in width.

Ensure the band or cable clamp is capable of horizontal rotation of 360 degrees.

699-4.4 Clamp-On Cantilever Arm: Attach the arm perpendicular to the street on which the street name sign assembly is viewed. Use a clamp and arm that are galvanized in accordance with ASTM A 123 unless otherwise specified in the Contract Documents. Ensure the arm has a cap secured in place.

699-4.5 Electrical Wiring: Install dedicated 14 AWG conductors to supply power to the sign. Connect the conductors to a dedicated 15 amp circuit breaker located either inside the controller cabinet or inside the electrical service disconnect. Using the same conduit system for both signal cables and internally illuminated sign conductors is permitted, unless otherwise specified.

Install conductors in such a manner as to prevent damage to conductors or conductor insulation. Remove and replace all damaged conductors /insulation at no additional cost to the Department.

Ensure drilled hole(s) through which conductor(s) pass through are fitted with a tight fitting rubber grommet.

Install continuous lengths of conductors between the dedicated circuit breaker and internally illuminated street name signs.

Do not splice conductors unless specified in the Contract Documents.

Provide one photoelectric cell to turn on/off all internally illuminated street name sign at each intersection. Use an ‘L’ bracket to mount the photoelectric cell as specified in the Contract Documents. Connect the photoelectric cell to a contactor assembly inside the controller cabinet to provide switching of the internally illuminated street name signs.

699-5 Method of Measurement.

699-5.1 General: Measurement for payment will be in accordance with the following tasks.

699-5.2 Furnish and Install: The Contract unit price each for Internally Illuminated Street Name Sign, furnished and installed, includes the Internally Illuminated Street Name Sign and Clamp-On Cantilever Arm as specified in the Contract Documents, all support and hanger hardware, photoelectric cell, relay assembly, field wiring to both the sign assembly, photoelectric cell, all miscellaneous materials, and labor necessary for a complete and accepted installation.

699-5.3 Furnish: The Contract unit price each for Internally Illuminated Street Name Sign, furnished, includes the Internally Illuminated Street Name Sign, and Clamp-On Cantilever Arm, and materials as specified in the Contract Documents, plus all shipping and handling costs involved in the delivery as specified in the Contract Documents.

699-5.4 Install: The Contract unit price each for Internally Illuminated Street Name Sign, installed, includes all miscellaneous materials and labor necessary for a complete and accepted installation as specified in the Contract Documents. The Engineer will supply the Internally Illuminated Street Name Sign and Clamp-On Cantilever Arm, as specified in the Contract Documents.

699-6 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 699- 1	Internally Illuminated Street Name Sign - each.

SECTION 700
HIGHWAY SIGNING

700-1 Description.

Furnish and erect aluminum or steel roadway signs, with supporting posts or columns, at the locations shown in the plans, in accordance with the details shown in the plans. Reflectorize all signs, and, when so specified in the plans, provide overhead signs with lighting.

The Department designates Ground Traffic Signs as all signs erected on the shoulders, slopes, or medians, but not extending over the traveled roadway.

The Department designates signs erected partially or completely over the traveled roadway or mounted on bridges as Overhead Traffic Signs, and may further classify some of these signs as Overhead Cantilever Traffic Signs.

700-2 Sign Assembly Design Requirements.

700-2.1 General: Sign assemblies as specified in the plans fall into two general categories: ground sign assemblies, and overhead sign assemblies.

Use any combination of sign materials described below. The Contractor may utilize different combinations for each type of sign assembly. However, ensure that the material combination used for each type is the same within the Contract.

700-2.2 Sign Panels: All sign panels shall be aluminum unless otherwise designated in the plans.

If using galvanized steel for the sign panels, provide the same dimensions, including the thickness, as those shown in the Contract Documents for aluminum.

Fabricate standard sign panel messages in accordance with details included in the Standard Highway Signs Manual published by the U.S. Department of Transportation. The Engineer will not require the submittal of shop drawings for these signs or for non-standard sign panels and messages fabricated in accordance with details shown in the plans. Submit seven copies of shop drawings indicating detailed layout of the sign legend, spacing, and border for all other signs to the Engineer prior to fabrication.

If the size of a sign is not specified in the plans, provide the size sign for conventional roadways as shown in the MUTCD.

700-2.3 Breakaway Support Mechanisms:

700-2.3.1 Frangible Supports: Provide posts for all frangible sign assemblies consisting of aluminum tubes up to 3 1/2 inches outside diameter with 3/16 inch wall thickness, or galvanized steel U-Channel up to 3 lb/ft as listed on the Qualified Products List (QPL).

700-2.3.2 Slip Bases: For posts with slip base assemblies, use either aluminum or galvanized steel in accordance with the requirements in the Design Standards. Alternative slip plane, plastic hinge, fracture elements, or combination sign support systems meeting the requirements of NCHRP 350 and Structures Manual wind load requirements may be used, subject to approval by the

Department and listing on QPL. The QPL shall classify these systems as directional or omni-directional systems.

700-2.4 Temporary Construction Sign Supports: Provide steel flanged U-channel consisting of rerolled rail steel or an equivalent billet steel, meeting the mechanical requirements of ASTM A 499, Grade 60, and meeting the chemical requirements of ASTM A 1. For each U-channel, punch or drill 3/8 inch diameter holes on 1 inch centers through the center of the post, starting approximately 1 inch from the top and extending the full length of the U-post. Ensure that the weight per foot of a particular manufacturer's U-channel size does not vary more than ±3 1/2% of its specified weight per foot. Taper the bottom end of the U-channel post for easier installation. Machine straighten the U-channel to a tolerance of 0.4% of the length. U-channel sign supports are listed on QPL.

Provide steel components that have been galvanized after fabrication in accordance with ASTM A 123 and have a smooth uniform finish free from defects affecting strength, durability, and appearance.

Attach the sign to the structural member using hardware meeting the manufacturer's recommendations and as specified in the Design Standards. Use attachment hardware (nuts, bolts, clamps, brackets, braces, etc.) of a non-corrosive metal, aluminum, or galvanized steel, meeting the vendor requirements specified on the QPL Drawings.

700-2.5 Overhead Sign Structures:

700-2.5.1 Department's Design: When the overhead sign structure is detailed in the plans, submit shop drawings to the Department for approval as specified in Section 5. Prior to the submittal of the shop drawings, determine the actual length of support columns for all sign structures on the basis of existing field conditions and include these lengths on the shop drawings.

700-2.5.2 Contractor's Design: When the overhead sign structure is not detailed in the plans, submit to the Department a foundation design and a sign structure design utilizing steel structural members. Meet the requirements of this Section and the FDOT Structures Manual.

Have designs and shop drawings prepared by a Specialty Engineer or the Contractor's Engineer of Record, and submit them to the Department for review and approval in accordance with Section 5.

Determine the actual length of support columns for all sign structures on the basis of existing field conditions, and include these lengths in the shop drawings and calculations.

700-2.5.3 Installation: Install nuts on anchor bolts in accordance with 649-5 and 649-6. Use ASTM A 325 bolt, nut and washer assemblies for all installations other than anchor bolts as follows. Use bolt, nut and washer assemblies that are free of rust and corrosion and that are lubricated properly as demonstrated by being able to easily hand turn the nut on the bolt thread for its entire length. Tighten nuts to the full effort of an ironworker using an ordinary spud wrench to bring the faying surfaces of the assembly into full contact which is referred to as snug tight condition. After bringing the faying surfaces of the assembly into full contact and to a snug tight condition, tighten nuts to achieve the minimum torque as specified in Table 700-1 unless the connection is an

alternate splice connection of a span sign structure, in which case, tighten nuts in accordance with the turn-of-nut method of Table 460-7 of Section 460. Maintain uniform contact pressure on the faying surfaces during snugging and the subsequent final tightening process, by using a bolt tightening pattern that balances the clamping force of each bolt, as closely as possible, with the equal clamping force of a companion bolt. Within 24 hours after final tightening, the Engineer will witness a check of the minimum torque using a calibrated torque wrench for 3 bolts or a minimum of 10% of the bolts, whichever is greater, for each connection; however, do not perform this check on alternate splice connections of span sign structures.

Table 700-1	
Bolt Diameter (in.)	Minimum Torque (ft.-lbs.)
3/8	15
1/2	37
5/8	74
3/4	120
7/8	190
1	275
1 1/8	375
1 1/4	525

700-2.6 Sign Background: Meet the requirements of Section 994. Use Type III, IV, V or VII sheeting for background sheeting, white legends, borders and shields on all signs, excluding STOP, DO NOT ENTER, and WRONG WAY. Use Type VII sheeting for STOP, DO NOT ENTER and WRONG WAY signs. Use Type III, IV, V or VII yellow-green fluorescent sheeting for S1-1 school advance signs and supplemental panels used with S1-1, S3-1 and S4-5 school signs. Do not mix signs having fluorescent yellow-green sheeting with signs having yellow reflective sheeting.

Use fluorescent orange Type VI or VII for all orange work zone signs.

Mesh signs shall meet the color, daytime luminance and nonreflective property requirements of Section 994, Type VI.

700-3 Materials.

700-3.1 General: Meet the materials requirements shown below and any additional requirements which the plans might show.

700-3.2 Concrete: For footings, use concrete meeting the requirements of Section 346.

700-3.3 Reinforcing Steel: For reinforcing steel in footings, meet the requirements of Section 415.

700-3.4 Aluminum Materials:

700-3.4.1 General: For aluminum materials, meet the general provisions of 965-1.

700-3.4.2 Sheets and Plates: For aluminum sheets and plates for sign panels, meet the requirements of ASTM B 209, Aluminum Association Alloy 6061-T6, 5154-H38 or 5052-H38 and those shown in the plans.

700-3.4.3 Extruded Tubing: For extruded aluminum tubing, meet the requirements shown in the plans.

700-3.4.4 Castings: Provide aluminum castings of the alloys shown in the plans. For aluminum alternates the Engineer will allow a cast base, provided the Contractor submits test reports giving evidence that the base to be used for each pole size is as strong as the pole with which it is to be used. Perform physical tests and submit certified reports for one base to be used with each pole size. Use Alloy A 356-T6 for the castings. Use aluminum bolts for connecting parts of the cast base.

700-3.4.5 Channels: For aluminum channels, meet the requirements of ASTM B 308 for the alloys shown in the plans.

700-3.4.6 Bolts, Nuts, and Lockwashers: For aluminum bolts, nuts, and lockwashers, meet the requirements shown in the plans. Ensure that finished bolts and washers are given an anodic coating of at least 0.0002 inch in thickness and are chromate-sealed.

700-3.5 Steel:

700-3.5.1 General: Only use structural steel, including bolts, nuts, and washers, that have been hot dip galvanized or metalized after fabrication. Perform hot dip galvanizing in accordance with ASTM A 123 or ASTM A 153 and metalizing in accordance with Section 562. For galvanized steel members, except plate for sign panels, meet the general requirements of Section 962 and the specific requirements of 962-9. For steel plate for use as sign panels, meet the requirements of ASTM A 283 for either Grade C or Grade D.

700-3.5.2 Specific Uses of Aluminum and Galvanized Steel: Use aluminum bolts, nuts, and hardware to connect parts of the cast base.

Use galvanized steel anchor bolts for anchoring base plates to concrete bases and for the nuts and washers.

For all other metal parts, the Engineer will allow galvanized steel as an alternate to aluminum.

700-3.6 Bearing Pads: For bearing pads, meet the requirements of 932-2.

700-3.7 Retroreflective Sheeting: All retroreflective sheeting must be listed on the QPL and meet the retroreflective sheeting requirements of Section 994.

700-3.8 Process Colors: Use transparent and black opaque process colors listed on the QPL meeting the requirements of 994-4 on retroreflective and nonreflective sheeting.

700-4 Preparation of Sign Blanks.

700-4.1 De-greasing and Etching for Aluminum Sign Blanks:

700-4.1.1 General: Prior to the application of reflective sheeting, use any of the methods shown below to de-grease and etch the aluminum sign blanks.

700-4.1.2 Hand Method: Under this method, de-grease and etch the blanks in one operation, using steel wool (medium grade) with any of the following combinations of materials:

(1) An abrasive cleanser of a commercial grade kitchen scouring powder.

(2) Acid and a suitable detergent solution.

(3) An alkaline solution.

Thoroughly rinse the blanks with clean water following all hand de-greasing operations.

700-4.1.3 Power-Washer Method: Under this method, de-grease the blanks with an inhibited alkaline cleanser, by spraying for 90 seconds with the solution between 135 and 249ºF, the exact temperature to be as recommended by the manufacturer of the cleanser. After the spraying, rinse the blanks with clean water. Then etch the blanks by immersing them in a 6 to 8% solution of phosphoric acid at a temperature of 100 to 180ºF for 60 seconds. After immersion, rinse the blanks in clean water.

700-4.1.4 Immersion Method: Under this method, de-grease the blanks by immersing them in a solution of inhibited alkaline cleanser at a temperature between 160 and 180ºF for three to five minutes, and then rinsing with clean water. Then etch blanks by immersing them in a 6 to 8% solution of phosphoric acid at a temperature of 100ºF for three minutes. After immersion, rinse the blanks in clean water.

700-4.1.5 Vapor De-greasing Method: Under this method, de-grease the blanks by totally immersing them in a saturated vapor of trichloroethylene. Remove trademark printing with lacquer thinner or a controlled alkaline cleaning system.

700-4.1.6 Alkaline De-greasing Method: De-grease the blanks by totally immersing them in a tank containing an alkaline solution, controlled and titrated in accordance with the solution manufacturer's directions. Adapt immersion time to the amount of soil present and the thickness of the metal. After immersion, thoroughly rinse the blanks with running water.

700-4.1.7 Etching Method when De-greasing is Separate Operation: If using either of the de-greasing methods described under 700-4.1.5 and 700-4.1.6, accomplish etching by one of the following alternate methods:

(1) Acid Etch: Etch well in a 6 to 8% phosphoric acid solution at 100ºF, or in a proprietary acid etching solution. Rinse thoroughly with running cold water, which may be followed by a hot water rinse.

(2) Alkaline Etch: Etch aluminum surfaces in an alkaline etching material that is controlled by titration. Meet the time, temperature, and concentration requirements specified by the solution manufacturer. After completing etching is complete, rinse the panel thoroughly.

700-4.2 Drying: Dry the panels using a forced-air drier. Use a device or clean canvas gloves, to handle the material between all cleaning and etching operations and the application of reflective sheeting. Do not allow the metal to come in contact with greases, oils or other contaminants prior to the application of reflective sheeting.

700-4.3 Fabrication of Sign Blanks: Fabricate all metal parts to ensure a proper fit of all sign components. Complete all fabrication, with the exception of cutting and punching of holes, prior to metal de-greasing and applying the reflective sheeting. Cut metal panels to size and shape and keep free of buckles,

warp, dents, burrs, and defects resulting from fabrication. Provide all sign panels with a flat surface. Where signs are to be fabricated from galvanized steel, cut the plates to the required size and drill prior to galvanizing.

700-5 Fabrication of Reflectorized Sign Faces.

700-5.1 Application of Sheeting: Apply reflective sheeting to the base panels with mechanical equipment in a manner specified for the manufacture of traffic control signs by the sheeting manufacturer. Ensure that sheeting applied to extruded aluminum sections adheres over and around the side legs of all panels to a minimum distance of 1/16 inch beyond the radius of top edge.

Match sign faces comprising two or more pieces of reflective sheeting for color and reflectivity at the time of sign fabrication. Reverse and apply consecutively alternate successive width sections of either sheeting or panels to ensure that corresponding edges of sheeting lie adjacent on the finished sign. The Engineer will not accept nonconformance that may result in non-uniform shading and an undesirable contrast between adjacent widths of applied sheeting.

700-5.2 Finish: Seal reflective sheeting splices and sign edges with materials the sheeting manufacturer supplies in a manner the sheeting manufacturer specifies for traffic control signs.

700-5.3 Screening-on Message: Screen message and borders on reflective sheeting in accordance with the recommendations of the ink or overlay manufacturer. Process either before or after applying the sheeting to the base panels.

700-5.4 Finished Sign Face: Provide finished signs with clean cut and sharp messages and borders. Ensure that finished background panels are essentially a plane surface.

700-5.5 Stenciling: For permanent roadway signs, mark the back of all finished panels at the bottom edge with "FDOT", the date of fabrication, the date of installation, and the fabricator's initials. For construction signs, mark the back of all finished panels at the bottom edge with the date of fabrication and the fabricator's initials. Make the markings unobtrusive, but legible enough to be easily read by an observer on the ground when the sign is in its final position. Apply the markings in a manner that is at least as durable as the sign face.

700-5.6 Product Changes: If changes in the formulation of the sheeting occur, submit new samples for re-evaluation for continued approval.

700-6 Acceptance of Signs.

700-6.1 Manufacturer's Certification and Recommendations: Ensure that the sign manufacturer certifies that the delivered signs conform to this Section and provides recommendations for storing and repairing signs.

700-6.2 Packaging and Shipping: Have the manufacturer package and ship the signs in a manner which will minimize possible damage.

700-6.3 Storage of Signs: If signs are stored prior to installation, store them in accordance with the manufacturer's recommendations.

700-6.4 Sign Inspection: Do not install signs until the Engineer inspects them for conformance with this Section. Provide all manufacturer certifications and recommendations prior to the Engineer's inspection. The Engineer will

inspect the signs upon delivery to the storage or project site and again at the final construction inspection. Repair and replace signs deemed unacceptable by the Engineer at no expense to the Department.

700-6.5 Imperfections and Repairs: Repair and replace signs containing imperfections or damage regardless of the kind, type, or cause of the imperfections or damage. Make repairs according to the manufacturer's recommendations and to the satisfaction of the Engineer. Ensure that completed repairs provide a level of quality necessary to maintain the service life warranty of the sign and are satisfactory in appearance to the Engineer.

700-7 Footings for Signs, Posts and Supports.

700-7.1 Excavation and Backfilling: Perform excavation and backfilling for the footings in accordance with Section 125, with the exceptions that no specific density is required and that the backfill may be tamped in 4 inches maximum layers. Use material that is at near optimum moisture and neither dry or saturated, and tamp to the extent directed by the Engineer. The Department may require that the backfilling be done with poured concrete.

Install spread footings which support sign structures overhanging the roadway as required in 455-25 through 455-37.

700-7.2 Mixing and Placing Concrete: For batching and mixing of concrete for footings, meet the requirements of Section 346, except that the Engineer will allow hand mixing by approved methods where the quantity to be mixed does not exceed 1/2 yd^3. Use cast-in-place or precast concrete for the footings. Obtain precast concrete footings from a plant that is currently on the list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3.

700-7.3 Forms: The Engineer will not require forms when the ground is sufficiently firm, in which case, sufficiently moisten the adjacent earth to prevent it from absorbing the moisture from the concrete. Where forms are required and the soil is not moist, place sufficient water, as directed by the Engineer, in the hole, and pour the concrete as soon as the water has been absorbed. Place at least 4 inches of loose earth, free from clods or gravel, over the top of the footing to effect curing.

700-7.4 Finishing Concrete: Trowel the top of the concrete to a smooth finish.

700-8 Erection of Signs and Sign Supports.

Do not erect overhead sign supports until the concrete strength in the support footing is at least 2,500 psi. Determine concrete strength from tests on a minimum of two test cylinders sampled and tested in accordance with ASTM C 31 and ASTM C 39 and verifying test results have been provided to the Engineer.

Erect the signs and sign structures in accordance with the details shown in the plans. The Contractor may fabricate the structural steel sign trusses in sections that will fit into available galvanizing vats. Prior to galvanizing, weld the joints as specified in 460-6 and in accordance with the details shown in the plans. Re-galvanize damaged parts as specified in Section 562.

Weld aluminum structures in accordance with 965-3.

700-9 Removal or Relocation of Signs.

Relocation of signs shall consist of removing the existing sign assembly and installing the sign on a new foundation.

When the plans call for existing ground-mounted signs to be relocated or removed, immediately remove supports and footings that project more than 6 inches above the ground surface after removing the sign panel from the assembly. Remove existing footings to a depth at least 12 inches below the ground surface. The costs will be included in the Contract unit price of the item to which it is incidental.

700-10 Overlay Existing Sign Panels.

Use 0.040-inch thick aluminum sheeting for overlays larger than 3 square feet placed on a sign panel. Replace hex head bolts on the sign surface using stainless steel flat head machine screws with nuts and lock washers to give a flat surface for the overlay panel. Install the overlay panels starting at the edge away from traffic. Place each panel against the sign using a clamp at the top to hold the panel in place. Drill 1/8-inch holes 1-inch inside the panel edge every 6-inches to 8-inches and install 1/4-inch to 3/8-inch length pop rivets. Install additional rivets along the outer edge 6-inches to 8-inches. Place the remaining panels using the same procedure with the overlap in the direction away from the traffic and with rivets along the overlap on 12-inch centers.

700- 11 Method of Measurement.

The quantities to be paid for will be:

(1) The number of ground traffic signs of each designated class of assembly, complete.

(2) The number of lighted overhead traffic signs of each designated class of assembly, complete.

(3) The number of existing signs removed, relocated, modified of each designated class of assembly, complete.

(4) The number of overhead signs span wire mounted, bridge mounted, and lighted sequential, of each designated class of assembly, complete.

For the purpose of payment, a sign assembly consists of all the signs mounted on a single structure (one, two or three posts, or overhead structure) or all the signs on a bridge mounted sign structure and the sign structure.

700-12 Basis of Payment.

Price and payment will be full compensation for furnishing and installation of all materials necessary to complete the signs in accordance with the details shown in the plans; including sign panels complete with sheeting, painting, and message; sign posts and supports, footings, excavation, etc.; for the lighted signs, all costs of the electrical installation for lighting, up to the point of connection by others; and all other work specified in this Section, including all incidentals necessary for the complete item.

SECTION 701
AUDIBLE AND VIBRATORY PAVEMENT MARKINGS

701-1 Description.

Apply audible and vibratory pavement markings in accordance with the Contract Documents.

701-2 Materials.

701-2.1 Thermoplastic: Use thermoplastic material meeting the requirements of 971-1 and 971-10 and listed on the Qualified Products List (QPL). The Engineer will take random samples of the materials in accordance with the Department's Sampling, Testing and Reporting Guide schedule.

701-2.2 Glass Spheres: Use glass spheres meeting the requirements of 971-1 and 971-2 and listed on the QPL. The Engineer will take random samples of glass spheres in accordance with ASTM D 1214 and the Department's Sampling, Testing and Reporting Guide schedule.

701-3 Equipment.

Use equipment capable of providing continuous, uniform heating of the striping material to temperatures exceeding 390ºF, mixing and agitating the material in the reservoir to provide a homogenous mixture without segregation. Use equipment that will maintain the striping material in a plastic state, in all mixing and conveying parts, including the line dispensing device until applied. Use equipment which is capable of producing a consistent pattern of transverse bars positioned at regular and predetermined intervals. Use equipment which meets the following requirements:

(a) capable of traveling at a uniform rate of speed, both uphill and downhill, to produce a uniform application of striping material and capable of following straight lines and making normal curves in a true arc.

(b) capable of applying glass spheres to the surface of the completed stripe by automatic sphere dispensers attached to the striping machine such that the glass spheres are dispensed closely behind the installed line. Use a glass sphere dispensers equipped with an automatic cut-off control that is synchronized with the cut-off of the thermoplastic material and applies the glass spheres uniformly on the entire traffic stripe surface with 50 to 60% embedment.

(c) equipped with a special kettle for uniformly heating and melting the striping material. The kettle must be equipped with an automatic temperature control device and material thermometer for positive temperature control and to prevent overheating or scorching of the thermoplastic material.

(d) meets the requirements of the National Fire Protection Association, state and local authorities.

701-4 Application.

701-4.1 General: Before applying traffic stripes and markings, remove any material that would adversely affect the bond of the traffic stripes by a method approved by the Engineer.

Before applying traffic stripes to any Portland cement surface, apply a primer, sealer or surface preparation adhesive of the type recommended by the manufacturer. Offset longitudinal lines at least 2 inches from construction joints of Portland cement concrete pavement.

Apply traffic stripes or markings only to dry surfaces, and when the ambient air and surface temperature is at least 50ºF and rising for asphalt surfaces and 60°F and rising for concrete surface.

Apply striping to the same tolerances in dimensions and in alignment specified in 710-5. When applying traffic stripes and marking over existing markings, ensure that not more 2 inches on either end and not more that 1 inch on either side of the existing line is visible.

Conduct field tests in accordance with FM 5-541 and 5-579. Remove and replace markings not meeting the requirements of this Section.

701-4.2 Thickness: Apply base lines having a thickness of 0.079 to 0.085 inches, exclusive of the transverse audible bars, when measured above the pavement surface at the edge of the base line.

As an alternative to the flat base line, a profiled baseline meeting the following dimensions may be applied. The profiled baseline shall have a minimum height of 0.155 inches, when measured above the pavement surface at the edge of the inverted rib profile. The thickness in the bottom of the profile marking shall be 0.035 to 0.050 inches. The individual profiles shall be located transversely across the full width of the traffic stripe at approximately 1.0 inch on center, with a bottom width between 0.090-0.310 inches.

701-4.3 Dimensions of Transverse Audible Bars: Apply the raised transverse bar with a profile such that the leading and trailing edge are sloped at a sufficient angle to create an audible and vibratory warning.

Transverse bars on shoulder and centerline markings shall have a height of 0.45 to 0.55 inches, including the base line. The height shall be measured above the pavement surface at the edge of the marking, after application of drop-on glass spheres. The bars shall have an approximate length of 2.5 inches. The bars may have a drainage channel on each bar, the width of each drainage channel will not exceed 1/4 inch at the bottom of the channel. The longitudinal distance between bars shall be 30 inches.

701-4.4 Retroreflectivity: Apply white and yellow audible and vibratory markings that will attain an initial retroreflectance of not less than 300 mcd/lx·m^2 and not less than 250 mcd/lx m^2, respectively. Measure, record and certify on a Department approved form and submit to the Engineer, the retroreflectivity of white and yellow pavement markings in accordance with FM-5-579.

The Department reserves the right to test the markings within 3 days of receipt of the Contractor's certification. If the retroreflectivity values measure below values shown above, remove and reapply the striping.

701-4.5 Glass Spheres: Apply glass spheres to all markings. The manufacturer shall determine if a single or double application of glass spheres is used and the recommended drop rates for each application.

701-5 Contractor's Responsibility for Notification.

Notify the Engineer prior to the placement of audible and vibratory markings. Furnish the Engineer with the manufacturer's name and LOT numbers of the thermoplastic materials and glass spheres to be used. Ensure that the LOT numbers appear on the thermoplastic materials and glass spheres packages.

701-6 Protection of Newly Applied Audible and Vibratory Markings.

Do not allow traffic onto or permit vehicles to cross newly applied pavement markings until they are sufficiently dry. Remove and replace any portion of the pavement markings damaged by passing traffic or from any other cause.

701-7 Observation Period.

Pavement markings are subject to a 180 day observation period under normal traffic. The observation period will begin with the satisfactory completion and acceptance of the pavement marking work.

The pavement markings shall show no signs of failure during the observation period. The Department reserves the right to check the color and retroreflectivity within 30 days prior to the end of the observation period.

Replace, at no expense to the Department, any pavement markings that do not perform satisfactorily under traffic during the 180 day observation period.

701-8 Corrections for Deficiencies.

Correct all deficiencies by removal and reapplication of a 1.0 mile LOT centered around the deficiency at no cost to the Department.

701-9 Submittals.

701-9.1 Submittal Instructions: Prepare a certification of quantities, using the Department's current approved form, for each project in the Contract. Submit the certification of quantities and daily worksheets to the Engineer. The Department will not pay for any disputed items until the Engineer approves the certification of quantities.

701-9.2 Contractor's Certification of Quantities: Request payment by submitting a certification of quantities no later than Twelve O'clock noon Monday after the estimate cut-off date or as directed by the Engineer, based on the amount of work done or completed. Ensure the certification of quantities consists of the following:

(a) Contract Number, FPID Number, Certification Number, Certification Date and the period that the certification represents.

(b) The basis for arriving at the amount of the progress certification, less payments previously made and less any amount previously retained or withheld. The basis will include a detailed breakdown provided on the certification of items of payment.

701-10 Method of Measurement.

The quantities to be paid for under this Section will be as follows:

(a) The length, in net miles, of 6 inches Solid Traffic Stripe, authorized and acceptably applied.

(b) The total traversed distance in gross miles of 10-30 skip line. The actual applied line is 25% of the traverse distance for a 1:3 ratio. This equates to 1,320 feet of marking per mile of single line.

701-11 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including, all cleaning and preparing of surfaces, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment will be withheld until all deficiencies are corrected.

Payment will be made under:

Item No. 701- 1	Audible and Vibratory Pavement Markings.

SECTION 705
OBJECT MARKERS AND DELINEATORS

705-1 Description.

Furnish and install object markers to mark obstructions within or adjacent to the roadway of the types and at the locations called for in the Design Standards or on the plans.

Furnish and install delineators along the side of the roadway to indicate the alignment of the roadway as indicated in the Design Standards or on the plans.

705-2 Materials.

705-2.1 General: Meet the following requirements:

Recycled Plastic Products .....Section 972
Object Markers and Delineators.....Section 993
Retroreflective and Nonreflective Sign Sheeting.....Section 994

705-2.2 Product Acceptance on the Project: Ensure that delineators, delineator posts, and markers used to delineate guardrail and barrier wall are listed on the Qualified Products List.

Provide to the Engineer a manufacturer's certification conforming to the requirements of Section 6, which confirms that each product meets the requirements of this Section.

705-3 Installation Requirements.

Install delineators, object markers, and reflector units for guardrail and barrier wall and in accordance with the MUTCD, Design Standards and plans.

705-4 Method of Measurement.

The quantity to be paid for will be the number of delineators or object markers furnished, installed and accepted.

705-5 Basis of Payment.

Prices and payments will be full compensation for work specified in this Section, including the cost of labor, materials, and incidental items required to complete the work.

Payment will be made under:

Item No. 705- 10	Object Marker - each.
Item No. 705- 11	Delineator – each.

SECTION 706
RAISED RETRO-REFLECTIVE PAVEMENT MARKERS AND BITUMINOUS ADHESIVE

706-1 Description.

Place raised Retro-Reflective Pavement Markers (RPMs) and adhesive, which upon installation produces a positive guidance system to supplement other reflective pavement markings.

706-2 Materials.

Use only Class B markers unless otherwise shown on the plans.

Meet the requirements of Section 970.

706-2.1 Product Acceptance on the Project. Use only reflective pavement markers and bituminous adhesive that are listed on the Qualified Products List.

Provide to the Engineer a manufacturer's certification conforming to the requirements of Section 6, which confirms that each product meets the requirements of this Section.

706-3 Equipment.

Use equipment having either thermostatically controlled double boiler type units utilizing heat transfer oil or thermostatically controlled electric heating pots to install hot applied bituminous adhesive. Do not use direct flame melting units with flexible adhesives; however, this type of unit may be used with standard adhesive in accordance with manufacturer's recommendations. Use a melter/applicator unit suited for both melting and pumping the adhesive through heated applicator hoses.

Heat the adhesive to between 375 and 425ºF and apply directly to the bonding surface from the melter/applicator by either pumping or pouring. Maintain the application temperature between 375 and 425ºF. The adhesive may be reheated. However, do not exceed the manufacturer's recommendations for pot life at application temperatures.

706-4 Application.

Apply RPMs to the bonding surface using bituminous adhesives only. The Engineer will conduct field testing in accordance with FM 5-566. Correct RPMs not applied in accordance with these requirements at no cost to the Department.

Prior to application of adhesive, clean the portion of the bonding surface of any material which would adversely affect the adhesive.

Apply the adhesive to the bonding surface (not the marker) so that 100% of the bonding area of the marker will be covered, in accordance with adhesive manufacturer's recommendations. Apply sufficient adhesive to ensure, that when the marker is pressed downward into the adhesive, adhesive will be forced out around the entire perimeter of the marker.

Immediately remove excess adhesive from the bonding surface and exposed surfaces of the RPMs. Soft rags moistened with mineral spirits meeting Federal Specifications TT-T-291 or kerosene may be used to remove adhesive from exposed faces of the RPMs. Do not use any other solvent. If any adhesive, pavement marking materials or other foreign matter adheres to the reflective face of the marker, replace the marker at no cost to the Department.

Install RPMs with the reflective face of the RPM perpendicular to a line parallel to the roadway centerline. Do not install RPMs over longitudinal or transverse joints of the bonding surface.

Ensure that all final RPMs are in place prior to opening the road to traffic.

If more than 2% of the RPMs fail in adhesion or alignment within the first 45 days under traffic, replace all failed markers at no expense to the Department. If more than 5% of the markers fail in adhesion and or alignment during the initial 45 day period, the Engineer will extend the replacement period an additional 45 days from the date that all replacement markers have been installed. If, at the end of the additional 45 day period, more than 2% of all markers (initial installation and 45 day replacements combined) fail in adhesion or alignment, replace all failed markers at no expense to the Department.

706-5 Contractor's Responsibility for Notification.

Notify the Engineer prior to the placement of RPMs. At the time of notification, indicate the manufacturer and the LOT numbers of RPMs and bituminous adhesive that are intended for use. Verify that the approved LOT numbers appear on the material packages. Furnish a test report to the Engineer certifying that the materials meet all requirements specified.

706-6 Method of Measurement.

The quantities to be paid for will be the number of RPMs, furnished and installed, completed and accepted.

706-7 Basis of Payment.

706-7.1 General: Price and payment will be full compensation for all work specified in this Section.

706-7.2 Lump Sum Payment: Price and payment for Retro-Reflective Pavement Markers will not be measured or paid for separately, when the item for Painted Pavement Markings (Final Surface) is included in the proposal. Price and payment will be made in accordance with 710-11.2.

SECTION 709
TRAFFIC STRIPES AND MARKINGS-
TWO REACTIVE COMPONENTS

709-1 Description.

Apply Two Reactive Component traffic stripes and markings in accordance with the Contract Documents.

709-2 Materials.

709-2.1 Two Reactive Components: Use only Two Reactive Component materials listed on the Qualified Products List (QPL), and meet the requirements of 971-1 and 971-9. The Engineer will take random samples of the materials in accordance with the Department's Sampling, Testing and Reporting Guide schedule.

709-2.2 Glass Spheres: Use only glass spheres listed on the Qualified Products List (QPL), and meet the requirements of 971-1 and 971-2. The Engineer will take random samples of the glass spheres in accordance with ASTM D 1214 and the Department's Sampling, Testing and Reporting Guide schedule.

709-3 Equipment.

Use equipment capable of applying the Two Reactive Component material to the pavement. Use equipment which can produce varying width traffic stripes and which meets the following requirements:

(a) capable of traveling at a uniform rate of speed, both uphill and downhill, to produce a uniform application of the Two Reactive Component material and capable of following straight lines and making normal curves in true arcs.

(b) capable of applying glass spheres to the surface of the completed stripe by an automatic sphere dispenser attached to the striping machine such that the glass spheres are dispensed closely behind the installed line. Use a glass spheres dispenser equipped with an automatic cut-off control that is synchronized with the cut-off of the material and applies the glass spheres in a manner such that the spheres appear uniform on the entire traffic stripes and markings surface with, 50 to 60% embedment.

(c) capable of providing the manufacturer's recommended mixing ratio between the components in a thorough and consistent manner.

709-4 Application.

709-4.1 General: Remove existing pavement markings, such that scars or traces of removed markings will not conflict with new stripes and markings by a method approved by the Engineer.

Before applying traffic stripes and markings, remove any material by a method approved by the Engineer that would adversely affect the bond of the traffic stripes.

Offset longitudinal lines at least 2 inches from construction joints of portland cement concrete pavement.

Apply traffic stripes or markings only to dry surfaces, and when the ambient air and surface temperature is at least 40ºF and rising. Do not apply pavement markings when winds are sufficient to cause spray dust.

Apply striping to the same tolerances in dimensions and in alignment specified in 710-5. When applying traffic stripes and marking over existing markings, ensure that not more than 2 inches on either end and not more than 1 inch on either side of the existing line is visible.

Apply the Two Reactive Component product to the pavement in accordance with the manufacturer's instructions or as directed by the Engineer.

Conduct field tests in accordance with FM 5-541 and 5-579. Remove and replace traffic stripes and markings not meeting the requirements of this Section at no additional cost to the Department.

Apply all final pavement markings prior to opening the road to traffic.

709-4.2 Thickness: Apply traffic stripes and markings to attain a minimum wet film thickness in accordance with the manufacturer's recommendations.

709-4.3 Retroreflectivity: Apply white and yellow traffic stripes and markings that will attain an initial retroreflectivity of not less than 450 mcd/lx·m^2 and not less than 350 mcd/lx·m^2, respectively for all longitudinal and transverse lines.

Measure, record and certify on the Department approved form and submit to the Engineer, the retroreflectivity of white and yellow pavement markings in accordance with Florida Method FM-5-579.

The Department reserves the right to test the markings within 3 days of receipt of the Contractor's certification. Failure to afford the Department opportunity to test the markings will result in non-payment. The test readings should be representative of the Contractor's striping performance. If the retroreflectivity values measure below values shown above, the striping will be removed and reapplied at the Contractor's expense.

709-4.4 Color: Use materials that meets the requirements of 971-1.

709-4.5 Glass Spheres: Apply reflective glass spheres to all white and yellow traffic stripes or markings, at the rates determined by the manufacturer's recommendations.

709-5 Contractor's Responsibility for Notification.

Notify the Engineer prior to the placement of the materials. Furnish the Engineer with the manufacturer's name and batch numbers of the materials and glass spheres to be used. Ensure that the approved batch numbers appear on the materials and glass spheres packages.

709-6 Protection of Newly Applied Traffic Stripes and Markings.

Do not allow traffic onto or permit vehicles to cross newly applied pavement markings until they are sufficiently dry. Remove and replace any portion of the pavement markings damaged by passing traffic or from any other cause, at no additional cost to the Department.

709-7 Observation Period.

Pavement markings are subject to a 180 day observation period under normal traffic. The observation period shall begin with the satisfactory completion and acceptance of the work. The pavement markings shall show no signs of failure due to blistering, excessive cracking, chipping, discoloration, poor adhesion to the pavement, loss of reflectivity or vehicular damage. The Department reserves the right to check the color and retroreflectivity any time prior to the end of the observation period.

Replace, at no additional expense to the Department, any pavement markings that do not perform satisfactorily under traffic during the 180 day observation period.

709-8 Corrections for Deficiencies.

Deficiencies will be corrected by removal and reapplication of a 1.0 mile section centered around the deficiency at no additional cost to the Department.

709-9 Method of Measurement.

The quantities to be paid for under this Section will be as follows:

(a) The length, in net miles, of 6 inch Solid Traffic Stripe, authorized and acceptably applied.

(b) The total traversed distance in gross miles of 10-30 or 3-9 skip line. The actual applied line is 25% of the traverse distance for 1:3 ratio. This equates to 1,320 feet of marking per mile of single line.

(c) The net length, in feet, of all other types of lines and stripes, authorized and acceptably applied.

(d) The area, in square feet, of Remove Existing Pavement Markings, acceptably removed.

709-10 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including, all cleaning and preparing of surfaces, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment will be withheld until all deficiencies are corrected.

Payment will be made under:

Item No. 709 Two Reactive Components
Traffic Stripes, Solid – per net mile.
Traffic Stripes, Solid – per foot.
Traffic Stripes, Skip – per gross mile.
Traffic Stripe – Two Reactive Components, Remove – per square foot.

SECTION 710
PAINTED PAVEMENT MARKINGS

710-1 Description.

Apply Painted Traffic Stripes and Markings, in accordance with the Contract Documents.

710-2 Materials.

Use only materials listed on the Qualified Products List (QPL) meeting the following requirements:

Raised Retro-reflective Pavement Markers and BituminousAdhesive	Section 970
Waterborne Paint	971-1 and 971-3
Fast Dry Solvent Paint	971-1 and 971-4
Glass Spheres	971-1 and 971-2

The Engineer will take random samples of all material in accordance with the Department's Sampling, Testing and Reporting Guide schedule.

710-3 Equipment.

Use equipment that will produce continuous uniform dimensions of pavement markings of varying widths and meet the following requirements:

(a) Capable of traveling at a uniform, predetermined rate of speed, both uphill and downhill, in order to produce a uniform application of paint and capable of following straight lines and making normal curves in a true arc.

(b) Capable of applying glass spheres to the surface of the completed stripe by an automatic sphere dispenser attached to the striping machine such that the glass spheres are dispensed closely behind the installed line. Use a glass spheres dispenser equipped with an automatic cut-off control that is synchronized with the cut-off of the traffic paint and applies the glass spheres in a manner such that the spheres appear uniform on the entire pavement markings surface with, 50 to 60% embedment.

(c) Capable of spraying the paint to the required thickness and width without thinning of the paint. Equip the paint tank with nozzles equipped with cut-off valves, which will apply broken or skip lines automatically.

710-4 Application:

710-4.1 General: Remove existing pavement markings, such that scars or traces of removed markings will not conflict with new pavement markings, by a method approved by the Engineer. Payment for marking removal will be in accordance with 102-5.8.

Before applying traffic stripes and markings, remove any material by a method approved by the Engineer that would adversely affect the bond of the traffic stripes.

Apply traffic stripes and markings only to dry surfaces, and when the ambient air and surface temperature is at least 40ºF and rising. Do not apply traffic stripes and markings when winds are sufficient to cause spray dust.

Apply traffic stripes and markings, having well defined edges, over existing pavement markings such that not more than 2 inches on either end and not more than 1 inch on either side is visible.

Mix the paint thoroughly prior to pouring into the painting machine. Apply paint to the pavement by spray or other means approved by the Engineer.

Conduct field testing in accordance with FM 5-541 and 5-579. Remove and replace traffic stripes and markings not meeting the requirements of this Section at no additional cost to the Department.

Apply all pavement markings prior to opening the road to traffic.

710-4.1.1 Final Surface: Painted Pavement Markings (Final Surface) will include two applications of painted pavement markings and one application of retro-reflective pavement markers applied to the final surface. Wait at least 14 days after the first application to apply the second application of Painted Pavement Markings (Final Surface). Second application must be applied prior to final acceptance of the project.

Apply all retro-reflective pavement markers meeting the requirements of Section 706.

710-4.2 Thickness: Apply paint to attain a minimum wet film thickness in accordance with the manufacturer's recommendations.

710-4.3 Retroreflectivity: Apply white and yellow pavement markings that will attain an initial retroreflectance of not less than 300 mcd/lx·m^2 and not less than 250 mcd/lx·m^2, respectively. Measure, record and certify on a Department approved form and submit to the Engineer, the retroreflectivity of white and yellow pavement markings in accordance with Florida Method FM 5-579.

The Department reserves the right to test the markings within 3 days of receipt of the Contractor's certification. Failure to afford the Department opportunity to test the markings will result in non-payment. The test readings should be representative of the Contractor's striping performance. If the retroreflectivity values measure below values shown above, reapply the striping at no additional cost to the Department.

For work zone markings, ensure that the minimum retrorefectance of white and yellow pavement markings are not less than 150 mcd/lx m^2. If the retroreflectivity values fall below the 150 mcd/lx m^2 value within six months of initial application, the striping will be reapplied at the Contractor's expense.

710-4.4 Color: Use paint material that meets the requirements of 971-1.

710-4.5 Glass Spheres: Apply glass spheres on all pavement markings immediately and uniformly following the paint application. The rate of application shall be based on the manufacturer's recommendation.

710-5 Tolerances in Dimensions and in Alignment.

Establish tack points at appropriate intervals for use in aligning stripes, and set a stringline from such points to achieve accuracy.

710-5.1 Dimensions:

710-5.1.1 Longitudinal Lines: Apply painted skip line segments with no more than ±12 inches variance, so that over-tolerance and under-tolerance lengths between skip line and the gap will approximately balance. Apply

longitudinal lines at least 2 inches from construction joints of portland cement concrete pavement.

710-5.1.2 Transverse Markings, Gore Markings, Arrows, and Messages: Apply paint in multiple passes when the marking cannot be completed in one pass, with an overall line width allowable tolerance of ±1 inch

710-5.1.3 Contrast Lines: Use black paint to provide contrast on concrete or light asphalt pavement, when specified by the Engineer. Apply black paint in 10 foot segments following each longitudinal skip line.

710-5.2 Alignment: Apply painted stripes that will not deviate more than 1 inch from the stringline on tangents and curves one degree or less. Apply painted stripes that will not deviate more than 2 inches from the stringline on curves greater than one degree. Apply painted edge stripes uniformly, not less than 2 inches or more than 4 inches from the edge of pavement, without noticeable breaks or deviations in alignment or width.

Remove and replace at no additional cost to the Department, traffic stripes that deviate more than the above stated requirements.

710-5.3 Correction Rates: Make corrections of variations in width at a maximum rate of 10 feet for each 0.5 inches of correction. Make corrections of variations in alignment at a maximum rate of 25 feet for each 1 inch of correction, to return to the stringline.

710-6 Contractor's Responsibility for Notification.

Notify the Engineer prior to the placement of the materials. Furnish the Engineer with the manufacturer's name and batch numbers of the materials and glass spheres to be used. Ensure that the approved batch numbers appear on the materials and glass spheres packages.

710-7 Protection of Newly Painted Pavement Markings.

Do not allow traffic onto or permit vehicles to cross newly applied pavement markings until they are sufficiently dry. Remove and replace any portion of the pavement markings damaged by passing traffic or from any other cause, at no additional cost to the Department.

710-8 Corrections for Deficiencies to Applied Painted Pavement Markings.

Reapply a 1.0 mile section centered around any deficiency, at no additional cost to the Department.

710-9 Submittals.

710-9.1 Submittal Instructions: Prepare a certification of quantities, using the Department's current approved form, for each project in the Contract. Submit the certification of quantities and daily worksheets to the Engineer. The Department will not pay for any disputed items until the Engineer approves the certification of quantities.

710-9.2 Contractor's Certification of Quantities: Request payment by submitting a certification of quantities no later than Twelve O'clock noon Monday after the estimate cut-off date or as directed by the Engineer, based on

the amount of work done or completed. Ensure the certification of quantities consists of the following:

(a) Contract Number, FPID Number, Certification Number, Certification Date and the period that the certification represents.

(b) The basis for arriving at the amount of the progress certification, less payments previously made and less any amount previously retained or withheld. The basis will include a detailed breakdown provided on the certification of items of payment.

710-10 Method of Measurement.

The quantities to be paid for under this Section will be as follows:

(a) The length, in net miles, of 6 inch Solid Traffic Stripe, authorized and acceptably applied.

(b) The total traversed distance in gross miles of 10-30 or 3-9 skip line. The actual applied line is 25% of the traverse distance for a 1:3 ratio. This equates to 1,320 feet of marking per mile of single line.

(c) The net length, in feet, of each of all other types of lines and stripes, authorized and acceptably applied.

(d) The number of pavement messages, symbols and directional arrows, authorized and acceptably applied.

(e) Lump Sum, as specified in 710-4.1.1 when the item for Painted Pavement Markings (Final Surface) is included in the proposal.

The net length, in feet of dotted and skip stripes other than 10-30 and 3-9 will be measured as the distance from the beginning of the first painted stripe to the end of the last painted stripe with proper deductions made for unpainted intervals as determined by plan dimensions or stations, subject to 9-1.3. Unpainted intervals will not be included in pay quantity.

The gross-mile measurement of 10-30 and 3-9 Skip Traffic Stripes will be taken as the distance from the beginning of the first painted stripe to the end of the last painted stripe, and will include the unpainted intervals. It will not include any lengths of unpainted intervals which, by design or by other intent of the Department, are greater than 30 feet. Final measurement will be determined by plan dimensions or stations, subject to 9-1.3.1.

710-11 Basis of Payment.

710-11.1 General: Prices and payments will be full compensation for all work specified in this Section, including, all cleaning and preparing of surfaces, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment will be withheld until all deficiencies are corrected.

710-11.2 Lump Sum Payment: When the item for Painted Pavement Markings (Final Surface) is included in the proposal, prices and payments will be full compensation for two applications of all painted pavement markings applied to the final surface, and one application of retro-reflective pavement markers applied to the final surface in accordance with Section 706.

Payment will be made under:

Item No. 710	Painted Pavement Markings. Traffic Stripes, Solid – per net mile. Traffic Stripes, Solid – per foot. Traffic Stripes, Skip – per gross mile. Traffic Stripes, Skip – per foot. Dotted/Guideline – per foot. Messages –each. Arrows – each. Yield Markings – per foot.
Item No. 710-90	Painted Pavement Markings (Final Surface) – lump sum.

SECTION 711
THERMOPLASTIC TRAFFIC STRIPES AND MARKINGS

711-1 Description.

Apply new thermoplastic traffic stripes and markings, or refurbish existing thermoplastic traffic stripes and markings, in accordance with the Contract Documents.

711-2 Materials.

711-2.1 Thermoplastic: Use only thermoplastic materials listed on the Qualified Products List (QPL). The Engineer will take random samples of all material in accordance with the Department's Sampling, Testing and Reporting Guide schedule.

711-2.1.1 Initial or Recapped Stripes and Markings: Use materials meeting the requirements of 971-1 and 971-5.

711-2.1.2 Refurbishing Existing Stripes and Markings: Use materials meeting the requirements of 971-1 and 971-5, or 971-6 when specifically indicated in the Contract Documents.

711-2.1.3 Preformed Stripes and Markings: Use Materials meeting the requirements of 971-1 and 971-7.

711-2.2 Glass Spheres: Use only glass spheres listed on the Qualified Products List (QPL), meeting the requirements of 971-1 and 971-2. The Engineer will take random samples of all glass spheres in accordance with ASTM D 1214 and the Department's Sampling, Testing and Reporting Guide schedule.

711-2.3 Sand: Use materials meeting the requirements of 971-5.4.

711-3 Equipment.

Use equipment capable of providing continuous uniform heating of striping materials to temperatures exceeding 390ºF, mixing and agitation of the material reservoir to provide a homogeneous mixture without segregation. Use equipment that will maintain the striping material in a plastic state, in all mixing and conveying parts, including the line dispensing device until applied. Use

equipment which can produce varying width traffic stripes and which meets the following requirements:

(a) Capable of traveling at a uniform, predetermined rate of speed, both uphill and downhill, in order to produce a uniform application of striping material and capable of following straight lines and making normal curves in a true arc.

(b) Is capable of applying glass spheres to the surface of the completed stripe by a double drop application for initial traffic striping and marking and a single drop application for recapping and refurbishing. The bead dispenser for the first bead drop shall be attached to the striping machine in such a manner that the beads are dispensed closely behind with the thermoplastic material. The second bead dispenser bead shall be attached to the striping machine in such a manner that the beads are dispensed immediately after the first bead drop application. Glass spheres dispensers shall be equipped with an automatic cut-off control that is synchronized with the cut-off of the thermoplastic material and applies the glass spheres in a manner such that the spheres appear uniform on the entire traffic stripes and markings surface with, 50 to 60% embedment.

(c) Equipped with a special kettle for uniformly heating and melting the striping material. The kettle must be equipped with an automatic temperature control device and material thermometer for positive temperature control and to prevent overheating or scorching of the thermoplastic material.

(d) Meet the requirements of the National Fire Protection Association, state, and local authorities.

711-4 Application.

711-4.1 General: Remove existing pavement markings such that scars or traces of removed markings will not conflict with new stripes and markings by a method approved by the Engineer. Cost for removing conflicting pavement markings during maintenance of traffic operations to be included in Maintenance of Traffic, Lump Sum.

Before applying traffic stripes and markings, remove any material by a method approved by the Engineer that would adversely affect the bond of the traffic stripes. Before applying traffic stripes to any Portland cement concrete surface, apply a primer, sealer or surface preparation adhesive of the type recommended by the manufacturer. Offset longitudinal lines at least 2 inches from any longitudinal joints of Portland cement concrete pavement.

Apply traffic stripes or markings only to dry surfaces, and when the ambient air and surface temperature is at least 50ºF and rising for asphalt surfaces and 60°F and rising for concrete surfaces.

Apply striping to the same tolerances in dimensions and in alignment specified in 710-5. When applying traffic stripes and markings over existing markings, ensure that not more than 2 inches on either end and not more than 1 inch on either side of the existing line is visible.

Apply thermoplastic material to the pavement either by spray, extrusion or other means approved by the Engineer.

Conduct field tests in accordance with FM 5-541 and 5-579. Remove and replace traffic stripes and markings not meeting the requirements of this Section at no additional cost to the Department.

Apply all final pavement markings prior to opening the road to traffic.

711-4.1.1 Preformed Thermoplastic: Apply markings only to dry surfaces and when ambient air temperature is at least 32°F. Prior to installation, follow the manufacturer's recommendations for pre-heating.

711-4.2 Thickness:

711-4.2.1 Initial or Recapped Stripes and Markings: Apply or recap traffic stripes or markings such that, before application of drop-on glass spheres, all lane lines, center lines, transverse markings and traffic stripes and markings within traffic wearing areas (such as dotted turning guide lines), will have a thickness of 0.10 to 0.15 inch when measured above the pavement surface at the edge of the traffic stripe or marking.

Also, all gore, island, and diagonal stripe markings, bike lane symbols and messages, wherever located, will have a thickness of 0.09 to 0.12 inch when measured above the pavement surface at the edge of the traffic stripe or marking.

711-4.2.2 Refurbishing Existing Traffic Stripes and Markings: Apply a minimum of 0.06 inch of thermoplastic material. Ensure that the combination of the existing stripe and the overlay after application of glass spheres, does not exceed the maximum thickness of 0.150 inch for all lines.

711-4.3 Retroreflectivity: Apply white and yellow traffic stripes and markings that will attain an initial retroreflectivity of not less than 450 mcd/lx·m^2 and not less than 350 mcd/lx·m^2, respectively for all longitudinal lines. All transverse lines, messages and arrows will attain an initial retroreflectivity of not less than 300 mcd/lx·m^2 and 250 mcd/lx·m^2 for white and yellow respectively. All pedestrian crosswalks, bike lane symbols or messages in a proposed bike lane shall attain an initial retroreflectivity of not less than 275 mcd/lx·m^2.

Measure, record and certify on the Department approved form and submit to the Engineer, the retroreflectivity of white and yellow pavement markings in accordance with Florida Method FM-5-579.

The Department reserves the right to test the markings within three days of receipt of the Contractor's certification. The test readings should be representative of the Contractor's striping performance. If the retroreflectivity values measure below values shown above, the striping will be removed and reapplied at the Contractor's expense.

711-4.4 Glass Spheres:

711-4.4.1 Longitudinal Lines: For initial traffic striping and marking, apply the first drop of Type 4 or larger glass spheres immediately followed by the second drop of Type 1 glass spheres. For refurbishing, apply a single drop of Type 3 glass spheres. Apply reflective glass spheres to all markings at the rates determined by the manufacturer's recommendations.

711-4.4.2 Transverse Stripes and Markings: Apply a single drop of Type 1 glass spheres. Apply reflective glass spheres to all markings at the rates determined by the manufacturer's recommendations.

Apply a mixture consisting of 50% glass spheres and 50% sharp silica sand to all thermoplastic pedestrian crosswalk lines and bike lane symbols at the rates determined by the manufacturer's recommendations.

711-4.4.3 Preformed Markings: These markings are factory supplied with glass spheres and skid resistant material. No additional glass spheres or skid resistant material should be applied during installation.

711-5 Contractor's Responsibility for Notification.

Notify the Engineer prior to the placement of the thermoplastic materials. Furnish the Engineer with the manufacturer's name and batch numbers of the thermoplastic materials and glass spheres to be used. Ensure that the approved batch numbers appear on the thermoplastic materials and glass spheres packages.

711-6 Protection of Newly Applied Traffic Stripes and Markings.

Do not allow traffic onto or permit vehicles to cross newly applied pavement markings until they are sufficiently dry. Remove and replace any portion of the pavement markings damaged by passing traffic or from any other cause, at no additional cost to the Department

711-7 Observation Period.

Pavement markings are subject to a 180 day observation period under normal traffic. The observation period shall begin with the satisfactory completion and acceptance of the work.

The pavement markings shall show no signs of failure due to blistering, excessive cracking, chipping, discoloration, poor adhesion to the pavement, loss of reflectivity or vehicular damage. The Department reserves the right to check the color and retroreflectivity any time prior to the end of the observation period.

Replace, at no additional expense to the Department, any pavement markings that do not perform satisfactorily under traffic during the 180 day observation period.

711-8 Corrections for Deficiencies.

Recapping applies to conditions where additional striping material is applied to new or refurbished traffic stripes or markings to correct a deficiency. Recap a 1.0 mile section centered around the deficiency with additional striping material or by complete removal and reapplication at no additional cost to the Department.

If recapping will result in a thickness exceeding the maximum allowed, the traffic stripes or markings will be removed and reapplied.

711-9 Method of Measurement.

711-9.1 General: The quantities to be paid for under this Section will be as follows:

(a) The length, in net miles, of 6 inch Solid Traffic Stripe, authorized and acceptably applied.

(b) The total traversed distance in gross miles of 10-30 or 3-9 skip line. The actual applied line is 25% of the traverse distance for a 1:3 ratio. This equates to 1,320 feet of marking per mile of single line.

(c) The net length, in feet, of all other types of lines and stripes, authorized and acceptably applied.

(d) The area, in square feet, of Removal of Existing Pavement Markings, acceptably removed.

(e) The number of pavement messages, symbols and directional arrows, authorized and acceptably applied.

711-9.2 Certification of Quantities Submittal Instructions: Prepare a certification of quantities, using the Department's current approved form, for each project in the Contract. Submit the certification of quantities and daily worksheets to the Engineer. The Department will not pay for any disputed items until the Engineer approves the certification of quantities.

Make all requests for payment by submitting these certifications no later than Twelve O'clock noon Monday after the estimate cut-off date or as directed by the Engineer, based on the amount of work done or completed. Ensure the certification of quantities consists of the following:

(a) Contract Number, FPID Number, Certification Number, Certification Date and the period that the certification represents.

(b) The basis for arriving at the amount of the progress certification, less payments previously made and less any amount previously retained or withheld. The basis will include a detailed breakdown provided on the certification of items of payment.

711-10 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including, all cleaning and preparing of surfaces, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment will be withheld until all deficiencies are corrected.

Payment will be made under:

Item No. 711	Thermoplastic
	Traffic Stripes, Solid - per net mile.
	Traffic Stripes, Solid - per foot.
	Traffic Stripes, Skip - per gross mile.
	Dotted/Guideline - per foot.
	Messages - each.
	Arrows - each.
	Yield Markings - per foot.
	Thermoplastic, Remove – per square foot.

SECTION 713
PERMANENT TAPE STRIPES AND MARKINGS

713-1 Description.

Apply permanent tape traffic stripes and markings, in accordance with the Contract documents. Stripes and markings are divided into two classes, Standard and High Performance, and are differentiated by their retroreflectivity and durability. High performance tapes are required for all longitudinal markings. Standard tapes are limited to transverse lines, arrows and messages.

713-2 Materials.

Use only permanent tape traffic stripes and markings materials listed on the Qualified Products List (QPL), meeting the requirements of 971-1 and 971-8. The Engineer will take random samples of the materials in accordance with the Department's Sampling, Testing and Reporting Guide schedule.

713-3 Equipment.

Use equipment that is mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

Ensure the mechanical applicator is equipped with film cut-off device and a measuring device that automatically and accumulatively measures the length of each line placed with an accuracy tolerance of ±2 percent. Tape may be placed by hand on short sections 500 feet or less if the tolerances in dimensions and in alignment specified in 710-5 are met.

713-4 Application.

713-4.1 Removal of Existing Traffic Stripes: Remove existing traffic stripes and markings, such that scars or traces of removed markings will not conflict with new stripes and markings by a method approved by the Engineer.

Before applying traffic stripes and markings, remove any material by a method approved by the Engineer that would adversely affect the bond of the traffic stripes.

Apply a primer, sealer or surface preparation adhesive of the type recommended by the manufacturer. Ensure the tape stripes and markings adheres to the pavement surface.

Offset longitudinal lines at least 2 inches from construction joints on portland cement concrete pavement.

Apply traffic stripes or markings only to dry surfaces, and when the ambient air and surface temperature is at least 55ºF and rising.

Apply striping to the same tolerances in dimensions and in alignment specified in 710-5. When applying traffic stripes and marking over existing markings, ensure that not more than 2 inches on either end and not more than 1 inch on either side of the existing line is visible.

Apply traffic stripes and markings to the pavement by means approved by the Engineer. The stripes and markings shall be installed immediately following the paving operation. Conduct field testing in accordance with FM 5-541 and FM 5-579. Remove and replace pavement stripes and markings

not meeting the requirements of this Section at no additional cost to the Department.

Apply all final pavement markings prior to opening the road to traffic.

713-4.2 Thickness: Apply traffic stripes or markings such that, the stripes or markings will have a thickness above the pavement surface as designated on the Qualified Products List for the particular product used.

713-4.3 Retroreflectivity:

713-4.3.1 General: Black portions of contrast tapes and black masking tapes must be non-reflective and have a reflectance of less than 5 mcd/lx m^2.

713-4.3.2 Standard Markings: Apply white and yellow traffic stripes and markings that will attain an initial retroreflectivity of not less than 300 mcd/lx·m^2 for white and contrast markings and not less than 250 mcd/lx·m^2 for yellow markings.

713-4.3.3 High Performance Markings: Apply white and yellow traffic stripes and markings that will attain an initial retroreflectivity of not less than 450 mcd/lx·m^2 for white and contrast markings and not less than 350 mcd/lx·m^2 for yellow markings.

713-4.4 Color: Use material meeting the requirements of 971-1.

713-5 Contractor's Responsibility for Notification.

Notify the Engineer prior to the placement of pavement stripes and marking material. Furnish the Engineer with the manufacturer's name and batch numbers of the material to be used. Ensure that the approved batch numbers appear on the material packages.

713-6 Protection of Newly Applied Stripes.

Do not allow traffic onto or permit vehicles to cross onto newly applied traffic stripes and markings until they are sufficiently bonded. Remove and replace any portion of the traffic stripes and markings damaged by passing traffic or from any other cause, at no additional cost to the Department.

713-7 Observation Period.

Pavement markings are subject to a 180 day observation period under normal traffic. The observation period shall begin with the satisfactory completion and acceptance of the work.

The pavement markings shall show no signs of failure due to blistering, excessive cracking, chipping, discoloration, poor adhesion to the pavement, loss of reflectivity or vehicular damage. The Department reserves the right to check the color and retroreflectivity any time prior to the end of the observation period.

Replace, at no additional expense to the Department, any pavement markings that do not perform satisfactorily under traffic during the 180 day observation period.

713-8 Corrections for Deficiencies.

Remove and reapply a 1.0 mile section centered around any deficiency, as determined by the Engineer, at no additional cost to the Department.

713-9 Method of Measurement.

713-9.1 General: The quantities to be paid for under this Section will be as follows:

(a) The length, in net miles, of 6 inch Solid Traffic Stripe, authorized and acceptably applied.

(b) The total traversed distance in gross miles of 10-30 or 3-9 skip line. The actual applied line is 25% of the traverse distance for a 1:3 ratio. This equates to 1,320 feet of marking per mile of single line.

(c) The net length, in feet, of all other types of lines and stripes, authorized and acceptably applied.

(d) The area, in square feet, of Remove Existing Markings acceptably removed.

(e) The number of pavement messages, symbols and directional arrows, authorized and acceptably applied.

713-9.2 Certification of Quantities Submittal Instructions: Prepare a certification of quantities, using the Department's current approved form, for each project in the Contract. Submit the certification of quantities and daily worksheets to the Engineer. The Department will not pay for any disputed items until the Engineer approves the certification of quantities.

Make all requests for payment by submitting these certifications no later than Twelve O'clock noon Monday after the estimate cut-off date or as directed by the Engineer, based on the amount of work done or completed. Ensure the certification of quantities consists of the following:

(a) Contract Number, FPID Number, Certification Number, Certification Date and the period that the certification represents.

(b) The basis for arriving at the amount of the progress certification, less payments previously made and less any amount previously retained or withheld. The basis will include a detailed breakdown provided on the certification of items of payment.

713-10 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including, all cleaning and preparing of surfaces, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment will be withheld until all deficiencies are corrected.

Payment will be made under:

Item No. 713-101-	Permanent Tape (Standard).
Item No. 713-102-	Permanent Tape (High Performance).

SECTION 715
HIGHWAY LIGHTING SYSTEM

715-1 Description.

Install a highway lighting system in accordance with the details shown in the plans. Include in the system the light poles, bases, luminaires, ballasts, pull boxes, cable, conduit, substations, expansion joints, protective devices, transformers and control devices; all as specified or required for the complete facility. Use pole assemblies listed on the Department's Qualified Products List (QPL) when standard aluminum pole assemblies or standard high mast light assemblies are required by the Contract Documents.

715-2 Shop Drawings and Working Drawings.

Submit shop drawings and working drawings with descriptive specifications and engineering data for panel board, transformer, primary oil switch, fused cutouts, non-standard light poles (including brackets), luminaires, ballast, photo-electric cell, screw type foundations, and cable or any other item requested by the Engineer as specified in Section 5.

715-3 Materials and Equipment to be Installed.

715-3.1 General: Meet the materials and equipment requirements of Section 992. Provide products of established, reputable manufacturers of electrical equipment, meeting NEC requirements, the regulations of the National Board of Fire Underwriters, and the approval of the Engineer.

715-3.2 Criterion Designation of Materials and Equipment: Where a criterion specification is designated for any material or equipment to be installed, by the name or catalog number of a specific manufacturer, understand that such designation is intended only for the purpose of establishing the style, quality, performance characteristics, etc., and is not intended to limit the acceptability of competitive products. The Engineer will consider products of other manufacturers which are approved as similar and equal as equally acceptable.

715-4 Furnishing of Electrical Service.

Start the system with a weatherhead on a riser on a service pole and extend through the required metering equipment of the power company, and through the lighting system as shown.

The power company will provide service to the areas in the vicinities indicated. Consult and cooperate with the power company in locating its distribution transformer and service pole so that the lines will be as short and direct as possible. Bear any line-extension costs up to the first 2,000 feet. Furnish or install only those parts of the metering equipment or connections that are customary and required by the power company in the locality involved.

715-5 Excavation and Backfilling.

715-5.1 General: For excavation and backfilling, meet the requirements of Section 125, except that when rock is encountered, carry the excavation 3 inches below the required level and re-fill with sand or with selected earth material, 100% of which passes the 1 inch sieve.

715-5.2 Trenches for Cable: Construct trenches for cable or conduit no less than 6 inches in width and deep enough to provide a minimum cover in accordance with the Design Standards.

715-5.3 Placing Backfill for Cable: For installation of the cable, place an initial layer of 6 inches thick, loose measurement, sand or selected earth material, 100% of which passes a 1 inch sieve. Place and compact the remaining material in accordance with 125-8.

715-6 Foundations for Light Poles.

715-6.1 Concrete Foundations: Provide foundations for light poles of the sizes and shapes shown in the plans. Construct precast or cast-in-place concrete foundations in accordance with the Design Standards. Obtain precast foundations from a plant that is currently on the Department's list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3.

715-6.2 Setting Anchor Bolts: Set anchor bolts according to manufacturer's templates and adjust to a plumb line, check for elevation and location, and hold rigidly in position to prevent displacement while pouring concrete.

715-6.3 Installation: Do not erect roadway light poles or high mast light poles until the concrete strength in the cast-in-place foundation is at least 2,500 psi. Determine concrete strength from tests on a minimum of two test cylinders sampled and tested in accordance with ASTM C 31 and ASTM C 39 and verifying test results have been provided to the Engineer.

Fill the voids around precast concrete foundations under roadway light poles with flowable fill meeting the requirements of Section 121 or clean sands placed using hydraulic methods to a level 6 inches below grade.

715-6.4 Alternate Foundation: The Contractor may use screw type foundations which are listed on the Qualified Products List, as an alternate foundation. Screw type foundations must be in accordance with the following requirements:

(a) Design: For steel screw type foundations, meet the latest edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals and the requirements herein. Provide steel equaling or exceeding the requirements of ASTM A 53, Type E, Grade B for the pipe and ASTM A 36 for the plates and bars. Design the screw type foundation with the soil properties listed on Design Standards, Index No. 17515 or the actual properties of the in-situ soil, accounting for the presence of the water table. Take into account the variability of the soil strata above and below the water table which may result in deeper foundations, larger diameter pipe, or both.

Design screw type foundations to be installed by auguring into the ground using a right hand turning movement with a working installation torque of up to 20,000 ft lb. Provide a minimum base plate thickness of 1 3/8 inches. Provide base plates with holes to match the number and location of the light pole anchor bolts. Make the holes 1/16 inch larger in diameter than the light pole anchor bolts. Use base plates of sufficient size to provide the required bolt edge distances. Notch the base plates to indicate the orientation of the shaft cableways. Provide pipes for these screw type foundations having a minimum of

10.75 inches outside diameter and a minimum wall thickness of 0.365 inch. Provide an opening at the bottom of the pipe for drainage purposes. Hot-dip galvanize the whole foundation after fabrication in accordance to ASTM A 123.

(b) Installation: Prior to installation, submit pole reaction, screw foundation shop drawings and soil property data to the Engineer for approval.

Install by auguring into undisturbed ground. Use only sufficient downward pressure to ensure engagement of the augers. The Engineer will not allow installation into pre-excavated hole. Ensure that the pole manufacturer provides bolts for connecting the pole to the foundation, and install bolts complete with nuts and lockwashers. Do not allow the top of the installed base plate to protrude more than 2 inches above the ground surface.

715-7 Laying Cables.

Place the direct-burial cables by moving the cable reel along the trench so that the cables are placed directly in their final position in the trench, with a minimum of handling and dragging. Space the cables at least 3 inches apart, both vertically and horizontally, and separate them with clean sand. Place the bottom cables on a 3 inches bed of sand and cover the top cables with 3 inches of sand prior to backfilling. Leave at least 3 feet of slack cable where the cable enters and leaves ducts, and after looping into light poles. Leave adequate slack in light poles and bracket cables and other conductors. Protect cables pulled into conduit or ducts against abrasion, kinking, and twisting. Locate pull boxes so that the cable is not subjected to excessive pulling stresses.

715-8 Splicing.

Make all conductor splices in the bases of the light poles, or in pull boxes designed for the purpose. Do not make underground splices unless specifically authorized by the Engineer, and then only as directed by him.

Make all necessary splices or connections with solderless connectors or compression sleeves. Do not use twist-on connectors if any of the conductors involved are larger than No. 10.

715-9 Conduit and Ducts.

715-9.1 General: Install conduit and ducts at the locations shown in the plans, or as required for a satisfactory installation. Provide conduit or ducts for all crossings under roads and streets.

715-9.2 Conduit in Structures: Use conduit of either rigid steel or PVC for embedding in structural concrete. Install an expansion fitting at every structural expansion joint through which the conduit passes. Provide exposed runs of conduit with adequate expansion joints as shown in the plans or approved by the Engineer. Obtain the Engineer's approval of the design of the expansion joints.

715-9.3 Pre-wired Direct-burial Duct: Where specified in the plans or directed by the Engineer, install a pre-wired, flexible polyethylene plastic pipe containing the conductors for the lighting circuits. Provide conductors and polyethylene pipe as described in the plans.

715-10 Erecting Light Poles.

715-10.1 General: Install the light poles at the locations and in accordance with the details shown in the plans. Unless otherwise specifically approved by the Engineer, fasten bracket (truss) arms to the pole prior to erection. Do not field weld on any part of the pole assembly. Plumb the poles after erection and use metal shims or leveling nuts if necessary to obtain precise alignment. Use a thin cement grout where necessary to eliminate unevenness or irregularities in the top of the base.

715-10.2 Adjusting Anchor Bolts and Installing Nuts on Anchor Bolts: Where poles are to be placed on existing foundations or bases with anchor bolts in place, furnish poles with a base which fits the anchor bolt spacing. Include the cost of any necessary extension of existing anchor bolts in the price bid for the lighting system. For high mast light pole bases, install nuts on anchor bolts in accordance with 649-5.

715-10.3 Installation of Luminaire: Install the luminaire on the truss arm in accordance with the manufacturer's instructions, and place it so that the light pattern is evenly distributed along the roadway.

715-10.4 Electrical Connections: Make primary ballast connections in accordance with manufacturer's instructions. Install sufficient cable to allow all connections to be made outside the light pole base. Connect the ground conductor to the ground stud provided.

715-10.5 Identification Plates: If required by the Contract Documents, stamp the identification plate on the pole with an identifying number or legend. Number the poles consecutively, beginning with number 1. Stamp each light pole number with 3/4 inch figures and stamp each circuit number with 1/2 inch figures.

715-10.6 Screen Installation for High Mast Light Pole Bases: Install a screen in accordance with 649-6.

715-11 Grounding.

Ground in accordance with the National Electrical Code and local codes which exceed these Specifications.

Ground each metal light pole not on a bridge structure with an approved rod, 20 feet in length and at least 5/8 inch in diameter.

For poles on bridge structures, bring the grounding conductors out to a pull box at each end of the structure and connect them to driven ground rods, 20 feet in length and at least 5/8 inch in diameter.

The 20 feet length of rod may be either two rods 10 feet in length connected by a threaded coupling and driven as a single rod or two rods 10 feet in length separated by at least 6 feet.

Make all bonds between ground wires and grounding electrode assemblies or arrays with an exothermic bond with the following exception: do not exothermically bond grounding electrode to grounding electrode connections.

The work specified in this Section will not be paid for directly, but will be considered as incidental work.

Ground all high mast poles in accordance with the details for grounding in the Design Standards, Index No. 17502.

715-12 Labeling.

Stencil labels on the cases of oil switch, transformer, panel board, and photo-electric cell with white oil paint, as designated by the Engineer. Also, mark the correct circuit designations in accordance with the wiring diagram on the terminal marking strips of each terminal block and on the card holder in the panel board.

715-13 Markers.

Construct duct, cable, and splice markers as shown in the plans, and place them over the ends of underground ducts and at each change in direction of cable or conduit run. Place markers flat on the ground with 1 inch projecting above finished grade.

715-14 Tests of Installation.

Upon completion of the work, test the installation to ensure that the installation is entirely free of ground faults, short circuits, and open circuits and that it is in satisfactory working condition. Furnish all labor, materials, and apparatus necessary for making the required tests. Remove and replace any defective material or workmanship discovered as a result of these tests at no expense to the Department, and make subsequent re-tests to the satisfaction of the Engineer.

Make all arrangements with the power supplier for power. Pay all costs, excluding energy charges, required for the test period.

Not less than 48 hours prior to the beginning of the test period, give the power supplier the schedule for such test.

Test the installation under normal operating conditions during the seven day test period specified in 715-15, rather than as a continuous burn test period.

If the work is not open to traffic at the end of the seven day test period, de-energize the lighting system until the work is opened.

715-15 Acceptance of Highway Lighting.

The Engineer may make partial acceptance of the highway lighting based on satisfactory performance of all highway lighting for seven consecutive days. The seven day evaluation period may commence upon written authorization by the Engineer that highway lighting is considered ready for acceptance evaluation. Contract Time will be charged during the entire highway lighting evaluation period. Correct any defects in materials or workmanship which might appear during the evaluation period at no expense to the Department. Transfer to the Department any guarantees on equipment or materials furnished by the manufacturer and ensure that the manufacturer includes with such guarantees the provision that they are subject to such transfer, and proper validation of such fact. The Department's written acceptance of highway lighting and the transfer to the Department of all manufacturer guarantees will be conditions precedent to final acceptance of all work under the Contract in accordance with 5-11.

715-16 Method of Measurement.

The quantities to be paid for will be as follows, completed and accepted:

(a) Conduit: The length, in feet, including elbows, sweeps, connecting hardware, trenching and backfill as indicated in the plans and the Design Standards, and the cost of restoring cut pavement, sidewalks, sod, and etc., to its original condition.

(b) Luminaire and Truss Arm: The Contract unit price will include the truss arm, luminaire with lamp, and all necessary mounting hardware as indicated in the plans and the Design Standards.

(c) Load Center: The Contract unit price will include the service pole, insulators, weatherheads, transformers, enclosures, panel boards, breakers, safety switches, H.O.A. switches, lighting protectors, fuses, photo electric assembly, meter base, and all external and internal conduit and conductors for the service as indicated in the plans and the Design Standards.

(d) Light Pole Foundation: The Contract unit price will include the foundation and anchor bolts with lock nuts and washers as indicated in the plans and the Design Standards.

(e) Luminaire: The Contract unit price will include the luminaire with lamp and necessary mounting hardware as indicated in the plans and the Design Standards.

(f) Pull Box: The Contract unit price will include the pull box and cover as indicated in the plans and the Design Standards.

(g) High Mast Parts: The Contract unit price will include the part specified with all mounting hardware as indicated in the Contract Documents and the Design Standards.

(h) Frangible Base for Light Pole: The Contract unit price will include the frangible base, attachments, bolts, and washers as indicated in the plans and the Design Standards.

(i) Photo Electric Control Assembly: The Contract unit price will include the photo electric control, transformers, conduit, and conductors as indicated in the plans and the Design Standards.

(j) Pre-Fab Pilaster: The Contract unit price will include the pilaster and all mounting hardware as indicated in the plans.

(k) High Mast Lighting Pole Complete: The Contract unit price will include the pole, luminaires with lamps, lowering system, breakers and anchor bolts with lock nuts and washers as indicated in the plans and the Design Standards.

(l) Conductor: The length, in feet, as indicated in the plans and the Design Standards.

(m) Lighting Pole Complete: The Contract unit price will include the pole, truss arm, luminaire with lamp, anchor bolts with lock nuts and washers, frangible base and foundation.

(n) Pole Cable Distribution System: The Contract Unit price will include the surge protector, fuse holders with fuses, waterproof connectors and the waterproof wiring connection to the luminaries.

715-17 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including all materials, equipment and tests.

DIVISION III
MATERIALS

AGGREGATES

SECTION 901
COARSE AGGREGATE

901-1 General.

901-1.1 Composition: Coarse aggregate shall consist of naturally occurring materials such as gravel, or resulting from the crushing of parent rock, to include natural rock, slags, expanded clays and shales (lightweight aggregates) and other approved inert materials with similar characteristics, having hard, strong, durable particles, conforming to the specific requirements of this Section.

Coarse aggregate for use in nonstructural concrete applications or hot bituminous mixtures may also consist of reclaimed Portland cement concrete meeting the requirements of 901-5. Washing of this material will not be required if the requirements of 901-1.2 for maximum percent of material passing the No. 200 sieve can be met without washing.

Materials substantially retained on the No. 4 sieve, shall be classified as coarse aggregate.

Approval of mineral aggregate sources shall be in accordance with 6-3.3.

901-1.2 Deleterious Substances: All coarse aggregates shall be reasonably free of clay lumps, soft and friable particles, salt, alkali, organic matter, adherent coatings, and other substances not defined which may possess undesirable characteristics. The weight of deleterious substances shall not exceed the following percentages:

Coal and lignite (AASHTO T 113)	1.00
Soft and friable particles (AASHTO T 112)*	2.00
Clay lumps (AASHTO T 112)*	2.00
Plant root matter (visual inspection in AASHTO T 27)****	0.005
Wood and wood matter (visual inspection in AASHTO T 27)****	0.005
Cinders and clinkers	0.50
Free shell**	1.00
Total Material passing the No. 200 sieve (FM 1-T 011) At Source with Los Angeles Abrasion less than or equal to 30	2.50
At Source with Los Angeles Abrasion greater than 30	1.75
At Point of Use	3.75
Fine-Grained Organic Matter (AASHTO 194)	0.03
Chert (less than 2.40 specific gravity SSD)(AASHTO T-113)***	3.00

*The maximum percent by weight of soft and friable particles and clay lumps together shall not exceed 3.00.

**Aggregates to be used in asphalt concrete may contain up to 5% free shell. Free shell is defined as that portion of the coarse aggregate retained on the No. 4 sieve consisting of loose, whole, or broken shell, or the external skeletal remains of other marine life, having a ratio of the maximum length of the particle

to the shell wall thickness exceeding five to one. Coral, molds, or casts of other shells, and crushed clam and oyster shell indigenous to the formation will not be considered as free shell.

***This limitation applies only to coarse aggregates in which chert appears as an impurity. It is not applicable to aggregates which are predominantly chert.

****Plant root matter, and wood and wood matter shall be considered deleterious when any piece exceeds two inches in length or 1/2 inch in width.

901-1.3 Physical Properties: Coarse aggregates shall meet the following physical property requirements, except as noted herein:

Los Angeles Abrasion (FM 1-T 096) ..... maximum loss 45%
Soundness (Sodium Sulfate) AASHTO T104 ..... maximum loss 12%*
Flat or elongated pieces** ..... maximum 10%

*For source approval - Aggregates exceeding soundness loss limitations will be rejected unless performance history shows that the material will not be detrimental for Portland Cement Concrete or other intended usages.

**A flat or elongated particle is defined as one having a ratio between the maximum and the minimum dimensions of a circumscribing prism exceeding five to one.

901-1.4 Gradation: Coarse aggregates shall conform to the gradation requirements of Table 1, when the stone size is specified. However, Table 1 is waived for those aggregates intended for usage in bituminous mixtures, provided the material is graded on sieves specified in production requirements contained in 6-3.3, and meets uniformity and bituminous design requirements.

TABLE 1
Standard Sizes of Coarse Aggregate

Amounts Finer than Each Laboratory Sieve (Square Openings), weight percent								
Size No.	Nominal Size Square Openings	4 inches	3 1/2 inches	3 inches	2 1/2 inches	2 inches	1 1/2 inches	1 inch
1	3 1/2 to 1 1/2 inches	100	90 to 100	-	25 to 60	-	0 to 15	-
2	2 1/2 inches to 1 1/2 inches	-	-	100	90 to 100	35 to 70	0 to 15	-
24	2 1/2 inches to 3/4 inch	-	-	100	90 to 100	-	25 to 60	-
3	2 inches to 1 inch	-	-	-	100	90 to 100	35 to 70	0 to 15
357	2 inches to No. 4	-	-	-	100	95 to 100	-	35 to 70
4	1 1/2 inches to 3/4 inch	-	-	-	-	100	90 to 100	20 to 55
467	1 1/2 inches to No. 4	-	-	-	-	100	95 to 100	-

TABLE 1
Standard Sizes of Coarse Aggregate

Amounts Finer than Each Laboratory Sieve (Square Openings), weight percent								
Size No.	Nominal Size Square Openings	4 inches	3 1/2 inches	3 inches	2 1/2 inches	2 inches	1 1/2 inches	1 inch
5	1 inch to 1/2 inch	-	-	-	-	-	100	90 to 100
56	1 inch to 3/8 inch	-	-	-	-	-	100	90 to 100
57	1 inch to No. 4	-	-	-	-	-	100	95 to 100
6	3/4 inch to 3/8 inch	-	-	-	-	-	-	100
67	3/4 inch to No. 4	-	-	-	-	-	-	100
68	3/4 inch to No. 8	-	-	-	-	-	-	-
7	1/2 inch to No. 4	-	-	-	-	-	-	-
78	1/2 inch to No. 8	-	-	-	-	-	-	-
8	3/8 inch to No. 8	-	-	-	-	-	-	-
89	3/8 inch to No. 16	-	-	-	-	-	-	-
9	No. 4 to No. 16	-	-	-	-	-	-	-
10	No. 4 to 0	-	-	-	-	-	-	-

TABLE 1 (Continued)
Standard Sizes of Coarse Aggregate

Amounts Finer than Each Laboratory Sieve (Square Openings), weight percent								
Size No.	Nominal Size Square Openings	3/4 inch	1/2 inch	3/8 inch	No. 4	No. 8	No. 16	No.50
1	3 1/2 inches to 1 1/2 inches	0 to 5	-	-	-	-	-	-
2	2 1/2 inches to 1 1/2 inches	0 to 5	-	-	-	-	-	-
24	2 1/2 inches to 3/4 inch	0 to 10	0 to 5	-	-	-	-	-
3	2 inches to 1 inch	-	0 to 5	-	-	-	-	-

TABLE 1
Standard Sizes of Coarse Aggregate

Amounts Finer than Each Laboratory Sieve (Square Openings), weight percent								
Size No.	Nominal Size Square Openings	4 inches	3 1/2 inches	3 inches	2 1/2 inches	2 inches	1 1/2 inches	1 inch
357	2 inches to No. 4	-	10 to 30	-	0 to 5	-	-	-
4	1 1/2 inches to 3/4 inch	0 to 15	-	0 to 5	-	-	-	-
467	1 1/2 inches to No. 4	35 to 70	-	10 to 30	0 to 5	-	-	-
5	1 inch to 1/2 inch	20 to 55	0 to 10	0 to 5	-	-	-	-
56	1 inch to 3/8 inch	40 to 85	10 to 40	0 to 15	0 to 5	-	-	
57	1 inch to No. 4	-	25 to 60	-	0 to 10	0 to 5	-	-
6	3/4 inch to 3/8 inch	90 to 100	20 to 55	0 to 15	0 to 5	-	-	-
67	3/4 inch to No. 4	90 to 100	-	20 to 55	0 to 10	0 to 5	-	-
68	3/4 inch to No. 8	90 to 100	-	30 to 65	5 to 25	0 to 10	0 to 5	-
7	1/2 inch to No. 4	100	90 to 100	40 to 70	0 to 15	0 to 5	-	-
78	1/2 inch to No. 8	100	90 to 100	40 to 75	5 to 25	0 to 10	0 to 5	-
8	3/8 inch to No. 8	-	100	85 to 100	10 to 30	0 to 10	0 to 5	-
89	3/8 inch to No. 16	-	100	90 to 100	20 to 55	5 to 30	0 to 10	0 to 5
9	No. 4 to No. 16	-	-	100	85 to 100	10 to 40	0 to 10	0 to 5
10	No. 4 to 0	-	-	100	85 to 100	-	-	-

NOTE: The gradations in Table 1 represent the extreme limits for the various sizes indicated, which will be used in determining the suitability for use of coarse aggregate from all sources of supply. For any grade from any one source, the gradation shall be held reasonably uniform and not subject to the extreme percentages of gradation specified above.

901-2 Natural Stones.

Course aggregate may be processed from gravels, granites, limestones, dolomite, sandstones, or other naturally occurring hard, sound, durable materials meeting the requirements of this Section.

901-2.1 Gravels: Gravel shall be composed of naturally occurring quartz, free from deleterious coatings of any kind. The minimum dry-rodded weight AASHTO T 19 shall be 95 lb/ft^3.

Crushed gravel shall consist of a minimum of 85%, by weight, of the material retained on the No. 4 sieve, having at least three fractured faces.

901-2.2 Granites: Coarse aggregate produced from the crushing of granites shall be sound and durable. For granites to be used in bituminous mixtures and surface treatments, the Los Angeles Abrasion requirement of 901-1.3 is modified to permit a maximum loss up to 50 (FM 1-T 096). Maximum amount of mica schist permitted is 5% (FM 5-584).

901-2.3 Limestones, Dolomite and Sandstone: Coarse aggregates may be produced from limestone, dolomite, sandstones, and other naturally occurring hard, durable materials meeting the requirements of this Section.

Pre-Cenozoic limestones and dolomite shall not be used as crushed stone aggregates either coarse or fine for Asphalt Concrete Friction Courses, or any other asphalt concrete mixture or surface treatment serving as the final wearing course. This specifically includes materials from the Ketone Dolomite (Cambrian) Newala Limestone (Mississippian), and Northern Alabama and Georgia.

As an exception to the above up to 20% fine aggregate from these materials may be used in asphalt concrete mixtures other than Friction Courses which serve as the final wearing course.

901-2.4 Cemented Coquina Rock: : For Cemented Coquina Rock to be used in bituminous mixtures, the Los Angeles Abrasion requirement of 901-1.3 is modified to permit a maximum loss up to 50 (FM 1-T 096) provided that the amount of material finer than No. 200 generated during the Los Angeles Abrasion test is less than 18%.

901-3 Manufactured Stones.

901-3.1 Slags: Coarse aggregate may be produced from molten nonmetallic by-products consisting essentially of silicates and aluminosilicates of calcium and other bases, such as air-cooled blast-furnace slag or phosphate slag, provided it is reasonably uniform in density and quality, and reasonably free from deleterious substances as specified in 901-1.2. In addition, it must meet the following specific requirements:

Sulphur content ..... not more than 1.5%
Dry rodded weight AASHTO T 19..... minimum 70 lb/ft3
Glassy Particles.....not more than 10%

Slag shall not be used as an aggregate for Portland cement concrete.

For Air-Cooled Blast Furnace Slag, the Los Angeles Abrasion requirement of 901-1.3 is modified to permit a maximum loss up to 50 (FM 1-T 096) provided that the amount of material finer than No. 200 sieve generated during the Los Angeles Abrasion test is less than 18%.

901-4 Lightweight Aggregates.

901-4.1 Lightweight Coarse Aggregate for Bituminous Construction: Lightweight coarse aggregate may be produced from naturally occurring

materials such as pumice, scoria and tuff or from expanded clay, shale or slate fired in a rotary kiln. It shall be reasonably uniform in quality and density, and free of deleterious substances as specified in 901-1.2, except that the term cinders and clinkers shall apply to those particles clearly foreign to the extended aggregate in question.

In addition, it must meet the following specific requirements:

Material passing the No. 200 Sieve ..... maximum 3.00%, (FM 1-T 011)
Dry loose weight (AASHTO T 19)* ..... 33-55 lb/ft^3
Los Angeles Abrasion (FM 1-T 096) ..... maximum 35%
Ferric Oxide (ASTM C 641) ..... maximum 1.5 mg

*Source shall maintain dry-loose unit weight within ±6% of Quality Control average. Point of use dry-loose unit weight shall be within ±10% of Source Quality Control average.

901-4.2 Lightweight Coarse Aggregate for Structural Concrete: The requirements of 901-4.1 are modified as follows:

Aggregates shall not be produced from pumice and scoria.

Los Angeles Abrasion (FM 1-T 096, Section 12) shall be 45%, maximum.

Gradation shall meet the requirements of AASHTO M 195 for 3/4 inch, 1/2 inch and 3/8 inch.

901-5 Reclaimed Portland Cement Concrete.

The reclaimed Portland cement concrete shall be from a source which was produced and placed in accordance with applicable Specifications. The material shall be crushed and processed to provide a clean, hard, durable aggregate having a uniform gradation free from adherent coatings, metals, organic matter, base material, joint fillers, and bituminous materials.

The Contractor's (Producer's) crushing operation shall produce an aggregate meeting the applicable gradation requirements. The physical property requirements of 901-1.3 for Soundness shall not apply and the maximum loss as determined by the Los Angeles Abrasion (FM 1-T 096) is changed to 50.

The sources of reclaimed Portland cement concrete will be treated as a mine and subject to the requirements of Section 6 and Section 105.

901-6 Exceptions, Additions and Restrictions.

Pertinent specification modifications, based on material usage, will be found in other Sections of the specifications.

SECTION 902
FINE AGGREGATE

902-1 General.

902-1.1 Composition: Fine aggregate shall consist of natural silica sand, screenings, local materials, or subject to approval, other inert materials with similar characteristics, or combination thereof, having hard, strong, durable particles, conforming to the specific requirements of this Section.

Approval of mineral aggregate sources shall be in accordance with 6-3.3.

902-1.2 Deleterious Substances: All fine aggregate shall be reasonably free of lumps of clay, soft or flaky particles, salt, alkali, organic matter, loam or other extraneous substances. The weight of deleterious substances shall not exceed the following percentages:

Shale.....1.0
Coal and lignite.....1.0
Cinders and clinkers.....0.5
Clay Lumps.....1.0

902-2 Silica Sand.

902-2.1 Composition: Silica sand shall be composed only of naturally occurring hard, strong, durable, uncoated grains of quartz, reasonably graded from coarse to fine, meeting the following requirements, in percent total weight.

Sieve Opening Size	Percent Retained	Percent Passing
No. 4	0 to 5	95 to 100
No. 8	0 to 15	85 to 100
No. 16	3 to 35	65 to 97
No. 30	30 to 75	25 to 70
No. 50	65 to 95	5 to 35
No. 100	93 to 100	0 to 7
No. 200	minimum 96	maximum 4

Silica sand from any one source, having a variation in Fineness Modulus greater than 0.20 either way from the Fineness Modulus of target gradations established by the producer, may be rejected.

902-2.2 Organic Impurities: Silica sand shall be subject to the colorimetric test for organic impurities. If the color produced is darker than the standard solution, the aggregate shall be rejected unless it can be shown by appropriate tests that the impurities causing the color are not of a type that would be detrimental to Portland Cement Concrete. Such tests shall be in accordance with AASHTO T 21 and AASHTO T 71. When tested for the effect of organic impurities on strength of mortar, the strength ratio at seven and 28 days, calculated in accordance with Section 11 of AASHTO T 71, shall not be less than 95%.

902-3 Sands for Miscellaneous Uses.

902-3.1 Anchor Bolts and Pipe Joints: Sand for setting anchor bolts, pipe joints or other similar uses shall meet the quality requirements of 902-2 except that gradation requirements are waived.

902-3.2 Brick Masonry: Sand for brick masonry shall meet the quality requirements of 902-2 except for gradation requirements. All the materials shall pass the No. 8 sieve, and be uniformly graded from coarse to fine.

902-3.3 Sand-Cement Riprap: Sand for sand-cement riprap shall meet the quality requirements of 902-2 except for gradation requirements. The material shall meet the following gradation limits:

Sieve Size	Percent Passing
No. 4	minimum 97%
No. 100	maximum 20%
No. 200	maximum 5%

902-4 Filter Material for Underdrains.

Silica sand for use as filter material for Types I through IV Underdrains shall meet the requirements of 902-2 except that the requirements of 902-1.2 and 902-2.2 shall not apply. The aggregate shall be reasonably free of organic matter and other deleterious materials. The gradation requirements of 902-2.1 shall apply except no more than 2% shall pass the No. 200 sieve.

Filter material for Type V Underdrain shall meet the above requirements except that there shall be no more than 1% of silt, clay and organic matter, that the aggregate shall have a Uniformity Coefficient of 1.5 or greater, and that 10% diameter shall be No. 70 to 35 sieve. The Uniformity Coefficient shall be determined by the ratio D60 divided by D10, where D60 and D10 refer to the particle diameter corresponding to 60 and 10% of the material which is finer by dry weight.

902-5 Screenings.

902-5.1 Composition: Screenings shall be composed of hard, durable particles, either naturally occurring, such as gravel screenings, or resulting from the crushing or processing of the parent rock, to include natural rock, slags, expanded clays or shales (lightweight aggregates), or other approved inert materials with similar characteristics.

Aggregates classified as screening shall conform to the following gradation requirements:

Sieve Size	Percent Passing
3/8 in.	100%
No.4	75 to 100%

902-5.2 Specific Requirements:

902-5.2.1 Screenings from Department Approved Sources of Coarse Aggregate: Processed screenings from fully Approved Sources of Coarse Aggregate are subject to gradation. Should Coarse Aggregate Source Approval status change, or unsatisfactory in-service history develop, additional control requirements may be implemented.

Screenings for use in hot bituminous mixture may consist of screenings from the processing of reclaimed portland cement concrete pavement to produce coarse aggregate.

902-5.2.2 Screenings from Other Sources: Screenings, from sources other than Department Approved Sources of Coarse Aggregate, must meet the following additional general requirements:

Modified Los Angeles Abrasion: 95% statistical probability of meeting maximum loss of 23%.

Specific Gravity*
Absorption*
Soundness*
Sulfur*
Phosphate*
Extraneous Substances*

*Specific specification requirements based on material usage found in appropriate Bituminous or Portland Cement Sections.

Based on specific material characteristics, processing techniques and in-service history on Department projects, specific source requirements may be assigned.

902-5.2.3 Screenings for Use in Portland Cement Concrete: Screenings produced from either the Miami Oolite, Miami Ft. Thompson, or Loxahatchee Ft. Thompson Formations may be substituted for silica sand for use in concretes, except for concrete pavements, approach slabs, bridge decks and precast superstructure segments. (However, screenings will be permitted in the concrete when the bridge deck or approach slab is to be covered with an asphalt concrete surface course.)

These screenings must meet the gradation requirements of AASHTO M 6, Section 6.1, as well as the maximum percent passing the No. 200 sieve, Fineness Modulus, and Organic requirements of 902-2 Silica Sand. In addition, the saturated, surface dry specific gravity shall be at least 2.48.

902-6 Local Materials.

Local materials shall be composed of hard, strong, durable particles, either naturally occurring, such as natural sands, or resulting from the crushing or processing of parent rock, to include natural sand and rock, slags, expanded clays or shales (lightweight aggregate), or other approved inert materials with similar characteristics.

Aggregates classified as local material shall conform to the following gradation requirements:

Sieve Size	Percent Passing
3/8 in.	100%
No. 10	85 to 100%
No. 200	maximum 15%

In addition to meeting the requirements of 902-1.2, the material shall not contain excessive quantities of other deleterious substances, such as roots, cans, debris, etc. If clay size material is present, it shall not exceed 7%, as determined by AASHTO T 88, and it shall be of a type which will not produce clay balls when used. The aggregate must be suitable for designated use, as determined by laboratory tests. If the deposit consists of stratified layers of varying characteristics and gradation, the producer shall employ such means as necessary to secure a uniform material.

Local materials will not be required to be produced under the requirements of 6-3.3, provided they can meet the above requirements.

902-7 Exceptions, Additions and Restrictions.

Other specification modifications, based on material usage may be found in the appropriate Sections of the specifications.

SECTION 911
LIMEROCK MATERIAL FOR BASE AND STABILIZED BASE

911-1 General.

This Section governs materials to be used on construction of limerock base and limerock stabilized base.

911-2 Furnishing of Material.

Except as might be specifically shown otherwise, all limerock material and the sources thereof shall be furnished by the Contractor. Approval of mineral aggregate sources shall be in accordance with 6-3.3. Any limerock material occurring in State-furnished borrow areas shall not be used by the Contractor in constructing the base, unless permitted by the plans or other Contract Documents.

911-3 Composition.

The minimum of carbonates of calcium and magnesium in the limerock material shall be 70%. The maximum percentage of water-sensitive clay mineral shall be 3. Determination shall be at the option of the Engineer.

911-4 Liquid Limit and Plasticity Requirements.

911-4.1 Material for Limerock Base: The liquid limit shall not exceed 35 and the material shall be non-plastic.

911-4.2 Material Used in Limerock Stabilized Base: The liquid limit shall not exceed 35 and the plastic index shall not exceed ten.

911-5 Mechanical Requirements.

911-5.1 Deleterious Material: Limerock material shall not contain cherty or other extremely hard pieces, or lumps, balls or pockets of sand or clay size material in sufficient quantity as to be detrimental to the proper bonding, finishing, or strength of the limerock base.

911-5.2 Gradation and Size Requirements:

911-5.2.1 For Limerock Base: At least 97% (by weight) of the material shall pass a 3 1/2 inch sieve and the material shall be graded uniformly down to dust. The fine material shall consist entirely of dust of fracture. All crushing or breaking-up which might be necessary in order to meet such size requirements shall be done before the material is placed on the road.

911-5.2.2 For Limerock Stabilized Base: For this use the limerock material shall meet the requirements of 911-5.2.1 except that 97% shall pass the 1 1/2 inch sieve.

911-6 Limerock Bearing Ratio Requirements.

Limerock material used in construction of limerock base shall have an average LBR value of not less than 100. The average LBR value of material

produced at a particular source shall be determined in accordance with an approved quality control procedure.

SECTION 913
SHELL MATERIAL

913-1 General.

913-1.1 Composition: Shell materials to be used for shell base or shell stabilized base, shall consist of naturally occurring deposits formed essentially of broken mollusk shell, corals and the skeletal remains of other marine invertebrates. Live or steamed shell, or man-made deposits as a by-product of the shellfish industry will not be permitted.

Approval of mineral aggregate sources shall be in accordance with 6-3.3.

913-1.2 Deleterious Substances: Shell materials shall be reasonably free of lumps of clay, organic matter, and other substances not defined which may possess undesirable characteristics. The material shall not contain silica sand in sufficient quantity to prevent bonding.

913-1.3 Physical and Chemical Properties: Shell materials shall meet the following physical and chemical requirements:

Limerock Bearing Ratio (FM 5-515) - The material shall have an average LBR value of not less than 100. Material represented by any individual LBR value of less than 90 is unacceptable.

Plasticity (AASHTO T 89 and AASHTO T 90) - That portion of the material passing the No. 40 sieve shall be non-plastic.

Carbonates (FM 5-514) - The minimum percentage of carbonates of calcium and magnesium shall be 50.

913-2 Dredged Shell.

913-2.1 Definition: Dredged shell shall be defined as those shell materials meeting the requirements of 913-1, which are dredged from ocean, bay or lake deposits.

913-2.2 Gradation Requirements: Materials classified as Dredged Shell shall meet the following gradation requirements:

Passing 3 1/2 inch sieve	97% (maximum dimension not to exceed 6 inches)
Passing No. 4 sieve	maximum 50%
Passing No. 200 sieve	maximum 7.5% (by weight)

913-3 Bank-Run Shell.

913-3.1 Definition: Bank-Run Shell shall be defined as those shell materials meeting the requirements of 913-1 which are presently found as “dry land” deposits.

913-3.2 Gradation Requirements: Materials classified as Bank-Run Shell shall meet the following gradation requirements:

Passing 3 1/2 inch sieve	97% (maximum dimension not to exceed 6 inches)
Passing No. 4 sieve	maximum 80%
Passing No. 200 sieve	maximum 20% (washed)

913-4 Exceptions, Additions and Restrictions.

Other specification modifications, based on material usage, may be found in applicable Sections of the specifications.

SECTION 913A
SHELL - ROCK MATERIAL

913A-1 General.

Shell-rock materials to be used for shell-rock base shall be defined as naturally occurring heterogeneous deposits of limestone with interbedded layers or lenses of loose and cemented shell, to include cemented sands (calcitic sandstone). This material shall be mined and processed in a manner that will result in a reasonably homogenous finished product.

Approval of mineral aggregate sources shall be in accordance with 6-3.3.

913A-2 Deleterious Substances.

Shell-rock materials shall not contain lumps of clay, organic matter, cherty or other extremely hard materials, or other substances not defined, in sufficient quantity as to be detrimental to the finishing, strength, or performance of the base. The material shall not contain loose, free silica sand in sufficient quantity to prevent bonding of the base, or to result in a surface which is susceptible to distortion under construction traffic, or accumulation of loose sand on the finished surface which precludes bonding of the bituminous tack coat with the base, nor shall the material contain more than 50% loose, free shells, corals or skeletal remain of other marine invertebrates (retained on the No. 4 sieve). Materials shall contain no water sensitive clay minerals.

913A-3 Physical and Chemical Properties.

Shell-rock material shall meet the following physical and chemical properties:

Limerock Bearing Ratio (LBR) (FM 5-515) - Production of this material shall be controlled so as to meet the following requirements for LBR value:

The average of test values shall not be less than 100.

No individual test value shall be less than 90.

No two consecutive test values between 90 and 100.

Plasticity (AASHTO T 89 and AASHTO T 90) - That portion of the material passing the No. 40 sieve shall be non-plastic.

Carbonates (FM-5-514) - The minimum of the average percentage of carbonates of calcium and magnesium shall be 50. Material represented by any individual carbonate LOT average of less than 45% is unacceptable.

Gradation Requirements - Materials classified as shell-rock shall be graded uniformly down to dust and in addition, meet the following specific requirements:

Passing 3 1/2 inch sieve (maximum dimension not to exceed 6 inches) ..... minimum 97%
Passing No. 4 sieve..... maximum 70%
Passing No. 200 sieve.....maximum 20% (washed)

SECTION 914
STABILIZATION MATERIALS

914-1 General.

This Section governs materials to be used in subgrade stabilization. Meet the following requirements:

Plasticity Index (AASHTO T 90)	Maximum 10
Liquid Limit (AASHTO T 89)	Maximum 40
Passing a 3 1/2 inch screen (AASHTO T 27)	Minimum 97%
LBR	No Requirement

914-2 Materials for Stabilizing (Limerock Bearing Ratio).

914-2.1 Commercial Materials: Materials may be either limerock, shell rock, cemented coquina or shell base sources approved in accordance with 6-3.3.

914-2.2 Local Materials: Local materials used for stabilizing may be soils or recyclable materials such as crushed concrete, roof tiles and asphalt coated base or reclaimed pavement provided the following limits for Organic Content are met.

Average Organic Content* (FM1-T 267)	Maximum 2.5%
Individual Organic Content Sample (FM1-T 267)	Maximum 4%
*Note: A minimun of three samples per source	

Materials that contain hazardous substances or contaminates shall not be used.

If toxic substances, elements or compounds are suspected to exist at concentrations exceeding limits defined by EPA, qualifying tests shall be performed. Test methods for these substances shall be those mandated by EPA and analyzed by a certified laboratory.

SECTION 915
CEMENTED COQUINA SHELL MATERIAL

915-1 Composition.

Cemented Coquina Shell Materials to be used as cemented coquina base or stabilized base, shall be defined as naturally occurring deposits formed

essentially of broken mollusk shell, corals and the skeletal remains of other marine invertebrates, which are presently found as "dry land" deposits and which have been cemented together by carbonates or other natural cementing agents.

Approval of mineral aggregate sources shall be in accordance with 6-3.3.

915-2 Deleterious Substances.

Cemented Coquina Shell Materials shall be reasonably free of lumps of clay, organic matter, and other substances not defined which may possess undesirable characteristics. The material shall not contain loose, free silica sand in sufficient quantity to prevent bonding.

915-3 Physical and Chemical Properties.

Cemented Coquina Shell shall meet the following physical and chemical properties.

Limerock Bearing Ratio (FM-515) - The material shall have an average LBR value of not less than 100. Material represented by any individual LBR value of less than 90 is unacceptable.

Plasticity (FM 1-T 089 and FM 1-T 090) - That portion of the material passing the No. 40 sieve shall be non-plastic.

Carbonates (FM 5-514) - The average percentage of carbonates of calcium and magnesium shall be 45. Material represented by any individual carbonate and magnesium LOT average of less than 40.5% is unacceptable.

915-4 Gradation requirements.

Cemented Coquina shall have the following gradation requirements:

Passing 3 1/2 inch sieve	97% (maximum dimension not to exceed 6 inches)
Passing No. 4 sieve	maximum 70%
Passing No. 200 sieve (dry weight)	maximum 20% (by washing)

915-5 Exceptions, Additions and Restrictions.

Other specification modifications, based on material usage, may be found in applicable Sections of the specifications, or revisions thereto.

SECTION 916
BITUMINOUS MATERIALS

916-1 Superpave PG Asphalt Binder.

916-1.1 Requirements: Superpave PG asphalt binders, identified as PG 64-22, PG 67-22, and PG 76-22, shall meet the requirements of 916-1.2, AASHTO M-320 and the following additional requirements:

1. The mass loss AASHTO T-240 shall be a maximum of 0.5% for all grades.

2. The spot test AASHTO T-102 with standard naphtha shall be negative for all grades. As an exception, a positive spot will be accepted if the PAV

Residue (AASHTO R-28) at 110ºC meets all the requirements for the particular grade.

3. The smoke point FM 5-519 shall be a minimum of 260ºF for all grades.

4. The intermediate test temperature at 10 rad/s. for the Dynamic Shear Rheometer test AASHTO T-315 shall be 25ºC for all grades.

5. An additional high temperature grade of PG 67 is added for which the high test temperature at 10 rad/sec for the Dynamic Shear Rheometer test AASHTO T-315 shall be 67ºC.

6. All PG asphalt binders having a high temperature designation of PG 67 or lower shall be prepared without modification.

7. All PG asphalt binders having a high temperature designation higher than PG 67 shall be produced with a styrene-butadiene-styrene (SBS) or styrene-butadiene (SB) elastomer polymer modifier and resultant binder shall meet all requirements of this Specification; in addition the phase angle at 76ºC (AASHTO T-315) shall be less than or equal to 75 degrees.

8. The maximum viscosity AASHTO T-202 shall be 2400 poises for PG 64-22 and 3600 poises for PG 67-22.

All hot mix asphalt (except hot mix asphalt containing 20% RAP or greater) shall contain Superpave PG asphalt binder grade PG 67-22 unless otherwise specified in the plans and/or Specifications for the hot mix asphalt product.

For all PG binder used in all hot mix asphalt, silicone shall be added to the PG binder at the rate of 25 cm^3 of silicone mixed to each 5,000 gal. of PG binder. If a disbursing fluid is used in conjunction with the silicone the resultant mixture containing the full 25 cm^3 of silicone shall be added in accordance with the manufacturer's recommendation. The blending of the silicone with the PG binder shall be done by the supplier prior to the shipment.

All PG binder and asphalt rubber binder for Friction Course mixes and for other hot mix asphalt products containing RAP shall contain 0.5% heat stable anti-strip additive by weight of PG binder unless specifications for the hot mix asphalt product requires testing by FM 1 T-283 and the test results indicate it is not required, or the mixture contains hydrated lime. Where FM 1 T-283 indicates an anti-strip additive is required, it shall be from 0.25 to 0.75%. The anti-strip additive shall meet the requirements of 916-5. The anti-strip additive shall be introduced into the PG binder by the supplier during loading. An exception to this requirement shall be PG 76-22 used in FC-5 mixtures with 100% Oolitic limestone.

Where PG binder is used in mixes containing reclaimed asphalt pavement (RAP), the requirements of 334-2.3.4 must also be met.

916-1.2 Qualified Products List: The Superpave PG asphalt binders supplied under this Specification shall be one of the products included on the Qualified Products List as specified in 6-1. Any marked variation from the original test values for a material below the established limits or evidence of inadequate quality control or field performance of a material will be considered to be sufficient evidence that the properties of the material have changed, and the material will be removed from the Qualified Products List.

For each binder grade, the supplier may be required to submit to the State Materials Office a split sample of material representative of test results submitted with the Product Evaluation Application. In addition, for modified binders, the original PG binder grade, the modifier product designation, and amount added shall be indicated on the Product Evaluation Application and in the Quality Control Program below. Suppliers shall not ship any PG binder until notified that the product is on the Qualified Products List and an approved Quality Control Program meeting the requirements of 916-1.3 has been implemented.

916-1.3 Quality Control Program: The supplier of Superpave PG asphalt binder shall at a minimum have a Quality Control Program meeting the requirements of this Specification which is based on AASHTO R-26. The Quality Control Program shall be submitted in electronic format to the State Materials Office for approval.

The requirements for the Quality Control program apply to the supply location of PG binders for the use on Florida Department of Transportation projects. The supply location of PG binder may represent refinery production, terminal distribution, blending, processing and/or modification location. Rack blending (blending from two tank sources) will be permitted to meet the requirements for a PG asphalt binder product. Any special handling requirements such as rack blending and manufacture of polymer modified asphalt shall be described in the Quality Control program. The requirements of these Specifications for a Quality Control Program do not apply to Recycle Agents at this time.

916-1.3.1 Identification of Personnel and Supply Locations: The supplier's primary and secondary representatives responsible for Quality Control shall be identified by name, title, address, telephone, fax and e-mail address. At least one of the representatives shall be located at the supply location. The supply locations shall be identified by name, address and telephone.

916-1.3.2 Specification Compliance and Quality Control Testing: Specification Compliance Testing shall consist of complete testing of each PG binder shipped in accordance with AASHTO M-320 and 916-1.1 of these Specifications. Results of Specification Compliance Testing shall be available to the supplier within five working days of sampling. Specification Compliance Testing shall be conducted by a testing laboratory that participates at least annually in the AMRL Proficiency Sample Program for both Performance Graded Asphalt Binder and Viscosity Graded Asphalt Cement. The primary testing lab and any other labs to be used for Specification Compliance Testing shall be identified in the suppliers Quality Control Program. The results from each AMRL Proficiency Sample for each testing laboratory shall be forwarded by the supplier for each supply location in electronic format to the State Materials Office. Acceptable performance in the AMRL Proficiency Sample Program shall be a minimum of 3 for each test. A rating of less than 3 shall require identification of appropriate action on the part of the supplier and be acceptable to the State Materials Engineer.

Quality Control testing as a minimum shall consist of testing a representative sample of each PG binder shipped by the supplier in accordance with either:

(1) AASHTO T-202 Standard Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer or

(2) AASHTO T-315 Test Method for Determining Rheological Properties of Asphalt Binder using a Dynamic Shear Rheometer (DSR).

Results of Quality Control Testing shall be available to the supplier within five hours of sampling. A Quality Control test result outside the specification limits will require immediate sampling and testing for Specification Compliance and appropriate action taken. The Quality Control testing and location where the test will be done shall be identified in the suppliers Quality Control Program.

916-1.3.3 Frequency of Sampling and Testing: Sampling of PG binders shall be done in accordance with AASHTO T-40. Initial Specification Compliance test results shall be required for each PG binder grade for each new LOT of material which will be further subjected to Quality Control Testing in accordance with 916-1.3.2. A new LOT will occur when the material in a tank changes and the Specification Compliance Test may no longer be representative of the material in the tank. This may be due to an incoming bulk shipment of material, change in refinery run, the manufacture of a product, or a blend of material in a tank. Additional testing is as follows:

(1) Any PG binder shipped to a Department project during any one calendar month shall be tested at least once during that month for Specification Compliance in accordance with 916-1.3.2.

(2) When being shipped to Department projects, samples shall be obtained by the supplier and tested for Quality Control testing in accordance with 916-1.3.2. A single one quart representative sample of each PG binder shall be obtained and tested by the supplier each calendar week; for each rack blended PG binder, additional representative samples shall be obtained daily. Each Quality Control sample and additional daily rack blended samples shall be adequately identified and retained not less than eight weeks at the supply location. Any PG binder not shipped to Department projects is not required to be sampled or tested.

(3) Split samples of any PG binder will be provided when requested by a representative of the Department. In this situation three representative one quart samples will be obtained by the supplier under the direction of the Department. One sample will be submitted to the State Materials Office, one will be tested by the supplier for Specification Compliance and one will be tested by the supplier for Quality Control. The method of obtaining the three representative one quart samples is to obtain a single gallon sample, which is then stirred and poured into three one quart cans. When split samples are requested by the Department, the results from both parties will be made available within ten working days.

(4) For each rack blended PG binder, identify minimum daily Process Control Testing in the QC Plan.

916-1.3.4 Reporting: A monthly report by the supplier containing Specification Compliance and Quality Control Test results for each PG binder LOT shall be submitted by the supplier in electronic format using the form provided by the Department to the State Materials Office within seven days following the end of the calendar month. Test results for split samples shall also

be included. Process Control Test results shall not be included. Copies of these monthly reports and supporting test reports shall be available at the supply location for a minimum of 3 years.

The report shall consist of the Specification compliance testing and Quality Control Testing of the following as applicable by these Specifications.

SUPERPAVE PG ASPHALT BINDER		
Test and Method	Conditions	Specification Minimum/Maximum Value
Original Binder		
Superpave PG Asphalt Binder Grade		Report
Qualified Products List Number		Report
Polymer Modifier Type	(PG 76-22 Only)	Report
Spot Test, AASHTO T-102	Standard with Naphtha Solvent	Negative for all grades
Solubility, AASHTO T-44	in Trichlorethylene	Minimum 99.0%
Smoke Point, FM 5-519	COC	Minimum 260ºF
Flash Point, AASHTO T-48	COC	Minimum 450ºF
Rotational Viscosity, AASHTO T-316	275ºF	Maximum 3 Pa-s
Absolute Viscosity, AASHTO T-202	140ºF	Max. 2400 P (PG 64-22) Max. 3600 P (PG 67-22)
Dynamic Shear Rheometer, AASHTO T-315	$G^*/\sin\delta$, Test Temperature @ 10 rad/sec, °C Phase Angle, δ, (PG 76-22 Only)	Minimum 1.00 kPa Maximum 75 degrees
Rolling Thin Film Oven Test Residue (AASHTO T240)		
Rolling Thin Film Oven, AASHTO T-240	Mass Loss%	Maximum 0.50
Dynamic Shear Rheometer, AASHTO T-315	$G^*/\sin\delta$, Test Temperature @ 10 rad/sec, °C	Minimum 2.20 kPa
Pressure Aging Vessel Residue (AASHTO R-28) at 100ºC		

Dynamic Shear Rheometer, AASHTO T-315	$G^*\sin\delta$, 10 rad/sec. @ 25°C	Maximum 5000 kPa
Creep Stiffness, AASHTO T-313	S (Stiffness), @ 60 sec. @ -12°C M-value, @ 60 sec. @ -12°C	Maximum 300 Mpa Minimum 0.300
Pressure Aging Vessel Residue (AASHTO R-28) at 110ºC (Positive Spot Only)		
Dynamic Shear Rheometer, AASHTO T-315	$G^*\sin\delta$, 10 rad/sec. @ 25°C	Maximum 5,000 kPa
Creep Stiffness, AASHTO T-313	S (Stiffness), @ 60 sec. @ -12°C M-value, @ 60 sec. @ -12°C	Maximum 300 Mpa Minimum 0.300

916-1.3.5 Notification and Evaluation: In the event that a Specification Compliance test is outside specification requirements or a Quality Control test is outside limits established by the supplier as part of his Quality Control Program shipments of that product to Department projects will cease immediately and the Contractor and the State Materials Office will be notified and the product retested for Specification Compliance (resampling as appropriate). Where the retest for Specification Compliance meets all requirements, shipments of that product may resume. Where off-specification material has been shipped and the retest confirms the original test, the Contractor and State Materials Office will be informed of the steps taken to achieve specification compliance on the product shipped.

Where off-specification materials has been shipped, further shipment of that product to Department projects shall remain suspended until the cause of the problem is evaluated and corrected by the supplier to the satisfaction of the State Materials Engineer.

916-1.3.6 Certification and Verification: The supplier shall furnish certification on the bill of lading for each shipment of PG binder delivered to a Department project that includes: the quantity, the Superpave PG asphalt binder grade (including QPL number), PG binder LOT designation, the customer name, the delivery location, a statement that the binder is in conformance with 916-1 and the suppliers Quality Control Program, and the quantity of silicone and anti-strip agent addition as applicable, including product designation (QPL number as applicable). Any special handling or temperature requirements shall be indicated on the certification and are solely the responsibility of the Contractor to follow.

The Department may sample and test PG binder from the suppliers storage tank, the delivery vehicle, and/or Contractors storage tank to verify and determine compliance with this and other specification requirements. Where these tests identify material outside specification requirements, the State Materials Engineer may require the supplier to cease shipment of that PG binder product. Further shipment of that PG binder product to Department projects may

remain suspended until the cause of the problem is evaluated and corrected by the supplier as necessary to the satisfaction of the State Materials Engineer.

916-2 Recycling Agents.

916-2.1 Requirements: The asphalt recycling agent (RA) shall be an asphalt cement (PG asphalt binder) or an asphalt cement blended (as necessary) with a softening agent or flux oil, and shall meet the following requirements:

RECYCLING AGENTS		
Test	Conditions	Recycling Agent Minimum/Maximum Value
Absolute Viscosity – AASHTO T-202	140ºF	Target Viscosity ± 20%
Viscosity Ratio After AASHTO T-240	Visc. 140ºF after RTFOT Visc. 140ºF before RTFOT	maximum 3
Smoke Point FM 5-519	COC	minimum 260ºF
Flash Point AASHTO T-48	COC	minimum 400ºF
Solubility AASHTO T-44	in Trichlorethylene	minimum 99.0%

Rack blending of recycling agents (blending from two RA tank sources) will be permitted to meet a required target viscosity value.

Silicone shall be added to the recycling agent at a rate of 25 cm^3 for each 5,000 gallons of recycling agent. If a dispersing fluid is used in conjunction with the silicone, the resultant mixture containing the full 25 cm^3 shall be added, in accordance with the manufacturer's recommendation. The blending of silicone mixture with the residue shall be done by the supplier prior to shipment.

The recycling agent shall contain 0.5% heat-stable anti-strip additive by weight of asphalt from an approved source. The anti-strip additive shall meet the requirements of 916-5. The anti-strip additive shall be introduced and mixed into the recycling agent at the terminal.

Where a recycling agent is used in mixes containing reclaimed asphalt pavement (RAP), the requirements of 334-2.3.4 must also be met.

916-2.2 Sampling and Reporting: Sampling of recycling agents shall be done in accordance with AASHTO T-40. Initial Specification Compliance test results shall be required for each new LOT of material. A new LOT will occur when the material in a tank changes and the Specification Compliance Test may not be representative of the material in the tank. This may be due to an incoming bulk shipment of material, change in refinery run, the manufacture of a product, or a blend of material in a tank.

A monthly report by the supplier containing Specification Compliance Test results for each RA LOT shall be submitted by the supplier in electronic

format using the form provided by the Department to the State Materials Office within seven days following the end of the calendar month. Copies of these monthly reports and supporting test reports shall be available at the supply location for a minimum of three years.

916-2.3 Certification and Verification: The supplier shall furnish certification on the bill of lading for each shipment of recycling agent delivered to a Department project that includes: the quantity, the RA target viscosity, the RA LOT designation, customer name, delivery location, a statement that the RA is in conformance with 916-2, and the quantity of silicone and anti-strip agent addition, including product designation (QPL number as applicable).

The Department may sample and test recycling agents from the suppliers storage tank, the delivery vehicle, and/or Contractors storage tank to verify and determine compliance with this and other specification requirements. Where these tests identify material outside specification requirements, the State Materials Engineer may require the supplier to cease shipment of RA binder from that RA LOT(s). Further shipment of RA binder from that RA LOT(s) to Department projects may remain suspended until the cause of the problem is evaluated and corrected by the supplier as necessary to the satisfaction of the State Materials Engineer.

916-3 Cut-Back Asphalts.

916-3.1 Requirements: Rapid-curing, cut-back asphalt shall conform with the requirements of AASHTO M-81, except that the penetration range shall be from 60-120 instead of 80-120.

For Grade RC-3000, in addition to the requirements shown in Table 1 of AASHTO M-81 the following values shall be added to the requirements for Distillation Test:

Distillate, Percentage by Volume of Total Distillate to 680ºF	Grade RC-3000 Maximum
to 320ºF	0
to 374ºF	10
to 437ºF	40

All other requirements for the distillation test (and for other properties included in the table) shall be as shown in Table 1 of AASHTO M-81.

Medium-curing, cut-back asphalt shall conform with the requirements of AASTHO M-82.

916-3.2 Sampling, Certification, and Verification: Sampling of cut-back asphalts shall be done in accordance with AASHTO T-40. For each tank of cut-back asphalt delivered to or prepared at the asphalt terminal, the asphalt supplier shall submit a sample to the State Materials Office for testing before use. A pretest number will then be assigned by the State Materials Office which shall be furnished with all cut-back asphalt delivered to the project. The pretest number shall be valid for six months from the date of issue.

The Department may sample and test pre-tested cut-back asphalt from the suppliers storage tank, the Contractors transport tank and/or distributor to

verify and determine compliance with this and other specification requirements. Where these tests identify material outside specification requirements, the State Materials Engineer may require the supplier to cease shipment of that pretested cut-back asphalt product. Further shipment of that pretested cut-back asphalt product to Department projects may remain suspended until the cause of the problem is evaluated and corrected by the supplier as necessary to the satisfaction of the State Materials Engineer.

916-4 Emulsified Asphalts.

916-4.1 Requirements: Anionic Emulsified Asphalt shall meet the requirements of AASHTO M-140 with the exception that the cement mix test will be waived when the asphalt is used in non-mix application, such as tack coats and primes. Cationic Emulsified Asphalt shall meet the requirements of AASHTO M-208. Additional emulsions permitted by specifications shall meet the following requirements:

HIGH FLOAT EMULSIONS		
Test	Conditions	Asphalt Emulsion Grade AE-60
		Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc	122ºF	75/400 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Sieve Test		maximum 0.10%
Demulsibility	50 mL $CaCl_2$ 0.10 N	minimum 75%
Residue by Distillation		minimum 65%
Oil Portion	500ºF. Dist.	maximum 1% by volume
Tests on Residue:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	minimum 40
Absolute Viscosity	140ºF	minimum 3,200 poise
Ductility	77ºF, 50 mm/minute	minimum 400 mm
Float Test	140ºF	minimum 1,200 seconds
Solubility	in Trichlorethylene	minimum 97.5%

Test	Conditions	Asphalt Emulsion Grade AE-90
		Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc	122ºF	75/400 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Sieve Test		maximum 0.10%
Demulsibility	50 mL $CaCl_2$ 0.10 N	minimum 75%

Residue by Distillation		minimum 65%
Oil Portion	500ºF. Dist.	maximum 2% by volume
Tests on Residue:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	minimum 70
Absolute Viscosity	140ºF	minimum 1,600 poise
Ductility	77ºF, 50 mm/minute	minimum 400 mm
Float Test	140ºF	minimum 1,200 seconds
Solubility	in Trichlorethylene	minimum 97.5%

Test	Conditions	Asphalt Emulsion Grade AE-150
		Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc	122ºF	75/400 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour(b)	maximum 1%
Sieve Test		maximum 0.10%
Demulsibility	50 mL $CaCl_2$ 0.10 N	minimum 75%
Residue by Distillation		minimum 65%
Oil Portion	500ºF. Dist.	maximum 3% by volume
Tests on Residue:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	minimum 125
Absolute Viscosity	140ºF	minimum 800 poise
Ductility	77ºF, 50 mm/minute	minimum 400 mm
Float Test	140ºF	minimum 1,200 seconds
Solubility	in Trichlorethylene	minimum 97.5%

Test	Conditions	Asphalt Emulsion Grade AE-200
		Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc	122ºF	minimum 45 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Sieve Test		maximum 0.10%
Demulsibility	50 mL $CaCl_2$ 0.10 N	minimum 75%
Residue by Distillation		minimum 62%
Oil Portion	500ºF. Dist.	maximum 8% by volume
Tests on Residue:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	minimum 150
Absolute Viscosity	140ºF	minimum 400 poise
Ductility	77ºF, 50 mm/minute	
Float Test	140ºF	minimum 1,200 seconds

Solubility	in Trichlorethylene	minimum 97.5%

(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than five days.
(b) The 24-hour (one day) storage stability test may be used instead of the five day settlement test.

SPECIAL MS-EMULSION		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc	77ºF	minimum 45 seconds
Storage Stability	24 hour	maximum 1%
Sieve Test	50 mL $CaCl_2$ 0.10 N	maximum 0.10%
Demulsibility		minimum 65%
Residue by Distillation		minimum 62%
Naphtha Content	500ºF. Dist.	maximum 8% by volume
Tests on Residue:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	minimum 50
Ductility	77ºF, 50 mm/minute	minimum 400 mm
Absolute Viscosity	140ºF	minimum 800 poise
Solubility	in Trichloroethylene	minimum 97.5%
Maximum application temperature shall be 170ºF.		

EMULSIFIED ASPHALT GRADE CRS-2H		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc.	122ºF	100/400 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Demulsibility	35 mL 0.8% Sodium Dioctyl Sulfosuccinate (c)	minimum 40%
Particle Charge		positive
Sieve Test		maximum 0.1%
Residue		minimum 65%
Tests on Residue:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	80/140
Ductility	77ºF, 50 mm/minute	minimum 400 mm
Solubility	in Trichloroethylene	minimum 97.5%

(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than five days.
(b) The 24-hour (one day) storage stability test may be used instead of the five day settlement test.
(c) The demulsibility test shall be made within 30 days from date of shipment.

ASPHALT EMULSION PRIME (AEP)		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc.	77ºF	20/150 seconds

Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Sieve Test		maximum 0.1%
Residue		minimum 55%
Naphtha Content	500ºF. Dist	maximum 12% by volume
Tests on Residue:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	40/200
Ductility	77ºF, 50 mm/minute	minimum 400 mm
Solubility	in Trichloroethylene	minimum 97.5%

(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than five days.
(b) The 24-hour (one day) storage stability test may be used instead of the five day settlement test.

ASPHALT EMULSION GRADE RS-1h		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc	77ºF	20/100 seconds
Storage Stability	24 hour	maximum 1%
Demulsibility	35 mL 0.02N $CaCl_2$ (a)	minimum 60%
Sieve Test		maximum 0.10%
Residue by Distillation		minimum 55%
Naphtha Portion	500ºF. Dist (b)	maximum 3% by volume
Tests on Residue From Distillation Test:		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	minimum 60
Viscosity	140ºF	minimum 1,600 poise
Ductility	77ºF, 50 mm/minute	minimum 400 mm
Solubility	in Trichloroethylene	minimum 97.5%

(a) The demulsibility test shall be made within 30 days from the date of shipment.
(b) When RS-1H has been modified to include naphtha, the 24-hour storage stability test will be waived.

EMULSION PRIME (RS TYPE)		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc.	77ºF	minimum 75 seconds
Storage Stability	24 hour	maximum 1.0%
Sieve Test		maximum 0.1%
Naphtha Content		5/15% by volume
Residue		minimum 55%
Tests on Residue:*		
Penetration (0.1 mm)	77ºF, 100 g, 5 seconds	minimum 50
Viscosity	140ºF	minimum 800 poise
Solubility	in Trichloroethylene	minimum 97.5%

* Residue by distillation shall be in accordance with AASHTO T 59 except that the maximum temperature shall be 329 ± 10ºF [165 ± 5ºC] and the sample shall be maintained at this temperature for 20 minutes.

EPR-1 PRIME (e)		
Tests	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc.	77ºF	6/24 seconds
Storage Stability	24 hour	maximum 0.5%
Sieve Test (a)		maximum 0.1%
Residue by Distillation (b)		minimum 20%
Particle Charge Test (c)		positive
Test on Residue: (d)		
Flash Point	COC	minimum 410ºF
Viscosity	140ºF	600/1000 cSt

(a) Distilled water shall be used in place of 2% sodium oleate solution.
(b) Residue by distillation shall be in accordance with AASHTO T-59 with the exception that a 50 g sample is heated to 300ºF [149ºC] until foaming ceases, then cooling immediately and calculating results.
(c) Caution: this material has a positive particle charge, and therefore should not be mixed with materials having a negative particle charge.
(d) Residue by distillation shall be in accordance with AASHTO T-59 except that the maximum temperature shall be 329 ± 10ºF [165 ± 5ºC] and the sample shall be maintained at this temperature for 20 minutes.
(e) EPR-1 Prime shall not be diluted and in the event that EPR-1 Prime is not used in a 12-hour period, the material shall be thoroughly mixed by circulation or other suitable means prior to it's use.

EMULSIFIED ASPHALT GRADE CRS-1h		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc	77°F	20 – 100 seconds
Storage Stability	24 hour	maximum 1%
Demulsibility	35 ml 0.8% Sodium Dioctyl Sulfosuccinate (a)	minimum 60%
Sieve Test		maximum 0.10%
Residue by Distillation	500°F. Distillation	minimum 55%
Naphtha Portion	500°F. Distillation. (b)	maximum 3% by volume
Particle charge		positive
Tests on Residue From Distillation Test:		
Penetration (0.1mm)	77°F, 100g, 5 seconds	minimum 45
Viscosity	140°F	minimum 1600 poise
Ductility	77°F	minimum 400 mm
Solubility	in Trichloroethylene	minimum 97.5%

The demulsibility test shall be made within 30 days from the date of shipment.
When CRS-1 has been modified to include naphtha, the 24 hour storage stability will be waived.

EMULSIFIED ASPHALT GRADE NTSS-1hm		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc.	77°F	20 – 500 seconds
Storage Stability	24 hour	maximum 1%
Settlement	5 days	maximum 5%
Residue by Distillation		mimimum 50%
Naphtha Content	500°F. Distillation	maximum 1% by volume
Sieve Test		maximum 0.30% (a)
Tests on Residue From Distillation Test:		
Penetration (0.1mm)	77°F, 100g, 5 seconds	maximum 20
Softening Point ASTM D36		minimum 149°F
Dynamic Shear Rheometer AASHTO T315	G* sin&, 186.8°F @ 10rad/sec	minimum 1.00 kPa
Solubility	in Trichloroethylene	minimum 97.5%
(c) Sieve test may be waived if no application problems are present in the field.		

916-4.2 Sampling, Certification, and Verification: For each tank of emulsified asphalt delivered to or prepared at the asphalt terminal, the asphalt supplier shall submit a sample to the State Materials Office for testing before use. A pretest number will then be assigned by the State Materials Office which shall be furnished with all emulsified asphalt delivered to the project. The pretest number shall be valid for six months from the date of issue.

The Department may sample and test pretested emulsified asphalt from the suppliers storage tank, the Contractors transport tank and/or distributor to verify and determine compliance with this and other specification requirements. Where these tests identify material outside specification requirements, the State Materials Engineer may require the supplier to cease shipment of that pretested emulsified asphalt product. Further shipment of that pretested emulsified asphalt product to Department projects may remain suspended until the cause of the problem is evaluated and corrected by the supplier as necessary to the satisfaction of the State Materials Engineer.

916-5 Liquid Anti-strip Agents.

916-5.1 Requirements: Liquid anti-strip agents shall be tested by the Department in accordance with FM 5-508. Tensile strength ratios will be calculated for the following two conditions and expressed as percentages: 1) conditioned mixture without anti-strip to unconditioned mixture without anti-strip and 2) conditioned mixture with anti-strip to unconditioned mixture without anti-strip. A 20% gain in tensile strength ratio for condition #2 as compared to condition #1 shall be required.

916-5.2 Qualified Products List: Liquid anti-strip agents supplied under this Specification shall be one of the products included on the Qualified Products

List (QPL) as specified in 6-1. Liquid anti-strip agents meeting the criteria in 916-5.1 will be considered for inclusion on the Department's (QPL). For each liquid anti-strip agent, the supplier will submit to the State Materials Office one pint of a representative sample of liquid anti-strip agent when submitting the Product Evaluation Application. Liquid anti-strip agents must be requalified on an annual basis. If the liquid anti-strip agent has been modified then a new sample shall be submitted to the Department and tested per 916-5.1.

916-5.3 Mix Design Verification: Inclusion of a liquid anti-strip agent on the QPL does not guarantee that the anti-strip will be approved for use in an asphalt mixture. Specifications may require subsequent moisture susceptibility testing per FM 1 T-283 for the particular mix design. Results from this testing may indicate the need for a larger dosage rate of anti-strip agent (up to 0.75% maximum) or a different anti-strip agent to meet the specification requirements.

SECTION 917
MINERAL FILLER

917-1 Composition.

Mineral filler shall consist, in general, of limerock dust, portland cement, slag dust, hydrated lime, or any other inert mineral matter from sources approved by, the Engineer. The mineral filler shall be thoroughly dry and free from lumps consisting of aggregations of fine particles. Ground phosphate will not be allowed as a mineral filler.

Stone or slag screenings may also be used as filler material for asphalt concrete mixtures, under the provisions specified in 917-3, below.

917-2 Gradation.

The mineral filler shall meet the following gradation requirements:

Total passing No. 30 sieve	100%
Total passing No. 80 sieve	95% (minimum)
Total passing No. 200 sieve	65% (minimum)

917-3 Provision for Use of Coarser Filler Material.

Process screenings from stone or slag, having a coarser gradation than as specified above, may also be used as filler material provided the particular product, and the source thereof, are approved by the Engineer and that the material meets the following requirements.

(a) All of the material shall pass the No. 10 sieve, and not more than 35% shall pass the No. 200 sieve.

(b) The material passing the No. 200 sieve shall be free from organic impurities, and not more than 4.0% of such shall consist of clay minerals. The plasticity index of the material passing the No. 200 sieve shall not exceed 4.

(c) For the stone or slag material from which the screenings are produced the loss, when subjected to the Los Angeles Abrasion Test, shall not exceed 45%.

SECTION 919
GROUND TIRE RUBBER
FOR USE IN ASPHALT RUBBER BINDER

919-1 Description.

This Specification governs ground tire rubber for use in asphalt rubber binders for use in a variety of paving applications.

919-2 General Requirements.

The ground tire rubber shall be produced from tires by an ambient grinding method. The entire process or a final separate grinding process shall be at or above ordinary room temperature. The rubber shall be sufficiently dry so as to be free flowing and to prevent foaming when mixed with asphalt cement. The rubber shall be substantially free from contaminants including fabric, metal, mineral, and other non-rubber substances. Up to 4% (by weight of rubber) of talc or other inert dusting agent, may be added to prevent sticking and caking of the particles.

The ground tire rubber used shall be one of the products listed on the Department's Qualified Products List (QPL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6.

919-3 Physical Requirements.

The physical properties of the ground tire rubber shall be determined in accordance with FM 5-559, and shall meet the following requirements:

Specific Gravity.....1.10 to 1.20
Moisture Content.....Maximum 0.75%
Metal Contaminants .....Maximum 0.01%

Gradation - The gradation shall meet the limits shown in Table 919-1 for the type of rubber specified.

Table 919-1
Gradations of Ground Tire Rubber

Sieve Size % Passing	Type A	Type B	Type C
No. 16	---	---	100
No. 30	---	100	70-100
No. 50	100	40-60	20-40
No. 100	50-80	---	---

919-4 Chemical Requirements.

The chemical composition of the ground tire rubber shall be determined in accordance with ASTM D 297 and shall meet the following requirements:

Acetone Extract.....Maximum 25%
Rubber Hydrocarbon Content ..... 40 to 55%
Ash Content*.....Maximum 8%
Carbon Black Content ..... 20 to 40%
Natural Rubber ..... 16 to 45%

* 10% for Type A rubber

919-5 Packaging and Identification Requirements.

The ground tire rubber shall be supplied in moisture resistant packaging such as either disposable bags or other appropriate bulk containers. Each container or bag of ground tire rubber shall be labeled with the manufacturer's designation for the rubber and the specific type, maximum nominal size, weight and manufacturer's batch or LOT designation.

919-6 Certification Requirements.

The Contractor shall provide the Engineer a certification conforming to the requirements of Section 6 from the manufacturer, confirming that the ground tire rubber meets the requirements of this Section.

SECTION 921
PORTLAND CEMENT AND BLENDED CEMENT

921-1 General.

921-1.1 Type of Cement: Cement shall conform to the requirements of the following AASHTO designations except where a particular type of cement is specified on the plans or Specifications, and as specifically restricted in Section 346, cement may be Types I, II, III, IV, V (AASHTO M-85), or IP, IP (MS), IS (AASHTO M-240). Different brands of cement, cement of the same brand from different facilities, or different types of cement shall be stored separately and shall not be mixed.

921-1.2 Alkali Content: Only Portland cement containing a maximum of 0.60% alkali, or less, calculated as Na_2O (% Na_2O plus 0.658% K_2O), may be used with no further testing. When tests performed in accordance with ASTM C-33 X1.3 on coarse and fine aggregate indicate the aggregate to be non-reactive to alkalis, cements exceeding 0.60% alkali is allowed, but a supplementary cementitious material meeting the requirements of Section 929 shall be used.

921-1.3 Heat of Hydration: When the cement heat of hydration is 80 cal/g or less at seven days, the cement may be used in moderately and slightly aggressive environments without pozzolans or slag. If the heat of hydration is between 81 and 88 cal/gm at 7 days, pozzolans or slag meeting the requirements of Section 929 shall be used. If the heat of hydration is greater than 88 cal/gm at 7 days, use cement in slightly aggressive environments only.

Do not apply these requirements to Type I or III cement.

921-2 Terminology.

The following definitions are applicable to the production and quality control of cement:

Source of Supply - indicates a cement supplier responsible for supplying the final product. Where the supplier has more than one manufacturing facility, the source of supply may be designated as the manufacturer/facility.

Approved Source - indicates a cement supplier, including but not limited to a plant, a terminal, or a transfer facility, that has been qualified by the State Materials Office. A list of Approved Cement Sources will be maintained by the State Materials Office.

Quality Control Plan Status - indicates quality control approval status, for each cement supplier and will be maintained by the State Materials Office in conjunction with the Approved Source List.

Purchaser - The term “purchaser” in the AASHTO Specifications shall be taken as the Department.

Approved Laboratory – indicates a laboratory acceptable to the State Materials Office which has been currently inspected by the Cement and Concrete Reference Laboratory (CCRL), is actively participating in their proficiency program and which has all deficiencies noted at the time of inspection corrected.

The laboratory must also authorize CCRL to send copies of final inspection reports to the State Materials Office.

Mill Test Report – indicates a certification from the cement supplier identifying that the cement meets Section 921 and AASHTO M-85, the Type, the production period the sample represents and the chemical and physical analyses of the cement, and the silo number(s) where the cement is stored. The mill test report must identify that there is limestone in the cement, if limestone is included. An acceptable mill test report is found in the appendix of AASHTO M-85.

921-3 Packing, Handling and Storing.

Cement may be delivered in bags or in bulk. The storage building, bin or silo shall be weatherproof and shall be located convenient to the work. On small jobs, storage in the open may be permitted by the Engineer in which case raised platforms and adequate waterproof coverings shall be provided.

921-4 Rejection.

The entire contents of the sack or bulk container which contains cement that does not meet the requirements of this Specification or has been damaged, is partially set, lumpy or caked shall be rejected.

Bagged cement which varies more than 5% from the designated weight, or if the average weight of 50 sacks, taken at random, is less than the designated weight, the cement shall be rejected.

921-5 Quality Control Plan.

921-5.1 General: The quality control program of a cement supplier shall conform to Section 105. Cement suppliers shall submit a proposed quality control plan to the State Materials Office for plan approval. In addition to the quality control plan, the supplier must submit test reports from an approved laboratory which certifies that the cement in current production or supply conforms to these Specifications. Upon initial quality control plan approval and receipt of the cement mill test report, the suppliers will be placed in an approved source status with an approved quality control plan. An approved laboratory shall perform one quality control test per day. Submit a copy of the monthly mill test report to the State Materials Office. The mill test report shall indicate that the cement meets the requirements of this Specification. Also, the corresponding samples along with mill test reports shall be submitted to the Department, upon request.

Producers intending to use limestone as a component material in the production of cement shall describe the type and source of the limestone. In addition, the producer shall supply the Department with a sample of the limestone, a sample of the cement prior to the limestone being added and a sample of the cement after the limestone has been added. The analysis of these materials will be used as a baseline for information. In the event that the source of limestone used by the cement producer changes, additional samples of both the limestone and the cement with the limestone added shall be provided to the State Materials Office for evaluation.

Representatives from the Department may take samples from the cement production facility at a minimum of once per year to verify compliance with the producer's quality control plan.

The supplier's quality control plan shall be sufficient to insure that more than 97% of all cement delivered for FDOT work shall meet all Specification requirements. Upon request of the Department, the supplier shall provide split samples of the cement collected for quality control testing. Split samples shall be delivered to the State Materials Office and shall be identified as representing a designated LOT of cement.

921-5.2 Acceptance of Portland Cement: Portland Cement from an approved source with a current quality control plan approval may be accepted on the basis of mill test reports meeting the requirements of the applicable AASHTO and FDOT Specifications and a delivery ticket printed on the producer's letterhead and traceable to the mill test report. Mill test reports shall be provided upon request to the State Materials Office and corresponding samples for verification testing. Quality control testing shall be performed by an approved laboratory.

921-5.3 Cement Ownership and Responsibility: For purposes of quality control plan approval status, the cement supplier shall be responsible for cement quality until the cement is accepted by the concrete producer. Where the cement has been accepted by a concrete producer and is subsequently found deficient, the concrete plant quality control plan approval may be withdrawn with respect to further use of that cement and reinstated only when the deficiency is adequately resolved. Reinstatement is made by the State Materials Office.

921-5.4 Quality Control Plan Approval Control: The State Materials Office may withdraw quality control plan approval and may require cement shipments to be individually tested prior to incorporation into Department work. Quality control plan approvals may be rescinded when the performance of cement is in question, including problems with concrete quality, inconsistent quality control data, or failure of quality control or verification test results. Discontinuance of approval may be based on testing at the point of use, testing by the manufacturer or proven poor performance of the cement in concrete.

In the specific instance of a failing cement sample taken by the Department at the cement source, the failure shall initiate the Department to retest the sample. Failure of the retest will be considered adequate evidence to withdraw the quality control plan of the Cement Supplier.

Notification of failing test results will be distributed to the cement supplier (and concrete producers, if applicable) as designated in the approved quality control plan. Split samples of the initial sample may be provided to the cement supplier and concrete producer upon request.

Reinstatement of the quality control plan will occur when the cement producer identifies and corrects the specific cause of the failures or that a statistical analysis indicates that the current cement production meets or exceeds the requirements of this Specification.

921-5.5 Sampling of Cement: The verification samples may be taken at the manufacturer's plant, distribution facility or at the concrete production facility. Samples shall be obtained by one of the methods in Florida Methods FM 5-503.

Samples shall be a minimum of 10 pounds in size. At the concrete production facility, cement samples shall be jointly obtained by the Department Inspector and the concrete producer's representative.

SECTION 923
WATER FOR CONCRETE

923-1 General Requirements.

Water for use with cement shall be clear and free from injurious amounts of oil, acid, alkali, chlorides, organic matter, and other deleterious substances. It shall not be salty or brackish. If it contains quantities of substances which discolor it or make it smell or taste unusual or objectionable or cause suspicion, it shall not be used unless service records of concrete made with it indicates that it is not injurious to the quality of the concrete or approved by the Engineer. Wash water from mixer washout operations, (stored in a lined settling pond), and recycled wash water may be used only to sprinkle the coarse aggregate stockpiles and for use in the batching of concrete meeting the requirements of Section 347. Samples arriving at the laboratory shall be allowed 14 days for completion of tests. The frequency of testing, by the Department, of approved sources will be as outlined in the Sampling, Testing and Reporting Guide. At the discretion of the Engineer, the Department may require additional compliance testing at any time, of any water source.

923-2 Evaluation of Water for Concrete.

923-2.1 General: Water from city water supplies that are approved by a public health department may be accepted without testing. Wash water from mixer washout and recycled wash water shall meet the requirements of 923-3.2. and 923-4. All other sources of water shall meet the requirements 923-3.3 and 923-4. The concrete producer shall provide test data of water samples.

923-2.2 Source Approval: Wash water from mixer washout operations and recycled wash water shall be tested once per week for four weeks initially, and thereafter once per month for four months prior to its use, provided that the results of the test samples comply with all the applicable limits. All other sources shall test one sample initially.

923-2.3 Source Sampling: Open bodies of water and recycled water shall be tested monthly. Well and other sources of water will be tested once every three months. If the last eight consecutive well water samples meet the requirements, then the sample frequency may be reduced to one sample every six months, as approved by the Engineer. If a well water sample fails once the frequency has been changed, then the sampling frequency shall revert back to once every three months.

923-3 Chemical Requirements.

923-3.1 Testing: All chemical analysis or test shall be performed in accordance with AASHTO T-26 or Standard Methods for the Examination of Water and Wastewater.

923-3.2 Reclaimed Water: Water from mixer washout and recycled wash water shall be tested and approved before use and shall not exceed the following allowable limits:

Chemical Test	Maximum (%)
Equivalent Alkalis as (Na_2O + 0.658 K_2O)	0.06
Total Solids	5.00
Total Chlorides as Sodium Chloride	0.05
Sulfate as SO_4	0.30

923-3.3 All Other Sources: Water from all sources, other than public health approved sources, shall be tested and approved before use and shall not exceed the following allowable limits:

Chemical Test	Maximum (%)
Acidity or alkalinity calculated in terms of calcium carbonate	0.05
Total organic solids	0.05
Total inorganic solids	0.08
Total chlorides as sodium chloride	0.05

923-4 Physical Requirements for Mortar.

Mortar shall be tested in accordance with AASHTO T-106 with the following exception: the mortar shall not be tested for flow. The mortar, composed of the sampled water, shall have a compressive strength of not less than 90% when compared to a mortar prepared using distilled water and tested at seven days.

Water of a questionable quality, as determined by the Engineer, shall be subject to the acceptance criteria for time of set as required by AASHTO M-157, Table 1.

SECTION 924
ADMIXTURES FOR CONCRETE

924-1 General.

This Section covers materials for use as admixtures for concrete. The use of admixtures is restricted to those admixtures as may be allowed or required elsewhere in the specifications for specific concrete applications. Admixtures shall comply with applicable AASHTO and ASTM specifications as modified in 924-2.3 through 924-2.7. Admixtures that have been previously qualified for Department use are listed on a Qualified Products List.

924-2 Acceptance of Admixtures.

924-2.1 Qualified Products List (QPL): The Department maintains a list of qualified admixtures for air-entraining, water-reducing (Type A), accelerating

(Type C), water-reducing and retarding (Type D), water-reducer and accelerating (Type E), high range water reducing (Type F) and high range water-reducing and retarding (Type G), high range water-reducing (Type I - Plasticizing and Type II - Plasticizing and retarding) in producing flowing concrete, and corrosion inhibitor, which have been determined as meeting requirements for use on Department projects. Admixtures included on this list, will be permitted without further testing.

The inclusion of any specific product on the QPL, as specified in 6-1, indicates that the product has been given contingent approval, as evidenced by previous tests and apparent effectiveness under field conditions.

Except as specified in Sections 346 and 347, no further testing will be required for any product on the QPL unless there is indication in actual field use of inadequate or unreliable results.

924-2.2 Certification: Manufacturers of admixtures shall provide certified test results from an independent laboratory inspected by the Cement and Concrete Reference Laboratory (CCRL) on a regular basis for applicable tests, with all deficiencies corrected for QPL approval and upon request of the Engineer.

924-2.3 For Air-Entraining: Air-entraining admixtures shall meet the requirements of AASHTO M-154, except for the flexural strengths, relative durability factor, and length change requirements are waived.

924-2.4 For Type A (Water-Reducing) and Type D (Water-Reducing and Retarding): Water-reducing and water-reducing and retarding admixtures shall meet the requirements of AASHTO M-194 for Type A and D, respectively, except for the compressive strength at six months and one year, flexural strengths, and relative durability factor requirements are waived.

924-2.5 For Type C (Accelerating) and Type E (Water Reducing and Accelerating): Accelerating and water reducing and accelerating admixtures shall meet the requirements of AASHTO M 194 for Type C and Type E, respectively, except for the compressive strength at six months and one year, flexural strengths and relative durability factor requirements are waived.

924-2.6 For High Range Water-Reducing: High range water reducing admixtures shall meet the requirements of the applicable AASHTO or ASTM specifications as modified in 924-2.6.1 and 924-2.6.2.

924-2.6.1 For Type F or Type G: High range water reducing (Type F) and high range water reducing and retarding (Type G), shall meet the requirements of AASHTO M-194, except for the compressive strengths, at one year, and relative durability factor requirements are waived.

924-2.6.2 For Type I and Type II: High range water reducing (Type I) and high range water reducing and retarding (Type II), for use in producing flowing concrete shall meet the requirements of ASTM C-1017, except for the compressive strength, at one year, and relative durability factor requirements are waived.

924-2.7 For Corrosion Inhibitors: Corrosion inhibitors shall meet the requirements of ASTM G-109 and all requirements in this Section.

Calcium nitrite is a chemically reactive admixture used in concrete to inhibit the corrosion of embedded reinforcing steel and other metallic

components. The calcium nitrite supplier shall furnish the Engineer with test certificates from an independent laboratory indicating compliance with this Specification. The test certificate shall include corrosion inhibiting properties per ASTM G-109 and results of physical tests included in this section. Calcium nitrite shall be supplied by the same manufacturing source throughout the project. If a single primary source of calcium nitrite cannot be maintained throughout the project, new test certificates shall be submitted. The Engineer will determine specification compliance of a new supplier's product, and evaluate the effectiveness of the new calcium nitrite product before approving the source.

The active ingredient shall be calcium nitrite $Ca(NO_2)_2$.

The calcium nitrite shall be furnished in solution containing not less than 29% calcium nitrite solids. The concentration of the calcium nitrite solution shall be verified by spectrophotometric analysis or other comparable methods. The nitrite concentration shall be measured in accordance with Standard Methods for the Examination of Water and Waste Water, 18th Edition.

A volume of one gallon of calcium nitrite solution shall weigh within the range of 10.40 to 11.92 lb.

The calcium nitrite solution shall be added to the concrete mixture at a rate of 4.50to 4.60 gal/yd^3 of concrete.

The addition of calcium nitrite to the concrete mix shall not adversely affect the properties of fresh and hardened concrete.

Calcium Nitrite concrete shall meet the following physical requirements when mixed and tested in accordance with AASHTO M-194:

Water Content, % of control	95 to 100
Time of setting, allowable deviation from control, h:min:	
Initial: at least not more than	1:00 earlier nor 1:30 later
Final: at least not more than	1:00 earlier nor 1:30 later
Compressive Strength, min. % of control:	shall be 100 for all ages
Flexural strength, min, % of control:	shall be 100 for all ages
Length change, max Shrinkage (alternative Requirements): % of control	135
Increase over control	0.010
Relative durability factor, min	80

The following table lists the corrosion inhibiting test result limits for calcium nitrite concrete tested in accordance with ASTM G-109:

Maximum Allowable Test Results of Calcium Nitrite Concrete	
Measured average macrocell current any time during the test	10 μA
Average macrocell current at test completion	2 μA

Maximum Allowable Test Results of Calcium Nitrite Concrete	
Average visible corrosion measured as percent corroded area of control	85%

924-3 Performance Test on Air-Entraining Admixtures, for Effect on Strength of Concrete.

924-3.1 Conditions under which Test is Required: For any air-entraining admixture selected for use the Engineer may call for a performance test (either prior to or at any time during construction) for determining its effect on the strength of the concrete. In general, this check-test will be required only when there is indication that such admixture is giving erratic results or is unduly reducing the strength of the concrete. Testing shall be in accordance with 924-3.2 and 924-3.3.

924-3.2 Permissible Reduction in Strength of the Concrete: For concrete composed of the same cement and aggregates (and in the same proportions) to be used in the work, and containing the admixture under test, in an amount sufficient to produce between 3 and 5% entrained air in the plastic concrete, the compressive strength at seven days shall be at least 90% of the strength of the same concrete without the admixture.

924-3.3 Method of Test for Strength Reduction: The percentage reduction in strength shall be calculated from the average strength of at least three standard 6 inch by 12 inch cylinders of each class of concrete. Specimens shall be made and cured in the laboratory in accordance with ASTM C-192, and shall be tested in accordance with ASTM C-39. The percentage of entrained air shall be determined in accordance with ASTM C-173 or ASTM C-231.

924-4 Retesting.

The approved admixtures are required to be tested for their uniformity and equivalence whenever there is an indication of erratic results. The tests shall be performed in accordance with the following procedure. The admixture shall be checked for comparison between infrared spectrophotometry, pH value, specific gravity, and solids content. Any marked variation from the original curve, pH value, specific gravity, or solids content will be considered sufficient evidence that the chemistry of the original material has been changed and, therefore, the use of this material will be rejected and the material will be removed from the QPL.

SECTION 925
CURING MATERIALS FOR CONCRETE

925-1 Burlap.

Burlap for curing concrete shall consist either of two layers, each weighing 10 to 18 ounces/10sf^2, or of four layers, each weighing 6 to 7 ounces/10sf^2. Burlap which has been used as a container for sugar shall not be used. Burlap that is being used for the first time shall be thoroughly washed in order to remove starches used in sizing the material. Burlap shall be furnished in strips of at least

3 feet wide and shall be at least 3 feet longer than the width of surface to be covered.

925-2 Membrane Curing Compound.

925-2.1 General: Membrane curing compound shall conform to requirements of AASHTO M-148 (Type 1 for clear compound and Type 2 for white-pigmented compound), and the following additional requirements:

The membrane curing compound shall be of a consistency suitable for spraying at temperatures prevalent at the time of construction operations, and which forms a continuous, uniform film. It shall be free from precipitated matter caused by conditions of storage or temperature. The compound shall be relatively nontoxic. Thorough agitation shall be performed prior to shipment from manufacturer's plant and prior to use at job site.

Curing compound delivered to the job in drums shall be in the manufacturer's original container, labeled with the manufacturer's name, plant location, grade designation of compound, LOT number, and quantity.

Curing compound delivered in bulk shall be supplied from and delivered to storage tanks designed to provide thorough agitation by means of compressed air.

925-2.2 Sampling: Samples shall be obtained as specified in AASHTO M-148 with the following exception. Take one sample for each lot, batch, or other unit of production representing each 2,200 gallons or fraction there of. Filled containers, represented by the sample(s) shall be sealed and marked by the sampling agency for later identification and correlation. Each sample shall be at least 1 quart. Allow fourteen days for completion of the tests after arrival of the sample in the laboratory**.**

925-2.3 Storage: Curing compound that has been tested and stored for longer than six months but less than one year shall be retested prior to use. Compound that has been stored longer than one year shall not be incorporated into the work.

925-3 Sheet Materials.

925-3.1 General: Waterproof paper, polyethylene film and white burlap-polyethylene sheet, for curing concrete shall meet the requirements of AASHTO M-171, with the additional requirements for waterproof paper and for polyethylene film as shown below.

925-3.2 Additional Requirements for Waterproof Paper: The paper as prepared for use shall be in such dimensions that each unit as laid will extend at least 18 inches beyond the edges of the slab. If laid longitudinally, paper not manufactured in sizes which will provide this width shall be securely sewed or cemented together; the joints being sealed in such manner that they do not open up or separate during the curing period.

At the option of the Contractor, instead of the single longitudinal strip specified above, the blanket may be furnished in three strips; one strip being the neat width of the pavement, with two side strips.

925-3.3 Additional Requirements for Polyethylene Sheeting: The sheets, as prepared for use, shall be of such dimensions that each unit as laid will extend

beyond the edges of the slab by at least twice the thickness dimension of the pavement edge, and the sheets shall overlap by at least 18 inches.

No sheet may be reused except after individual inspection and approval by the Engineer. Any sheets determined by the Engineer to be so damaged as to not afford the protection to the concrete in preventing moisture loss during the curing period will be rejected.

925-4 Certification.

For burlap or white burlap-polyethylene, the Contractor shall provide the Engineer a certification conforming to the requirements of Section 6 from the manufacturer confirming that the requirements of this Section are met. Each certification shall cover only one type of burlap or white burlap-polyethylene sheeting.

SECTION 926
EPOXY COMPOUNDS

926-1 Types of Compounds.

Epoxy resin compounds for application to portland cement concrete, bituminous cement concrete, metals and other type surfaces shall be two-component systems of the applicable of the following types as designated.

Type	Description
A	An epoxy resin, for bonding fresh concrete to hardened concrete.
B	An epoxy resin adhesive, for bonding hardened concrete to hardened concrete and constructing doweled splices in precast prestressed concrete piles.
E	A fluid epoxy for crack injection in the repair of old structures.
F F-1 F-2	An epoxy for repairing spalled areas on concrete bridge structures with these subtypes: A non sagging gel type for vertical surfaces. A pourable type for repairs where forms are to be used.
G	An epoxy for rebuilding expansion joints and associated wearing surfaces.
H	An epoxy for structural bonding where asphalt overlays are to be in contact with the hardened compound.
I	An epoxy for filling small holes in concrete such as lifting bolt cut-outs on beams, etc.
J	An epoxy for installing rebar and anchor bolts into hardened concrete.
K	An epoxy for underwater sealing of the bottom of the jacket of an integral pile jacket system.
L	An epoxy for coating the interior of sewage disposal tanks.
M	A coal tar epoxy coating for steel sheet piles and H piles (water immersion).
N	An epoxy for preparing mortars and concrete for patching portland cement concrete pavement.
P	An epoxy for bonding metals.

Type	Description
Q	An epoxy for use in post tensioning anchorage protection systems.
T	Hot applied coal tar epoxy tape.

926-2 Epoxy Design Requirements.

926-2.1 General: All types of compounds except L, and M shall contain no volatile solvent.

All types of compounds except F, J, L, M, and N shall be basically pure reactive material with a maximum ash content of 2%.

All types shall have simple mix ratios of one to one or two to one or shall be supplied in pre-measured containers in which all of the contents of both packages are to be mixed.

Certain terms used in this specification shall have these meanings:

low modulus - the stress-strain property for which ultimate tensile strength is attained at over 10% elongation.

high modulus - the stress-strain property for which ultimate tensile strength is attained at under 6% elongation.

non-sagging gel - grades of mixed compounds which will not perceptibly flow under their own weight on a vertical surface in the unhardened state.

pourable - grades of mixed compound sufficiently fluid that they (either neat or filled) can be cast into and will take the shape of a mold.

926-2.2 Qualified Products List: All epoxy materials shall be one of the products listed on the Department's Qualified Products List. Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6.

Products may only be used for applications recommended by the manufacturer.

926-2.3 Certification: The Contractor shall provide the Engineer with certification from the manufacturer of the epoxy, confirming that the requirements of this Section are met. The certification shall conform to the requirements of Section 6. Each certification shall cover only one batch of epoxy materials.

926-3 Specific Requirements for Types A and B Compounds.

926-3.1 Mixing and Application: Types A and B epoxy compounds (for bonding fresh concrete to hardened concrete or bonding precast concrete parts) shall be mixed, applied, and cured in accordance with the manufacturer's directions, or as might be directed otherwise by the Engineer.

Epoxy compounds shall be used only under conditions which are compatible with the material being applied in accordance with the specific directions of the manufacturer.

926-3.2 Performance Tests:

(a) Epoxy Bonding Compounds: Epoxy Bonding Compounds shall be prepared and tested in accordance with FM 3-C882.The ratio of the compressive strength of the composite cylinder to the compressive strength of the weaker concrete shall not be less than 0.90.

(b) Epoxy Mortars: Epoxy mortar shall be prepared and tested in accordance with FM 3 C-882. The average compressive strength of the three test specimens shall be at least 5,000 psi.

926-4 Specific Requirements for Type E Compounds.

Epoxies for crack injection shall meet the Specification for Type B compound with these additional requirements:

Viscosity five minutes after mixing	300 to 600 cps at 77°F by ASTM D-2393
Wet bond strength to concrete, minimum	250 psi at seven days by Florida Method FM 5-518

926-5 Specific Requirements for Type F Compounds.

Epoxies for repairing spalled areas shall meet these requirements:

Subtype F-1 for repairing vertical and other surfaces shall be a trowelable low modulus, non-sagging gel epoxy compound capable of bonding to wet surfaces with these properties:

Color	Shall match gray color No. 36622 of Federal Standard No. 595a
Viscosity	Gel
Maximum sand loading	2.25 parts sand to one part mixed epoxy by volume
Elongation in tension minimum	10% by ASTM D-638, seven day cure
Wet bond to Steel and Concrete minimum	250 psi by Florida Test Method FM 5-518

Subtype F-2 for filling larger spalls where a form is required to build back to the original surface shall be a pourable low modulus type compound capable of bonding to wet surfaces with these properties:

Color	Shall match gray color No. 36622 of Federal Standard No. 595a
Maximum sand loading	2.25 parts sand to one part mixed epoxy by volume
Elongation in tension, minimum	10% by ASTM D-638, seven day cure
Exotherm	110°F by ASTM D-2471, 1 pint sample
Wet bond strength	250 psi at seven days by Florida Method FM 5-518

926-6 Specific Requirements for Type G Compounds.

Epoxies for rebuilding expansion joints shall be pourable types which may be mixed with sand and with these requirements for the mix:

Compressive strength	
at 24 hours, minimum	4,500 psi
at seven days, minimum by the method of 926-3.2(b)	7,500 psi

Compressive strength	
Bond to wet concrete at seven days by Florida Method FM 5-518	250 psi
Maximum sand loading	2.25 parts to one part mixed epoxy by volume
Elongation in tension at seven days, ASTM D-638,minimum	2%
Color	Natural
Exotherm, maximum by test method ASTM D-2471, 1 pint sample size	110°F

926-7 Specific Requirements for Type H Compounds.

Epoxies for structural bonding where bituminous pavement overlays will come in contact with the hardened compound shall meet the requirements for Types A and B compounds above and the manufacturer shall provide test data showing that cutback and emulsified asphalts, asphalt cement, and bituminous mixes shall bond to but not soften or otherwise damage the epoxy after a curing period of four days.

926-8 Specific Requirements for Type I Compounds.

Epoxies for cosmetic patching of small areas on new concrete structures and components shall be of any non-sagging grade which has a gray color matching that of Shade 36622 of the Federal Standards and which has been demonstrated to the Engineer to bond satisfactorily to the concrete.

926-9 Specific Requirements for Type J Compounds.

Epoxies for installing rebar and anchor bolts into the hardened concrete shall meet the requirements of Section 937 and be installed in accordance with Section 416. When the Contract Documents call for the use of Type J, Class I, II, III, IV, epoxy or a Class IV Adhesive Anchor System, use materials meeting the requirements of Section 937, constructed in accordance with Section 416.

926-10 Specific Requirements for Type K Compounds.

Epoxies for sealing the bottom of integral pile jackets in the repair of concrete piles shall be a type which will harden underwater with these requirements for the sand-epoxy mix:

Compressive strength at seven days, minimum by the method described in 926-3.2(b)	4,500 psi
Bond	
to wet concrete, minimum	250 psi
to wet pile jacket, minimum (by Florida Method FM 5-518)	150 psi
Maximum sand loading	2.25 parts to one part mixed epoxy by volume
Viscosity of mixed epoxy component at 77°F, five minutes by ASTM D-2393	1,000-2,000 cps

The epoxy sand mix shall be capable of flowing through water in the void area of the jacket so as to provide a water tight seal of the depth indicated on the plans or approved shop drawings and to maintain this seal during subsequent construction steps.

926-11 Specific Requirements for Type L Compounds.

Epoxies for coating the interior of sewage disposal system tanks shall be of an approved type. Manufacturers shall submit data and a record of previous usage showing satisfactory performance in the protection of concrete from the aggressive effect of sewage for a five year minimum to the State Materials Office.

926-12 Specific Requirements for Type M Compounds.

Epoxy coatings for steel sheet and H piles used in bridges, fender systems and other structures subject to immersion in water shall comply with the requirements of Corps of Engineers Specification C-200. Products not meeting these requirements may be approved by the State Materials Office on the basis of data furnished by the manufacturer documenting equal or superior performance.

Application of the epoxy coating shall meet the requirements of Section 560 for a coal tar epoxy coating.

926-13 Specific Requirements for Type N Compounds.

Epoxy adhesives for making epoxy mortar or concrete for patching portland cement concrete pavement shall be any of approved products listed at the time of the work. Mix designs for mortar and concrete shall be submitted to the Engineer at the time of the preconstruction conference. Approval shall be by a field demonstration made by the Contractor using the criteria of bond to the pavement, matching color, durability, and absence of excessive surface slicking under traffic flow for acceptance.

The basic approval of new adhesives shall be made by the State Materials Office using a six months road test with mortar-concrete mix designs recommended by the epoxy manufacturer.

926-14 Specific Requirements for Type Q Compounds.

These epoxy materials are to be used to protect the anchorages of post-tensioning tendons or bars and other uses indicated in the plans. The material shall produce a low exothermic reaction and have flow and fill characteristics suitable for machine base plate applications. The material will be extended with the aggregate supplied by the manufacturer. Mix with the full aggregate loading unless the use of less aggregate is approved by the Engineer.

The material shall be factory pre-proportioned including factory supplied aggregate. Deliver products in original containers with manufacturer’s name, date of manufacture, product identification label and batch numbers. Materials must be within the manufacturer’s recommended shelf life. Store and condition the product in full compliance with manufacturer’s recommendations.

The epoxy grout plus aggregate mix shall meet or exceed the specified physical properties stated herein as determined by the following standard ASTM test methods.

Property	Test Value	Test Method
Compressive Strength Cubes 7 day Cure at 77°F	> 10,000 psi	ASTM C-579B
Tensile Strength at 7 days	> 2,100 psi	ASTM C-307
Flexural Strength at 7day Cure at 77ºF	> 3,600 psi	ASTM C-580
Modulus of Elasticity 7 day Cure at 77ºF	< 2,100,000 psi	ASTM C-580
Coefficient of Thermal Expansion at 74 to 210°F	< 20 x 10^{-6} in/in/ºF	ASTM C-531
Peak Exotherm, Specimen 12 x 12 x 3 in.	< 150ºF	ASTM D-2471
Slant Shear at 7 days (Bond Strength to Concrete)	> 3000 psi	ASTM C-882
Thermal Compatibility	5 Cycles Passed	ASTM C-884
Linear Shrinkage at 7 days	0.025%	ASTM C-531
Flowability and Bearing Area	90% Contact area	ASTM C-1339
Gel Time, Specimen 12 x 12 x 3 in.	< 4:00 (hr.)	ASTM D-2471

926-15 Specific Requirements for Type T Tape Compounds.

Hot Applied Coal Tar Epoxy Tape used to protect tie back rods on sheet pile walls and bulkheads shall comply with the requirements of American Water Works Association standard C203. Application shall be according to the manufacturers published recommendations.

926-16 Packaging, Labeling, and Safety.

All containers shall be identified as Component A - contains epoxy resin or Component B - contains hardener, and shall show the type, mixing directions, batch numbers, manufacturer's name, date of packaging, shelf life expiration date and quantity in pounds or gallons. Mix ratios shall be prominently shown on labels. Potential hazards shall be stated on each package in accordance with the Federal Hazardous Products Labeling Act.

926-17 Storage.

Epoxy materials, which have been in storage for more than 12 months, will not be accepted for use.

926-18 Fillers.

Fillers for mixing mortars and grouts may be as recommended by the manufacturer of the particular epoxy compound and may be supplied as packages accompanying the epoxy or premixed in accordance with approved properties.

If a manufacturer recommends only the gradation of filler, it must be a silica sand commercially available in Florida and shall be a gradation listed in Table I or a specified blend of these gradations.

The silica sands specified in Table I shall be clean, kiln dried, packaged in strong moisture proof bags, contain no more than 0.2% organic trash, and be chloride free.

Fillers shall not be used with these compounds: Types E, J, L, and M.

When the fillers specified in Table I are used, the maximum amount shall be 2.25 volumes to one volume of mixed compound.

TABLE I
GRADATION REQUIREMENTS FOR FILLERS FOR USE WITH EPOXY COMPOUNDS

	GRADE			
	A	B	C*	D**
Sieve Opening Size	Required % Passing			
No. 4			95-100	95-100
No. 6		90-100		
No. 8			0-15	85-100
No. 16				65-97
No. 20	80-100	0-20		
No. 30	0-40			25-70
No. 50	0-10			5-35
No. 100				0-7

*For use only in sections 1 1/2 inches or greater in thickness.
**Same as quartz sand fine aggregate for cement concrete (902-1.3.1).

SECTION 929
POZZOLANS AND SLAG

929-1 Basis for Source Approval.

929-1.1 General: The cementitious materials supplier shall submit the proposed quality control plan, certified test reports from an approved independent laboratory acceptable to the State Materials Office, and a sample of the material for Department verification. The quality control program of a cementitious materials supplier shall conform to 105-3. Continuance of Department Qualifications is subject to satisfactory results from periodic verification evaluations. A verification sample may be taken at the manufacturer's plant, distribution facility or at the concrete producer's plant.

Upon review of the quality control plan and satisfactory verification of the test results, the plant will be placed on the Department's list of cementitious

materials sources with accepted Quality Control Programs. The cementitious materials supplier shall utilize a quality control plan accepted by the State Materials Office. The Department reserves the right to withdraw quality control plan acceptance and to require cementitious material shipments to be individually tested prior to incorporation into Department work. Quality control plans may be suspended when the performance of cementitious material is in question, including problems with concrete quality, inconsistent quality control data, or failure of quality control or verification test results.

Repulpable bags may be accepted by the Engineer, provided a successful demonstration by the producer has indicated complete degradation of the repulpable bags during the mixing operation and before the mix is discharged.

929-1.2 Approved Laboratory: The cementitious materials supplier's testing laboratory must maintain Cement and Concrete Reference Laboratory (CCRL) accreditation, be currently inspected by the CCRL, be actively participating in the CCRL proficiency program and have all deficiencies noted at the time of inspection corrected. The laboratory must authorize the CCRL to send a copy of the final inspection report to the State Materials Office.

929-2 Fly Ash.

929-2.1 Class C or Class F: Fly ash derived from the combustion of ground or powdered coal shall meet the requirements of ASTM C-618, Class C or Class F Fly ash. Sampling and testing of fly ash shall follow the requirements of ASTM C-311.

929-2.2 Petroleum Coke Class F: Fly ash resulting from the combustion of coal and petroleum coke shall meet the physical and chemical requirements of ASTM C-618 Class F fly ash. When petroleum coke Class F fly ash is used in concrete, the test results shall verify improved or comparable strength, sulfate resistance, corrosion protective properties and other durability requirements of concrete, as compared to ASTM C-618 Class F fly ash concrete. The strength and durability tests of concrete shall be performed in accordance with ASTM C-39, ASTM C-157, ASTM C-1012, ASTM C-1202, ASTM G-109, FM 5-516 and FM 5-522. Fly ash shall not include the residue resulting from the burning of municipal garbage or any other refuse with coal, or the burning of industrial or municipal garbage in incinerators. Sampling and testing of fly ash shall follow the requirements of ASTM C-311.

929-2.3 Bark Ash Class F: Fly ash resulting from the combustion of timber bark ash and coal shall meet the physical and chemical requirements of ASTM C-618 Class F fly ash. When bark ash is used in concrete, the strength and durability of the bark ash concrete shall be improved or comparable to the strength and the durability properties of ASTM C-618 Class F fly ash concrete. The tests shall be performed as specified in 929-2.2. Sampling and testing of fly ash shall follow the requirements of ASTM C-311.

929-2.4 Special Requirements:

929-2.4.1 Fly Ash (Class C): When a Class C fly ash is used in moderately or extremely aggressive environments, tests made by the CCRL approved independent laboratory shall verify improved sulfate resistance of the concrete in accordance with ASTM C-1012, and improved or comparable

corrosion protective properties measured by FM 5-522, as compared to similar concrete made with Class F fly ash.

929-2.4.2 Petroleum Coke and Bark Ash (Class F): For sources where the fly ash is not derived solely from ground or powdered coal combustion, certified test results performed by an independent approved laboratory, shall be submitted by the supplier. The performance-based comparison test results shall meet the requirements of 929-2.2 and 929-2.3 for petroleum coke and bark ash fly ashes, respectively.

929-2.5 Exceptions: Fly ash shall not be used in conjunction with Type IP or Type IS cements.

929-2.6 Acceptance Testing of Fly Ash: Acceptance of fly ash from sources operating under an approved quality control plan shall be based on the monthly certified quality control tests meeting the chemical (Supplementary Optional included) and physical requirements of ASTM C-618. When the loss on ignition exceeds 5%, the Uniformity Requirements in the Supplementary Optional Physical Requirements shall be mandatory. An approved laboratory shall perform the monthly quality control tests and a copy of their mill certificates shall be sent to the State Materials Office when the material is in use on Department projects. The certification shall indicate that the fly ash meets the requirements of this Specification. Also, the corresponding samples along with mill certificates shall be submitted to the Department, upon request.

929-3 Silica Fume.

929-3.1 General: Silica Fume shall meet the requirements of ASTM C-1240 using the referenced test methods and frequencies.

929-3.2 Acceptance Testing of Silica Fume: Acceptance of silica fume from sources operating under an approved quality control plan shall be based on the monthly certified quality control tests meeting the chemical (Supplementary Optional included) and physical requirements of ASTM C-1240. An approved laboratory shall perform the monthly quality control tests and a copy of their mill certificates shall be sent to the State Materials Office when the material is in use on Department projects. The certification shall indicate that the silica fume meets the requirements of this Specification. Also, the corresponding samples along with mill certificates shall be submitted to the Department, upon request.

929-4 Metakaolin.

929-4.1 General: Metakaolin shall meet the requirements of ASTM C-618 Class N with the following modifications:

1. The sum of $SiO_2 + Al_2O_3 + Fe_2O_3$ shall be at least 85%. The Material Safety Data Sheet shall indicate that the amount of crystalline silica, as measured by National Institute of Occupation Safety and Health (NIOSH) 7500 method, after removal of the mica interference, is less than 1.0%.
2. The loss on ignition shall be less than 3.0%.
3. The available alkalies, as equivalent Na_2O, shall not exceed 1.0%.
4. The amount of material retained on a No. 325 mesh sieve shall not exceed 1.0%.
5. The strength activity Index, at 7 days, shall be at least 85%.

6. When metakaolin is used in concrete, the test results shall verify improved or comparable strength, sulfate resistance, corrosion protective properties and other durability performance properties of concrete, as compared to the performance of silica fume concrete. The comparison strength and durability tests shall be performed in accordance with ASTM C-39, ASTM C-157, ASTM C-1012, ASTM C-1202, ASTM G-109, FM 5-516 and FM 5-522, by an approved independent testing laboratory. Sampling and testing of metakaolin shall follow the requirements of ASTM C-311.

929-4.2 Acceptance Testing of Metakaolin: Acceptance of metakaolin from sources operating under an approved quality control plan shall be based on the monthly certified quality control tests meeting the chemical (Supplementary Optional included) and physical requirements of ASTM C-618 Class N, as modified herein. An approved laboratory shall perform the monthly quality control tests and a copy of their mill certificates shall be sent to the State Materials Office, when the material is in use on Department projects. Also, the corresponding samples along with mill certificates shall be submitted to the Department, upon request. The certification shall indicate that the metakaolin meets the requirements of this Specification.

929-5 Slag.

929-5.1 General: Slag shall meet the requirements of ASTM C-989. Sampling and testing procedures shall follow the requirements of ASTM C 989.

929-5.2 Special Requirements: Only Ground Granulated Blast-Furnace Slag Grade 100 and 120 will be permitted.

929-5.3 Exceptions: Slag shall not be used in conjunction with Type IP or Type IS cements.

929-5.4 Acceptance Testing: Acceptance of slag from sources operating under an approved quality control plan shall be based on the monthly certified quality control tests meeting the chemical and physical requirements of ASTM C-989. An approved laboratory shall perform the monthly quality control tests and a copy of their mill certificates shall be sent to the State Materials Office when the material is in use on Department projects. Reference Cement used for determination of Slag Activity shall meet the requirements of ASTM C-989. The certification shall indicate that the slag meets the requirements of this Specification. Also, the corresponding samples along with mill certificates shall be submitted to the Department, upon request.

929-6 Ultra Fine Fly Ash.

929-6.1 General: Sampling and testing of the ultra fine fly ash shall follow the requirements of ASTM C-311. Ultra fine fly ash derived from the combustion of ground or powdered coal shall meet the requirements of ASTM C-618 as a Class F fly ash with the following modifications:

1. The pozzolanic activity index, at 7 days, shall be at least 85% of the control and the pozzolanic activity index, at 28 days, shall be at least 95% of the control.

2. Particles less than 3.25 microns shall be at least 50% of the particle size distribution, as measured by laser particle size analyzer. Particles less than

8.50 microns shall be at least 90% of the particle size distribution, as measured by laser particle size analyzer.

3. The amount of material retained when wet-sieved on a 45-µm sieve shall be less than 6.0%.

4. The moisture content shall be less than 1.0%.

5. The loss on ignition shall be less than 2.0%.

929-6.2 Exceptions: Ultra Fine Fly ash shall not be used in conjunction with Type IP or Type IS cements.

929-6.3 Acceptance Testing of Ultra Fine Fly Ash: Acceptance of fly ash from sources operating under an approved quality control plan shall be based on the monthly certified quality control tests meeting the chemical (Supplementary Optional included) and physical requirements of ASTM C-618. When the loss on ignition exceeds 2.0%, the Uniformity Requirements in the Supplementary Optional Physical Requirements shall be mandatory. An approved laboratory shall perform the monthly quality control tests and a copy of their mill certificates shall be sent to the State Materials Office when the material is in use on Department projects. The certification shall indicate that the fly ash meets the requirements of this Specification. Also, the corresponding samples along with mill certificates shall be submitted to the Department, upon request.

SECTION 930
MATERIALS FOR CONCRETE REPAIR

930-1 Description.

This Section covers cementitious materials used to repair concrete including defects or purposely placed openings in concrete elements. Materials containing organic compounds, such as bitumens and epoxy resin as the principal binder are not included. The requirements for epoxy resin materials are covered in Section 926.

930-2 Product Acceptance on the Project.

930-2.1 Product Acceptance: Use only products listed on the Department's Qualified Products List (QPL). Manufacturers seeking evaluation of products must submit an application in accordance with Section 6 and include independently certified test reports that the material meets the requirements of this Section. The application must describe detailed quality control requirements for installation including, but not limited to: maximum water to cementitious material ratio, formulation for two or more component systems special materials and/or equipment, recommendations for cleaning/preparing substrate surfaces, and curing requirements.

Provide the Engineer certification conforming to the requirements of Section 6 from the manufacturer confirming that the material(s) used meets the requirements of this Section and is the appropriate product for the intended use.

When specified in the Contract Documents, furnish a report of test results from an independent laboratory on samples taken from material shipped. Ensure the test was performed within 45 days prior to the shipping date of the material.

930-2.2 Material Supply, Storage, and Marking: The material shall be pre-proportioned including aggregate. Deliver products in original, unopened containers with manufacturer's name, date of manufacture, expiration date, product identification label and batch numbers. Store the material in an elevated dry and weather protected enclosure in full compliance with the manufacturer's recommendations. Material must be used within manufacturer's recommended shelf life.

The material from which the containers are made shall have water vapor transmission not greater than 2,048 lb/ft^2 in 24 hours as determined in accordance with Procedure B of ASTM E-96.

All containers shall be marked with the following information:

(a) LOT identification number and material expiration date

(b) Directions for use shall include but are not limited to the following:

(1) The type and kind of adhesive recommended (if any) to bond fresh repair material to the concrete or mortar being repaired.

(2) The recommended amount of resin, other liquid component, or both, to be mixed with the package contents.

(3) The recommended length of mixing time or sequence of mixing and resting times in minutes.

(c) Date the material was packaged.

(d) The yield in cubic feet or yield in ft^2/in thickness when mixed with the recommended amount of liquid.

(e) The net mass in each container. (The contents of any container shall not vary by more than 2% from the mass stated in markings. The average mass of filled containers in a LOT shall be not less than the mass stated in the markings.)

(f) Instructions for the maximum and minimum water (or solutions) to cementitious material ratio.

(g) Define the approximate working time.

930-2.3 Sampling, Mixing, and Additional Testing: A LOT is the packaged repair material normally placed on a pallet. A unit sample is a single container or package of material randomly selected from the LOT. Mix and install the material(s) in accordance with the manufacturer's recommendations. Manufacturers will be required to provide field representation upon request by the Engineer. The Department reserves the right to conduct further field testing on any approved material.

930-2.4 Rejection: All broken containers will be rejected. Material that fails to meet any of the requirements of this Specification will be rejected. Report all materials failing to meet this specification and state the reason(s) for rejection in writing to the Engineer and the producer or supplier. Material in local storage in the hands of a vendor for more than six months after testing will be retested before use, except for the scaling resistance test and length change immersed in sulfate solution test for Magnesium Ammonium Phosphate Concrete. Retested material will be rejected if it fails to conform to any of the requirements of this Specification.

930-2.5 Chemical Requirements: The material shall not contain total chlorides or other corrosive ingredients in excess of 0.40 lb/yd^3 of the hardened

concrete when used in reinforced and prestressed structures. Chloride determination shall be made in accordance with FM 5-516.

930-2.6 Laboratory Specimen Preparation:

930-2.6.1 Concrete: Packaged, dry concrete material shall contain aggregate of which more than 5% by mass of the total mixture is retained on a 3/8 inch sieve. The manufacturer shall indicate the maximum proportions of coarse aggregates used for extensions. This material can be used for repairing concrete with a depth up to six inches. Any depth larger than this shall be repaired with portland cement concrete meeting the requirements of Section 346.

Mechanically mix the packaged, dry concrete material with water and/or mixing liquid. Prepare and test three test specimens for each age of all of the hardened tests and each level of mixing temperature in accordance with ASTM C-31.

(a) The sample of packaged dry material shall be any combination of whole packages yielding not less than 0.667 ft^3 of hardened material.

(b) Use only liquid components based on the manufacturer's recommendation. Measure the maximum amount of liquid needed based on the quantity per bag stated in the instructions for use.

(c) Place the sample in the mixing machine and add the required amount of liquid. Start mixing immediately and continue mixing for the length of time indicated in the directions for use.

(d) When performing the slump test, schedule work so the test will be completed in 15 ± 1/2 minutes after mixing the liquid with the rapidly hardening materials.

(e) Mold the required number of specimens using additional samples as may be necessary, mixing in accordance with (a) through (d).

Use 4 in x 8 in test cylinders to mold concrete test specimens. The maximum nominal size of the aggregate in the concrete mix shall not exceed one inch.

930-2.6.2 Mortar: Packaged, dry mortar material may contain aggregate of which less than 5% by mass of the total mixture is retained on a 3/8 inch sieve. These materials may not be extended by the addition of aggregate in the field. This material can be used for repairing concrete with a depth up to six inches. Any depth larger than this shall be repaired with portland cement concrete meeting the requirements of Section 346.

Mechanically mix the packaged, dry mortar material with mixing liquid. Prepare and test three test specimens for each age of all of the hardened tests and each level of mixing temperature in accordance with ASTM C-109.

(a) The sample obtained from the packaged dry material shall weigh 6.6 ± 0.05 lbs and shall be representatively obtained from a whole package in accordance with FM 1 T-248.

(b) Base the quantity of liquid added during mixing on the quantity per unit of weight stated in the directions for use.

(c) When performing the flow test, schedule work so the test will be completed in 15 ± 1/2 minutes after mixing the liquid with the rapidly hardening materials.

(d) Mold the required number of specimens using additional samples as necessary mixing in accordance with (a) through (c).

930-2.6.3 Temperature: In those cases where the manufacturer has indicated in the package markings, or elsewhere, that the packaged repair material can be mixed and applied at temperatures that lie beyond the range of 55ºF to 85ºF, the product must be tested at the extreme of those temperatures. Specimens shall be mixed, molded and cured during the first three hours within ± 2ºF of the extreme temperature(s) stated by the manufacturer in the package markings.

930-2.6.4 Length Change: Make and cure the test specimens in accordance with ASTM C-157, except omit the curing period in Section 10.3; however both 11.1.1 and 11.1.2 shall apply for 28 day curing period. The average length change of the test specimens for each preparation temperature and for each storage condition after 28 days shall meet the requirements as shown below.

930-2.6.5 Time of Setting: Initial time of set for concrete materials will be tested in accordance with ASTM C-403. Initial time of set for mortar materials will be tested in accordance with ASTM C-191.

930-2.6.6 Manifestly Faulty Specimens: Visually examine each group of specimens representing a given test or a given age of test, including tests of freshly mixed concrete, before or during the test, or both, whichever is appropriate. Discard any specimen found to be manifestly faulty by such examination without testing. Visually examine all specimens representing a given test at a given age after testing, and should any specimen be found to be manifestly faulty the test results thereof shall be disregarded. Should more than one specimen representing a given test at a given age be found manifestly faulty either before or after testing, the entire test shall be disregarded and repeated. The test result reported shall be the average of the individual test results of the specimens tested or, in the event that one specimen or one result has been discarded, it shall be the average of the test results of the remaining specimens.

930-3 Materials for Repair of Predominately Horizontal Surfaces.

930-3.1 General: This material is intended to be used to repair concrete where the area to be treated will be on a horizontal surface. Examples of the type of locations for these materials are bridge decks, portland cement concrete pavements and other locations required by the Contract Documents. Follow the manufacturer's recommendations for preparing the surfaces and for mixing, placing, and curing the concrete unless otherwise directed in the Contract Documents.

930-3.2 Classification: The materials to be considered under this classification shall meet the following requirements:

930-3.2.1 Rapid Hardening: Moderate compressive strength for repairing concrete with an in-place compressive strength less than or equal to 4,000 psi.

930-3.2.2 Very Rapid Hardening: High compressive strength for repairing concrete with an in-place compressive strength greater than 4,000 psi.

930-3.3 Physical Properties: The repair material shall meet or exceed the physical properties stated in Table 1 as determined by the specified test methods.

Table 1 - Physical Properties of Repair Materials for Horizontal Surfaces			
Requirement	Test Method	Rapid Hardening	Very Rapid Hardening
Minimum Compressive Strength, psi			
3 hours	ASTM C-39* or ASTM C-109*	500	2,000
24 hours		2,000	4,000
7 days		4,000	6,000
28 days		Greater than or equal to strength at 7 days.	
Maximum Length Change (at 28 days), %			
Allowable expansion in water cured compared to length at one day	ASTM C-157	0.12	0.12
Allowable shrinkage in air cured compared to length at one day		-0.12	-0.12
Allowable difference between increase in water and decrease in air		0.2	0.2
Minimum Slump (Concrete), inches	ASTM C-143	3	3
Minimum Flow (Mortar), %	ASTM C-1437	100	80
Time of Setting (Initial), minutes	ASTM C-191* or ASTM C-403*	30 to 60	10 to 29
Coefficient of Thermal Expansion, in/in/°F	ASTM C-531	5.0×10^{-6} to 9.0×10^{-6}	5.0×10^{-6} to 9.0×10^{-6}
Minimum Bond Strength by Slant Shear, psi			
24 hours	ASTM C-882	400	400
7 days		Greater than or equal to strength at 24 hours.	
* as applicable			

930-3.4 Specimen Preparation:

930-3.4.1 Concrete: Samples shall be prepared in accordance with 930-2.6.1 except that work shall be scheduled so the test for flow will be completed in 5 ± 1/2 minutes after the start of mixing liquid with the very rapid hardening materials or 15 ± 1/2 minutes after mixing the liquid with the rapid

hardening materials. The tests for temperature, length change, and time of set shall be performed in accordance with 930-2.6.3 through 930-2.6.5.

930-3.4.2 Mortar: Samples shall be prepared in accordance with 930-2.6.2 except that work shall be scheduled so the test for flow will be completed in 5 ± 1/2 minutes after the start of mixing liquid with the very rapid hardening materials or 15 ± 1/2 minutes after mixing the liquid with the rapid hardening materials. The tests for temperature, length change, and time of set shall be performed in accordance with 930-2.6.3 through 930-2.6.5.

930-4 Materials for Repair of Predominately Vertical Surfaces.

930-4.1 General: This material is intended to be used to repair concrete where the area exposed in the field to be treated will be on a vertical surface. If an element has both horizontal and vertical surfaces, then the repair used will be for vertical surfaces. If it is not apparent which material is to be used, the vertical application will prevail. Examples of the type of locations for these materials are columns, caps, beams, piles, incidental concrete products, drainage structures and other locations required by the Contract Documents. Follow the manufacturer's recommendations for preparing the surfaces and for mixing, placing and curing the concrete.

930-4.2 Physical Properties: The repair material shall meet or exceed the physical properties stated in Table 2 as determined by the specified test methods.

Table 2 - Physical Properties of Repair Materials for Vertical Surfaces*

Requirement	Test Method	Test Value
Minimum Compressive Strength, psi		
24 hours	ASTM C-39** or ASTM C-109**	2,000
7 days		5,000
28 days		Greater than or equal to strength at 7 days
Maximum Length Change (at 28 days), %		
Allowable expansion in water cured compared to length at one day	ASTM C-157	0.12
Allowable shrinkage in air cured compared to length at one day		-0.08
Allowable difference between increase in water and decrease in air		0.2
Maximum Slump (Concrete), inches	ASTM C-143	3 ***
Maximum Flow (Mortar), %	ASTM C-1437	100
Time of Setting (Initial), minutes	ASTM C-191** or ASTM C-403**	10 to 60

Coefficient of Thermal Expansion, in/in/°F	ASTM C-531	5.0×10^{-6} to 9.0×10^{-6}
Minimum Bond Strength by Slant Shear, psi,		
24 hours	ASTM C-882	750
7 days		Greater than or equal to strength at 24 hours.
Minimum Flexural Strength, psi	ASTM C-580	750
Maximum Absorption (Mortar at 7 days), %	ASTM C-413	4
Minimum Surface Resistivity (Concrete at 28 days), KOhm-cm	FM 5-578	22

* use cement based materials modified with polymers and silica fume for extremely aggressive environments
** as applicable
*** for pump and pour applications, the slump can be adjusted according to the contract documents

930-4.3 Specimen Requirements:

930-4.3.1 Concrete: Samples shall be prepared in accordance with 930-2.6.1, 930-2.6.3 through 930-2.6.5.

930-4.3.2 Mortar: Samples shall be prepared in accordance with 930-2.6.2 through 930-2.6.5.

930-5 Material for Repair of Concrete in High Stress Concentration Areas.

930-5.1 General: This material is intended to be used to repair block-outs and holes in post-tensioned elements, load bearing area of a beam, and other locations required by the Contract Documents. Follow the manufacturer's recommendations for preparing the surfaces and for mixing, placing and curing the concrete. This material shall be a magnesium ammonium phosphate based concrete (MAPC).

930-5.2 Physical Properties: The MAPC material shall meet or exceed physical properties stated in Table 3 as determined by the specified standard test methods.

Table 3 - Physical Properties of Repair Material in High Load Areas

Requirement	Test Method	Test Value
Minimum Compressive Strength (at 28 days), psi	ASTM C-109	8,500
Minimum Flexural Strength (at 28 days), psi	ASTM C-348	600
Minimum Slant Shear Bond (at 14 days), psi	ASTM C-882	2,500

Table 3 - Physical Properties of Repair Material in High Load Areas		
Requirement	Test Method	Test Value
Time of Setting (Initial), minutes	ASTM C-191	15 to 60
Maximum Scaling Resistance	ASTM C-672	No scaling
Maximum Length Change (at 28 days), %		
Allowable expansion in water cured compared to length at one day	ASTM C-157	0.03
Allowable shrinkage in air cured compared to length at one day		-0.03
Maximum Expansion due to Sulfate Resistance (after 52 week of immersion), %	ASTM C-1012	0.1
Maximum Chloride Absorption at 21 days, %	NCHRP 12-19A*	1.5
* Use cube specimens meeting the requirements of ASTM C-109.		

930-5.3 Specimen Requirements:

930-5.3.1 Mortar: Samples shall be prepared in accordance with 930-2.6.2 and 930-2.6.4.

930-5.3.2 Curing of Compressive Strength, Flexural Strength and Slant Shear Bond Specimens: The test methods for compressive strength (ASTM C-109), flexural strength (ASTM C-348), and Slant Shear Bond (ASTM C-882) shall be modified so that the specimens are air cured instead of moist cured. All of these samples shall be air cured until the time of testing.

930-5.3.3 Time of Setting: Initial time of set for MAPC will be tested in accordance with ASTM C-191. The initial time of set shall be tested at a minimum of 95°F.

930-6 Packaged, Thermosetting Polymer Material For Concrete Repair.

930-6.1 General: This material covers packaged, thermosetting, polymer modified hydraulic cement for rapid repairs to hardened portland cement concrete pavement and structures. Only low odor materials, such as styrene diluted polyester resin, will be permitted.

If the area is being used for vehicular traffic, the repair material shall have a minimum compressive strength of 2,200 psi prior to opening to traffic or as noted in the plans.

930-6.2 Classification: The materials to be permitted as alternates shall meet the following requirements:

930-6.2.1 Type 1 Polymer: Moderate compressive strength for repairing concrete with an original compressive strength less than 4,500 psi.

930-6.2.2 Type 2 Polymer: Low modulus with a compressive strength less than 2,500 psi for repairing low quality and or moving concrete (across working cracks).

930-6.3 Physical Properties: The repair material shall meet or exceed the physical properties stated in Table 4 as determined by the specified standard test methods.

Table 4 - Physical Properties of Packaged, Thermosetting Polymer Materials			
Requirement	Test Method	Type 1 Polymer	Type 2 Polymer
Minimum Compressive Strength, psi			
3 hours	ASTM C-579	1,500	800
24 hours		3,500	1,500
7 days		4,500	2,000
28 days		Greater than or equal to 7 days	
Time of Setting (Initial), minutes	ASTM C-191	12 to 20 minutes	12 to 20 minutes
Minimum Slant Shear Bond (at 7 days), psi	ASTM C-882	3,500	2,000
Minimum Flexural Strength (at 7 days), psi	ASTM C-580	1,800	800
Minimum Tensile Strength (at 7 days), psi	ASTM C-307	900	400
Maximum Shrinkage, %	ASTM C-531	0.03	0.03
Maximum Expansion, per ºF	ASTM C-531	0.000012	0.000012
Maximum Absorption (Mortar at 7 days), %	ASTM C-413	4	4
Minimum Surface Resistivity (Concrete at 28 days), KOhm-cm	FM 5-578	22	22

930-6.4 Specimen Requirements:

930-6.4.1 Mortar: Samples shall be prepared in accordance with 930-2.6.2, 930-2.6.3 and 930-2.6.5.

930-6.4.2 Mixing: The catalyst, resin and aggregate blend shall be provided by the manufacturer and approved by the Department.

930-6.5 Constructability: Furnish to the Engineer for approval shop drawing as may be required to complete repairs in compliance with the design shown in the plans and the manufacturer's recommended repair system.

930-7 Special Fillers.

930-7.1 General: This material is intended to be used as filler material and for rapid repairs to pile jacket structures and other locations specified in the Plans when no design mix concrete is available or a special filler is specified in the Contract Documents. Follow the requirements of Section 457 for preparing the

surfaces, placing, testing and curing the concrete. Mix the material in accordance with the manufacturer's recommendations.

930-7.2 Classification: The materials to be considered under this classification shall meet the following requirements:

930-7.2.1 Cathodic Protection (CP) Filler: Provide cementitious based materials with a minimum cement content of 900 pounds of cement per cubic yard of mix. Material formulation must not contain fly ash, slag, silica fume or other mineral admixtures which may produce increased electrical resistance. The material shall not contain any chlorides or substances corrosive to metals.

930-7.2.2 Non-Cathodic Protection (Non-CP) Filler: Provide cementitious based materials with a minimum cement content of 900 pounds of cement per cubic yard of mix. The material shall not contain any chlorides or substances corrosive to metals.

930-7.2.3 Extended Materials: Where concrete filler materials are specified, approved mortar materials may be extended using 89 gradation aggregates from a certified FDOT approved source.

930-7.3 Physical Properties: The repair material shall meet or exceed the physical properties stated in Table 5 as determined by the specified standard test methods. Extended and non-extended materials shall meet the minimum requirements.

Table 5 - Physical Properties of Special Fillers

Requirement	Test Method	Cathodic Protection	Non-Cathodic Protection
Minimum Compressive Strength, psi			
24 hours	ASTM C-39* or ASTM C-109*	1,500	1,500
7 days		4,000	4,000
28 days		5,000	5,000
Maximum Length Change (at 28 days), %			
Allowable expansion in water cured compared to length at one day	ASTM C-157	0.12	0.12
Allowable shrinkage in air cured compared to length at one day		-0.12	-0.12
Allowable difference between increase in water and decrease in air		0.2	0.2
Slump (Concrete), inches	ASTM C-191* or ASTM C-403*	8	8

Table 5 - Physical Properties of Special Fillers			
Requirement	Test Method	Cathodic Protection	Non-Cathodic Protection
Time of Setting (Initial), minutes	ASTM C-191* or ASTM C-403*	30 to 90	30 to 90
Minimum Bond Strength by Slant Shear (at 7 days), psi	ASTM C-882	750	750
Minimum Flexural Strength (at 7 days), psi	ASTM C-580	750	750
Minimum Tensile Strength (at 7 days), psi	ASTM C-307	200	200
Surface Resistivity (at 28 days), KOhm-cm	FM 5-578	15 or less	22 or greater
*as applicable			

930-7.4 Specimen Requirements:

930-7.4.1 Concrete: Samples shall be prepared in accordance with 930-2.6.1, 930-2.6.3 through 930-2.6.5.

930-7.4.2 Mortar: Samples shall be prepared in accordance with 930-2.6.2 through 930-2.6.5.

930-7.5 Constructability: Furnish to the Engineer for approval shop drawing as may be required to complete repairs in compliance with the design shown in the plans and the manufacturer's recommended repair system.

SECTION 931
METAL ACCESSORY MATERIALS FOR CONCRETE PAVEMENT AND CONCRETE STRUCTURES

931-1 Reinforcement Steel (for Pavement and Structures).

931-1.1 Steel Bars: Billet steel bars for concrete reinforcement shall conform to the requirements of ASTM A-615 except that the process of manufacture will not be restricted. For processes not included in ASTM A-615 the phosphorus content will be limited to 0.08%. When the use of Rail Steel is permitted by the plans such steel shall meet the requirements of AASHTO M-42.

The following special requirements shall apply:

(1) Unless otherwise specified or shown on the plans all reinforcement bars No. 3 and larger shall be deformed bars.

(2) All billet-steel bars shall be of the grade called for on the plans.

(3) Twisted bars shall not be used.

(4) Wherever in the Specifications the word "purchaser" appears it shall be taken to mean the Department.

Acceptance of reinforcing steel shall be based on test samples taken randomly by the Department and manufacturer's certified mill analysis of test results meeting the specification limits of the ASTM or AASHTO designation for the particular size, grade and any additional requirements. Randomly taken test samples and certification of test values, representing each production LOT of reinforcing steel, shall be provided to the Engineer for each Contract prior to use. Randomly taken test samples shall be cut from bundled steel that is shipped to the jobsite.

931-1.2 Metal Fabric: Welded steel wire fabric for concrete reinforcement shall meet the requirements of AASHTO M-55.

Welded deformed steel wire fabric for concrete reinforcement shall meet the requirements of AASHTO M-221.

Wherever the word "purchaser" is used it shall mean the Department.

931-2 Metal Materials for Joints in Concrete Pavement.

931-2.1 Sheet Metal Bottom Strips: The sheet metal strip for protecting the bottom and side edges of transverse expansion joints shall be composed of galvanized sheet metal of 0.0157 inch minimum thickness and shall conform to the requirements of ASTM A-653.

The sheets shall be furnished in accordance with the dimensions shown on the plans. They may be in one continuous piece, or spliced. When splicing is used the metal shall be lapped not less than 3 inches and securely fastened, by welding or otherwise, in such manner as to leave the spelter undamaged and produce a smooth sliding surface in contact with the pavement slab. The splices shall be spaced not less than 10 feet apart and not less than 5 feet from either end. The complete sheet shall not vary from a straight line by more than 1 inch from end to end.

The Contractor shall provide the Engineer a certified mill analysis from the manufacturer of the sheet metal bottom strips including test results for thickness, dimension, grade, length, size, and spacing. Each certified mill analysis shall cover only one type of metal material for joints.

931-2.2 Bars and Chairs for Longitudinal Joints: Transverse reinforcing steel across the joint shall be deformed steel bars conforming to the requirements of 931-1.1 except that the bars may be any Grade shown in ASTM A-615.

These bars, and the chairs to hold them in place, shall be of the type and spacing as indicated on the plans.

931-2.3 Dowel Bars: Dowel bars shall be plain steel bars conforming to the requirements of ASTM A-615 for any Grade of steel shown. They shall be of the length, size and spacing as shown on the plans.

The Contractor shall provide the Engineer a certified test report from the manufacturer of the dowel bars confirming that the requirements of this Section are met. The certified test report shall conform to the requirements of Section 6 and include metallurgical mill analysis, grade, length and size. Each certification shall cover only one LOT for dowel bars.

931-2.4 Chairs and Metal Expansion Caps: The chairs and metal expansion caps shall be of an approved type as shown on the plans.

Dowel bars for expansion joints shall have a metal cap on one end so placed to provide ample space for movement of the slab. Continuous sleeves covering one half of the length of the bar will not be permitted. Other fasteners may be approved. Dowel bars shall be coated with an approved material to break the bond.

931-3 Metal Dowel Bar Assemblies for Joints in Concrete Pavement.

931-3.1 Qualified Products List: The dowel bar assembly used shall a product included on the Qualified Products List.

Manufacturers or distributors seeking approval of their material in accordance with this specification shall demonstrate the performance of their products in accordance with the requirements in 931-3.2 thru 931-3.6.

931-3.2 Rigidity: The dowel bars shall be supported by an approved welded assembly possessing sufficient rigidity to hold the dowel bars in position to such accuracy that error or deviation from its required position in any bar in the entire installation after the pavement has been finished shall be no greater than 1/2 inch.

The assembly shall have continuous parallel spacer bars and two continuous parallel bearing members of no less than 1/4 inch diameter wire. One spacer bar shall be located at or near each end of the dowel. Alternate ends of dowels shall be welded to a spacer bar in such a manner as to maintain the dowels parallel to each other and permit sliding movement in the joint.

The free ends of each dowel shall be retained securely in place by means of wire loops or metal tubes welded to the other spacer bar. An expansion cap shall be installed on one end of each bar if the dowels are being used in an expansion joint.

Suitable struts or ties shall be provided to hold the assembly in correct position during installation.

The assembly shall have an upright support welded to the spacer bar and continuous bearing member at the end of each dowel and a continuous bearing member.

If the upright support consists of a single vertical wire, the support shall be no less than 5/16 inch diameter wire. Otherwise, the support shall be no less than 1/4 inch in diameter.

931-3.3 Sand Plates: Sand plates, if required, shall be made from no less than 3/8 inch sheet steel. Each plate shall have no less than 0.1 ft^2 of bearing area. The plates shall be furnished in sufficient number to provide uniform support for the complete assembly. They may be furnished separate from the assembly units, or attached thereto by welding, suitable clips, or other approved means.

931-3.4 Welds: The welds of the assembly shall be made securely. A broken weld will be cause for rejection of the length of section of the assembly where it occurs.

931-3.5 Assembly Placement: When the dowel bar assembly is in place, it shall act as a rigid unit with each component part securely held in position relative to the other member of the assembly.

The entire assembly shall be held securely in place during placing, consolidating, and finishing the concrete by means of metal pins. Pins used on granular subbase or cold mixed bituminous stabilized subbase shall penetrate at least 12 inches below the dowel bar assembly. The pins shall be of no less than 1/4 inch diameter wire and shall be provided with a hook or arm welded to the pin in such a manner that it shall secure the assembly in place.

Nail securing systems may be used as an anchoring device on hot bituminous stabilized subbase. The nail shall be no less 1/8 inch in diameter, no less than 2 inches in length and the nail head or attached washer shall be not less than 1/2 inch outside diameter. The nail shall be driven through both ends of a metal strap after it has been placed around one of the lower transverse bars on the dowel bar assembly.

At least eight pins or nails shall be used for each 12 foot section (a lane width) of assembly. Sand plates, if required, shall be drilled to receive the pins.

The Contractor shall provide the equipment and personnel necessary to verify dowel bar location after the concrete is placed and has received the initial screeding.

931-3.6 Materials: The wire for the welded assembly shall be in accordance with all applicable requirements of ASTM A-82.

Apply one coat of rust preventative compound meeting the requirements of 560-2.6. Apply the rust preventive in accordance with the manufacturer's recommendations.

SECTION 932
NONMETALLIC ACCESSORY MATERIALS FOR CONCRETE PAVEMENT AND CONCRETE STRUCTURES

932-1 Joint Materials.

932-1.1 Preformed Joint Filler for Pavement and Structures: Preformed joint filler shall meet the requirements of AASHTO M-153 or AASHTO M-213, or cellulose fiber types meeting all the requirements of AASHTO M-213 (except for the asphalt content) is acceptable provided they contain minimums of 0.2% zinc borate as a preservative and 1.5% waterproofing wax. For AASHTO M-153, unless a particular type is specified, either Type I, Type II or Type III may be used.

Preformed joint fillers shall have a thickness equal to the width of the joint required, and shall be furnished in lengths equal to the widths of the slabs in which they are to be installed, except that strips which are of a length not less than the distance between longitudinal joints, or between longitudinal joint and edge, may be used if laced or clipped together in a manner approved by the Engineer. The depth and shape of the joint filler shall conform to the dimensions shown in the plans. For doweled joints, proper provision shall be made for the installation of the dowels.

932-1.1.1 Certification: The Contractor shall provide the Engineer a certification conforming to the requirements of Section 6 from the manufacturer, confirming that the preformed joint filler meets the requirements of this Section.

932-1.2 Joint Sealer for Pavement and Structures:

932-1.2.1 General: This Specification covers joint sealer intended for use in sealing joints in asphaltic concrete pavement and portland cement concrete pavement. These materials may also be used to seal joints in portland cement concrete bridges and other structures.

932-1.2.2 Material: The joint sealant shall be composed of a mixture of materials, typically but not limited to bituminous based, that will melt when heated for application and then solidify to form a resilient and adhesive compound capable of sealing joints in portland cement concrete and/or asphaltic concrete against the infiltration of moisture and foreign materials throughout normal pavement conditions and at ambient temperatures. The manufacturer shall have the option of formulating the material according to their Specifications. However, the requirements delineated in this Specification shall apply regardless of the type of formulation used. The material shall cure sufficiently to not flow from the joint or be picked up by vehicle tires after 3 hours at 77°F. The material shall be capable of a uniform application consistency suitable for filling joints without the inclusion of large air holes or discontinuities and without damage to the material.

Materials for pavement joints shall be tested according to ASTM D-5329. Manufacturers or distributors seeking approval of their material in accordance with this Specification shall demonstrate the performance of their products in accordance with Florida Test Methods FM 5-532.

932-1.2.2.1 Physical Requirements of Joint Sealants for Portland Cement Concrete Only:

Parameter	Limits
Pour Point	Greater than or equal to 20°F lower than the safe heating temperature as stated by the manufacturer.
Cone-Penetration, Non-immersed at 77°F, 150g, 5s	Greater than or equal to 20°F lower than the safe heating temperature as stated by the manufacturer.
Flow at 40°F, 5 h	Less than or equal to 5.0 mm
Bond, Non-immersed, 0°F for 5 cycles*	No cracking, separation, or opening that at any point is over 1/4 inch deep, in the sealant or between the sealant and the substrate.
*The depth of a crack, separation or opening shall be measured perpendicular to the side of the sealant showing the defect. At least two test samples in a group of three representing a given sample of sealant shall meet this requirement.	

932-1.2.2.2 Physical Requirements of Joint Sealants for Portland Cement Concrete and/or Asphaltic Concrete:

Parameters	Limits
Safe Heating Temperature	Equal to the pouring temperature as identified by the manufacturer
Cone-Penetration, Non-immersed at 77°F, 150g, 5s	Less than or equal to 90 mm
Flow at 40°F, 5 h	Less than or equal to 3.0 mm
Bond, Non-immersed, -20°F for 3 cycles*	No cracking, separation, or opening that at any point is over 1/4 inch deep, in the sealant or between the sealant and the substrate.
Resilience at 77°F	Recovery greater than or equal to 60%
Asphaltic Concrete Compatibility at 140°F	No failure in adhesion, formation of an oily exudates at the interface between the sealant and the asphaltic concrete, or softening or other deleterious effects on the asphaltic concrete or sealant.
*The depth of a crack, separation or opening shall be measured perpendicular to the side of the sealant showing the defect. At least two test samples in a group of three representing a given sample of sealant shall meet this requirement.	

932-1.2.3 Certification: The Contractor shall provide the Engineer a certification from the manufacturer conforming to the requirements of Section 6, confirming that the joint sealer materials meets the requirements of this Section.

932-1.2.4 Qualified Products List: The joint sealant materials used shall be one of the products listed on the Department's Qualified Products List (QPL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6.

932-1.2.5 Shipment: The material shall be delivered in containers plainly marked with the manufacturer's name or trademark product name, LOT number and date of expiration.

932-1.2.6 Bond Breaker Rod: The bond breaker rod shall be a closed cell, expanded polyethylene foam rod of the size and dimensions shown on the plans. It shall be compatible with the joint sealant and no bond or reaction shall occur between the rod and the sealant.

All bond breaker rods installed shall be covered by a sealant at the end of each work day.

Bond breaker tape approved by the sealant manufacturer may be used in lieu of bond breaker rod when sealing random cracks.

932-1.3 Low Modulus Silicone Sealant Materials:

932-1.3.1 Low Modulus Silicone Sealants: Silicone sealant shall be furnished in a one part or pre-measured two part formulation meeting the requirements specified herein. Manufacturers or distributors seeking approval of Low Modulus Silicone Sealants Types A, B and C shall demonstrate the performance of their products in accordance with FM 5-533.

Acetic acid cure sealants are not acceptable. A primer as specified in 932-1.4 for bonding sealant to concrete shall be used if required by the manufacturer. When a manufacturer's product is tested and approved by the Department using a primer, primer will be required for project installation.

Do not use Low Modulus Silicone Sealants Types A, B or C for bridge expansion joints.

Silicones shall be identified in the following manner:

Type A - A low modulus, non-sag (non-self-leveling) silicone formulation, used in sealing horizontal and vertical joints in cement concrete pavements and bridges (i.e., concrete-concrete joints). Tooling is required.

Type B - A very low modulus, self-leveling silicone formulation, used in sealing horizontal joints (including joints on moderate slopes) in cement concrete pavements and bridges (i.e., concrete-concrete joints). Tooling is not normally required.

Type C - An ultra-low modulus, self-leveling silicone formulation, used in sealing horizontal joints (including joints on moderate slopes) in cement concrete pavements and bridges (i.e., concrete-concrete joints). It can also be used to seal the joints between cement concrete pavements and asphalt concrete shoulders (including asphalt-asphalt joints). Tooling is not normally required.

Type D - An ultra-low modulus, self-leveling silicone formulation, cold-applied, rapid-cure, used to seal expansion joints that experience both thermal and/or vertical movements. The material must cure by chemical reaction and not by evaporation of solvent or fluxing of harder particles. Tooling shall not be required. Use according to Design Standards, Index number 21110.

932-1.3.2 Physical Requirements:

SILICONE SEALANT TYPE	Test Method	Type A	Type B	Type C	Type D
Flow (maximum)	MIL S 8802	0.3 inches			

SILICONE SEALANT TYPE	Test Method	Type A	Type B	Type C	Type D
Extrusion rate	MIL S 8802	1.25-4.2 g/s	1.7-11.0 g/s	4.58-9.2 g/s	3.3 – 9.2 g/s
Tack-free time at 77 ± 3ºF and 45 to 55% Relative Humidity	MIL S 8802	20-75 minutes	120 minutes, maximum	60 minutes, maximum	30 - 60 minutes
Specific gravity	ASTM D-792, Method A	1.1 to 1.515	1.10 to 1.40	1.26 to 1.34	1.26 to 1.34
Durometer hardness, Shore A (Cured seven days at 77 ± 3ºF and 50 ± 5% Relative Humidity)	ASTM D-2240	10-25			
Durometer hardness, Shore 00 (Cured 21 days at 77 ± 3ºF and 50 ± 5% Relative Humidity)	ASTM D-2240		40-80	20-80	
Tensile stress (maximum) at 150% elongation	ASTM D-412 (Die C)	45 psi	40 psi	15 psi	
Elongation (Cured seven days at 77 ± 3ºF and 50 ± 5% Relative Humidity)	ASTM D-412 (Die C)	800% minimum			600% minimum
Elongation (Cured 21 days at 77 ± 3ºF and 50 ± 5% Relative Humidity)	ASTM D-412 (Die C)		800% minimum	1400% minimum	
Ozone and Ultraviolet Resistance	ASTM C-793	No chalking, cracking or bond loss after 5,000			

SILICONE SEALANT TYPE	Test Method	Type A	Type B	Type C	Type D
		hours, minimum.			
Bond to concrete mortar briquets (primed if required) (Cured seven days at 77 ± 3ºF and 50 ± 5% Relative Humidity)	AASHTO T-132	50 psi minimum			
Bond to concrete briquets (Cured 21 days at 77 ± 3ºF and 50 ± 5% Relative Humidity)	AASHTO T-132		40 psi minimum	35 psi minimum (includes bond to asphalt)	
Movement Capability	ASTM C-719	No adhesive or cohesive failure and adhesion, 10 cycles at -50 to +100%			No adhesive or cohesive failure and adhesion, 10 cycles at +100/-50 % (joints 2" wide)

Portland Cement Mortar: Briquets shall be molded and cured 28 days minimum in accordance with AASHTO T-132. Cured briquets shall be dried at 230 ± 5ºF, sawed in half and bonded together with a thin section of sealant. After cure of sealant, briquets shall be tested in accordance with AASHTO T-132.

932-1.3.3 Field Cure: 6 inch samples of the sealant shall be taken by the Engineer from the joint at the end of a two week curing period and tested for durometer hardness (by Florida Method ANSI/ASTM D-2240), except that the requirements of a 1 inch sample width shall not apply. A minimum hardness of 7.0 is required as evidence of adequate cure.

932-1.3.4 Qualified Products List: The low modulus silicone sealant used shall be one of the products listed on the Department's Qualified Products List. Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6.

932-1.4 Primer: When required by the manufacturer's product, a primer shall be used.

The manufacturer shall perform quality control tests on each LOT of sealant primer material furnished to each project and furnish a certified report

that each LOT of primer material furnished to a project meets his Company's Specifications for that product and the primer is suitable for its intended use.

Sealant primer material shall be delivered in containers plainly marked with the manufacturer's name or trademark and product name, LOT number and date of expiration.

932-1.5 Backer Rod and Tape Bond Breakers: Backer rods and tape shall be compatible with the joint sealant and approved by the sealant manufacturer. No bond or reaction shall occur between the rod and the sealant.

932-1.6 Installation: Installation, material selection, joint dimensions, bond breaker suitability (by type and project) shall be in agreement with the requirements of Design Standards, Index Nos. 305 and 21110. Any modifications or exceptions to these requirements shall be shown in the plans.

For new construction projects or general use where the joints to be sealed have uniform width, a closed cell, expanded polyethylene foam backer rod bond breaker shall be required. For rehabilitation projects and similar joint seals where the joints to be sealed have irregular width, an open cell, expanded polyethylene foam backer rod bond breaker with an impervious skin shall be required.

The backer rod shall be compatible with the joint sealant. No bond or reaction shall occur between the rod and the sealant.

Tape bond breaker approved by the sealant manufacturer may be used in lieu of backer rod bond breaker when sealing joints and/or random cracks, as required.

Type D Silicone sealant shall be placed when the ambient temperature is rising and is between 55°F and 85°F and the temperature is expected to rise for the next three hours minimum to provide to adequate joint opening and compression of the sealant during curing.

All installed bond breakers shall be covered by sealant at the end of each work day.

A tolerance in cross-sectional height at midpoint of -1/16 to +3/16 inch will be allowed to the nominal values shown for each joint width on the plan sheet. The Engineer shall check one joint for each 1,000 feet of roadway by cutting out specimens. If the cross section of the cut specimen is out of the allowable range, additional specimens shall be taken as follows:

One joint every 100 feet of pavement not to exceed 500 feet.

If the average of the specimens is out of tolerance, the Contractor shall remove and replace the entire 500 feet section at no additional expense to the Department.

Installation tolerance shall be verified at 1,000 feet intervals.

932-2 Structure Bearing Pads.

932-2.1 Ancillary Structures - Plain or Fiber Reinforced Bearing Pads:

932-2.1.1 General: Furnish either plain or fiber reinforced (resilient) elastomer pads as shown in the Contract Documents. The elastomer shall be either natural rubber or polychloroprene (neoprene) and meet the material requirements of AASHTO M-251, Appendix X1. Finished pads shall meet the fabrication and tolerance requirements of AASHTO M-251.

932-2.1.2 Plain Pads: Plain pads shall be either molded, extruded, or vulcanized in large sheets and cut to size. Cutting shall not heat the material and shall produce a smooth finish. The finished pads shall withstand a uniform minimum ultimate compression load of 1750 lb/in^2.

932-2.1.3 Fiber Reinforced Pads: Fiber reinforced pads shall be preformed and constructed with either a homogeneous blend of elastomer and random-oriented high strength synthetic fiber cords or multiple layers of fabric and elastomer. Fabric shall be either fiberglass meeting the material requirements of AASHTO M-251, or 8 ounce cotton duck with pads manufactured in accordance with Military Specification MIL-C-882. Unless otherwise specified in the Contract Documents, holes will not be permitted in the fabric. Pads shall withstand a uniform minimum ultimate compression load of 4,000 lb/in^2 without detrimental reduction in thickness or extrusion.

932-2.2 Bridge Structures - Elastomeric Bearing Pads:

932-2.2.1 General: Furnish elastomeric bearing pads in accordance with the requirements of the "AASHTO LRFD Bridge Construction Specifications" Section 18.2, Elastomeric Bearings. Section 18.2 of the above mentioned specification establishes the requirements for plain, fabric reinforced and steel laminated elastomeric bearing pads for bridge structures. When steel reinforced bearings are specified, all edges of the embedded steel laminates, including at the laminate restraining devices and around holes and slots shall be covered with not less than 3/16 inch of elastomer or the minimum edge cover specified on the plans. All exposed laminations or imperfections that result in less than the specified elastomer cover of any surface of the steel laminations shall be repaired by the manufacturer at the point of manufacture. The repair shall consist of sealing the imperfections flush on the finished pads with a bonded vulcanized patch material compatible with the elastomeric bearing pad. Repairs employing caulking type material or repairing the bearings in the field will not be permitted.

932-2.2.2 Materials: Use only grade 2 (or higher) 100 percent virgin polychloroprene (neoprene) material. No wax antiozonants or other foreign material may accumulate or be applied to the surfaces of the bearing. Use ASTM A-36 or ASTM A-1011 Grade 36 Type I steel for the steel reinforcement in steel laminated elastomeric bearings. The minimum thickness for the steel reinforcement shall be +/- 0.1345 in. or ten gage material.

932-2.2.3 Testing: Comply with the testing requirements established in the "AASHTO LRFD Bridge Construction Specifications" Section 18.2. Unless otherwise shown in the Contract Documents, the rated service load for load testing shall be 1,600 pounds times the pad area in square inches. When the elastomer material is specified by Shore "A" hardness (durometer), comply with the testing and acceptance criteria in AASHTO M-251, Appendix X1 and X2.

932-2.2.4 Fabrication Tolerances: Fabricate elastomeric bearings to be within the tolerances stated in the "AASHTO LRFD Bridge Construction Specifications" Section 18.1.4, Manufacture or Fabrication.

932-2.2.5 Marking: Each elastomeric bearing pad shall be permanently marked. The marking shall consist of the order number, LOT number, pad identification number, elastomer type, and shear modulus or hardness (when shear modulus is not specified). Where possible, unless otherwise specified in the

plans, the marking shall be on a face which is visible after erection of the structure.

932-2.2.6 Mill Analysis Reports: For plain, fiber reinforced and elastomeric bearing pads, provide six certified copies of the manufacturer's complete mill analysis, including actual results of all tests specified in this Subarticle, properly identified by project number, to the Engineer. The mill analysis reports shall be for material representative of that furnished.

The manufacturer shall certify that each pad satisfies the design specification.

932-2.3 Certification: The Contractor shall provide the Engineer a certification conforming to the requirements of Section 6 from the manufacturer, confirming that the bearing pads, (plain, fiber reinforced or elastomeric) meets the requirements of this Section.

SECTION 933
ACCESSORY MATERIALS
FOR PRESTRESSED CONCRETE

933-1 Cables for Pretensioning.

The cables for prestressing concrete members shall be high-tensile-strength, 7-wire strand conforming to the requirements of ASTM A-416 with the addition of 9/16 inch strand meeting the following requirements:

TABLE 1
BREAKING STRENGTH REQUIREMENTS

Nominal Diameter of Strand, inch	Breaking Strength of Strand, lbf	Nominal Steel Area of Strand, in^2	Nominal Weight of Strands, lb/1,000 ft
Grade 270			
9/16	51,700	0.191	650

TABLE 2
YIELD STRENGTH REQUIREMENTS

Nominal Diameter of Strand, inch	Initial Load, lbf	Minimum Load at 1% Extension, lbf
Grade 270		
9/16	5,170	43,940

TABLE 3
DIAMETER RELATION BETWEEN CENTER AND OUTER WIRES

Nominal Diameter of Strand, inch	Minimum Difference Between Center Wire Diameter and Diameter of any Outer Wire, inch
Grade 270	
9/16	0.003

As an exception to the above, at the Contractor's option, stabilized strands may be used in lieu of stress relieved strands. Calculations shall be submitted, showing the substitution meets the following requirements:

1. The strands meet all the requirements of ASTM A-416, Grade 270.
2. The net compressive stress in the concrete after all losses is at least as large as that provided by the stress relieved strands.
3. The ultimate strength of the structure with the new strands meets the requirements of the applicable AASHTO Specifications.

933-2 Bars for Post-Tensioning.

The bars shall be of high-tensile-strength steel, and shall be equipped with wedge-tool end anchorages which will develop the minimum specified ultimate bar stress on the nominal bar area. The physical properties of the bar steel and the stress-strain curve, determined by static tensile tests, shall conform to the following:

Ultimate stress, minimum	145,000 psi
Stress at 0.7% elongation, minimum	130,000 psi
Stress at 0.3% elongation, minimum	75,000 psi
Elongation in 20 diameters, minimum	4%
Modulus of elasticity, minimum	25,000,000
Diameter tolerance	+0.02375 or -0.010 inch

933-3 Parallel Wire Assemblies for Post-Tensioning.

The wire assemblies shall consist of parallel wires of the number and size shown in the plans. Wires shall conform to the requirements of ASTM A-421, with Type BA (Button Anchorage) used for cold end deformations and Type WA used for the wedge-type anchorage without cold end deformations. At the option of the Contractor, stabilized strands may be used in lieu of stress relieved strands provided calculations are submitted, showing the substitution meets the requirements specified in 933-1 for stabilized strands.

933-4 Anchorages for Post-Tensioned Tendons.

933-4.1 For Bars: Wedge-type anchorages shall be used for bars. The wedge device shall develop the minimum ultimate stress specified for the nominal bar area. Wedge anchorages shall bear against anchorage plates fabricated of hot-rolled steel having physical characteristics not less than as specified for No. 1040 of the American Iron and Steel Institute (AISI) Specifications.

933-4.2 For Parallel Wire Assemblies: Anchorage for parallel wire assemblies may be provided by cold-end deformation of the wires (Button Anchorage) bearing against suitable anchorage plates, or by wedge-type anchorages of the sandwich-plate or conical type. The anchorage device shall be capable of developing at least 90% of the specified ultimate strength of the total number of wires anchored.

Conical type anchorages shall be embedded within the ends of the concrete members unless otherwise specified. Anchorages shall generally bear against embedded grids of reinforcing steel of approved type.

933-4.3 Alternates for Both Types: Alternate type anchorages will be considered if proposed by the Contractor. Any alternate anchorage will be required to develop the full specified ultimate strength for bars or at least 90% of the specified ultimate strength for parallel wire assemblies.

As a specific exception, threaded anchorages not on upset or over-size reinforcing ends will not be considered.

933-5 Required Tests for Reinforcing.

933-5.1 General: Tests shall be made to determine the physical characteristics of prestressing reinforcement. For tests specified to be made by the manufacturer, certified copies of all test results shall be submitted to the Department and the Department shall be privileged to have all tests witnessed by its Inspectors.

933-5.2 Cables, Wires and Wire Anchorages: Acceptance of cables, wires and wire anchorages shall be based on manufacturer's certified mill analysis of test results meeting the Specification limits of ASTM or AASHTO as specifically designated.

Certifications of cable for prestressing shall contain for each heat number or production LOT, all test results required by ASTM A-416 and the modulus of elasticity expressed in psi or the stress-strain curve with units identified.

Random samples may be selected and tested by the Department for verification purposes.

933-5.3 Bars:

933-5.3.1 Proof Test: During manufacture each bar shall be proof-tested to a minimum stress of 130,000 psi.

933-5.3.2 Static Test: From each mill heat received, one static test shall be made by the manufacturer on an assembled bar and anchorage, to determine the physical properties of the steel and the assembly. Such physical properties shall conform to the minimum physical properties specified in 933-2.

SECTION 934
NON-SHRINK GROUT

934-1 Scope.

This Section covers only prepackaged non-shrink cementitious grout for structural use.

934-2 Type Permitted.

Only non-metallic formulations of grouts are allowed. Gas producing, metal oxidizing and expansive aggregate grouts are not allowed.

934-3 Sampling and Testing Methods.

Perform concrete sampling and testing in accordance with the following methods:

Making and Curing Concrete Test Specimens
in the Laboratory .....ASTM C-192
Time of Setting Concrete Mixtures by

Penetration Resistance.....ASTM C-403
Determining Low-Levels of Chloride in Concrete and
Raw Materials .....FM 5-516
Compressive Strength of Hydraulic Cement
Mortars .....ASTM C-109
Flow of Grout for Preplaced Aggregate Concrete
(Flow Cone Method) .....ASTM C-939
Measuring Changes in Height of Cylindrical Specimens from
Hydraulic Cement Grout .....ASTM C-1090
Expansion and Bleeding of Freshly Mixed Grout for Preplaced
Aggregate Concrete in the Laboratory .....ASTM C-940

934-4 Requirements.

When tested as provided in 934-3, the grout shall meet the following requirements:

Property	Test Value
Compressive strength	
one day	2,500 psi minimum
3 days	5,000 psi minimum
Time of set, final	8 hours maximum
Chloride Content	0.40lb/yd3 maximum
Hardened Height Change at 1, 3, 14, and 28 Days	0.0% to 0.3%
Hardened Height Change at 1, 3, and 14 Days	≤ Height Change @ 28 Days
Expansion	≤ 2.0% @ 3 Hours
Bleeding, Final	0.0% @ 3 Hours

934-5 Product Acceptance on the Project.

Non-shrink grout used shall be one of the products listed on the Qualified Products List. Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6.

Acceptance will be made in accordance with the products listed on the Qualified Products List (QPL).

934-6 Rejection.

Materials shall be rejected at the point of use if the materials are caked, lumpy, or show any signs of deterioration. Materials shall be rejected if the grout does not achieve the design fluidity or consistency when mixed according to the manufacturer's recommendations.

All broken or open packages shall be rejected.

934-7 Packaging.

Cementitious materials for grouts must be packaged in suitable moisture resistant containers and clearly labeled. Where applicable, manufacturers recommendations, limitations and cautions shall be clearly visible on each label.

SECTION 936
WIRE ROPE FOR FENDER PILE CLUSTER

Unless otherwise shown on the plans, galvanized aircraft quality wire rope with ultraviolet ray resistant polypropylene impregnation shall be used. The polypropylene plastic shall form a wall of protection by using spacer wires in the outer gallery of each strand and shall be effectively bonded to the outer plastic jacket. The rope diameter shall be 1/2 inch and the outside diameter of the covering 5/8 inch. The rope construction shall be 6 by 19 independent wire rope core with nominal strength of 22,800 pounds. All ends shall be protected with heat shrinkable end caps, compatible with the rope's polypropylene. The caps shall provide an effective water-tight seal and shall be installed in accordance with the manufacturer's instructions. The rope shall conform to Federal Specifications W83420 for aircraft quality and the protective coating shall conform to ASTM A-475 (Type 1 coating).

SECTION 937
ADHESIVE BONDING MATERIAL SYSTEMS FOR STRUCTURAL APPLICATIONS

937-1 General Requirements.

Adhesive bonding material systems for structural applications shall consist of pre-packaged 2-part chemical components. The material systems shall be specifically intended for use in structural applications for bonding anchors and dowels to hardened concrete. Applications are limited to anchors and dowels installed in positions ranging from vertically downward to horizontal.

Do not use material from containers which are damaged or have been previously opened. Use only full packages of components. Combining of epoxy bonding components from bulk supplies is not permitted.

Material systems for Type HV and HSHV shall be pre-packaged to automatically proportion and mix the materials for use. Manual proportioning of the components will not be permitted.

937-1.1 Type HV Adhesives: Use Type HV adhesive bonding materials for all horizontal installations and vertical installations other than constructing doweled pile splices, except when Type HSHV is required. Type HV adhesives may not be substituted for Type HSHV adhesives.

937-1.2 Type HSHV Adhesives: Use higher strength Type HSHV adhesive bonding materials for installation of traffic railing barrier reinforcement and anchor bolts into existing concrete bridge decks and approach slabs. Type HSHV adhesives may be substituted for Type HV adhesives.

937-2 Qualified Products List.

Manufacturers of adhesive bonding material systems may apply for inclusion of individual products on the Qualified Products List. The application shall be

made in accordance with 6-1 and shall include certified test reports from an independent testing laboratory which shows the material system meets all the requirements specified herein.

937-3 Certification.

The Contractor shall provide the Engineer with certification from the manufacturer of the adhesive bonding material system, confirming that the requirements of this Section are met. The certification shall conform to the requirements of Section 6. Each certification shall cover only one LOT of adhesive materials.

937-4 Minimum Performance Requirements (FM 5-568).

When tested in accordance with FM 5-568, the adhesive bonding material system, for general use, shall meet the following requirements:

Uniform Bond Stress		
	Type HV	Type HSHV
Confined Tension	2,290 psi	3,060 psi
Damp-Hole Installation	1,680 psi	1,830 psi
Elevated Temperature	2,290 psi	3,060 psi
Horizontal Orientation	2,060 psi	2,060 psi
Short Term Cure	1,710 psi	1,710 psi
Specified Bond Strength	1,080 psi	1,830 psi

Maximum Coefficient of Variation for Uniform Bond Stress 20%

Long Term Load (Creep):

(1) The rate of displacement shall decrease during the 42 day application of load.

(2) At 42 days the total displacement due to creep (with load still applied) shall be less than 0.03 inch and during the last 14 days of the 42 day load duration, the total displacement due to creep shall be less than 0.003 inch.

(3) After removal of the 42 day load, the uniform bond Stress from a subsequent Confined Tension Test shall not be less than 1,826 psi.

937-5 Product Identification (Fingerprint) Properties (FM 5-569).

References for comparison including Infrared Absorption, Density or Average Weight, Gel Time or Setting Time, and Bond Strength shall be determined in accordance with FM 5-569.

937-6 Packaging and Marking.

The adhesive bonding material system shall be delivered to the project site in original unopened containers with the manufacturer's label identifying the product. Each package shall be clearly marked with the following information:

Manufacturer's name and address
Product Name
Date of Manufacture
Expiration Date

LOT Identification Number

Storage and Handling Requirements

Each package shall include the manufacturer's instructions for anchor and dowel installation. The instructions shall include the following information:

Diameters of drilled holes for applicable anchor and dowel sizes.

Cleaning procedure for drilled holes, including a description of permitted and prohibited equipment and techniques.

Allowable temperature ranges for storage, installation and curing.

Identification of acceptable mixing/dispensing nozzles.

Fabrication requirements for anchors and dowels.

Description of tools permitted or required for installation.

Method of identifying properly proportioned and mixed adhesive materials.

Time and temperature schedule for initial set and full-strength cure.

Special requirements for special installation conditions such as damp holes, or horizontal or near horizontal orientation of the anchor or dowel.

SECTION 942
PIPE GASKETS

942-1 Round Rubber Gaskets for Pipe Joints.

Except where O-ring type gaskets are specified for special cases and for special type pipe, round rubber gaskets for use in concrete pipe joints shall meet the requirements of ASTM C-443, with the additional requirements that the gasket used shall be of such cross sectional area and perimeter as to properly fit the space provided in the pipe joint in which it is to be used.

Prior to use, the gasket shall be stored in as cool a place as practicable.

942-2 Cold Adhesive Preformed Plastic Gaskets (For Sealing Elliptical Concrete Pipe Joints).

942-2.1 General: Cold adhesive preformed plastic gaskets shall be of a material, shape and size so as to effect a permanent water tight seal in joints of elliptical concrete pipe. A minimum of two pieces of gasket material shall be used in each joint.

The gasket material shall be protected by a 2-piece removable wrapper. To facilitate application, the 2-piece wrapper shall be so designed that one-half may be removed longitudinally without disturbing the other half.

The size of the gasket shall be in accordance with the manufacturer's recommendation for the particular joint in which it is to be used. However, the minimum size for each of the gaskets used in a joint shall be in accordance with the following:

Pipe Size (Inches)	Nominal Gasket Size (Inches)	Minimum Cross-Section (In2)
Up to 19 by 30	1 1/2	1.75
19 by 30 to 53 by 83	1 3/4	2.5
Over 53 by 83	2	3.25

The above minimum size requirements are based on a joint designed with a maximum taper of ten degrees and an in-place annular space of approximately 1/4 inch.

942-2.2 Composition: The gasket sealing the joints shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler. The material shall contain no solvents and shall not produce irritating fumes or obnoxious odors. The gasket shall not depend on oxidizing, evaporation or chemical action for its adhesive or cohesive strength.

The chemical composition of the gasket material shall meet the following requirements:

	Minimum	Maximum
Bitumen (petroleum plastic content) (% by weight)	50	70

	Minimum	Maximum
Ash-Inert Mineral Matter (% by weight)	30	50
Volatile Matter (@ 325º F) (% by weight)		2.0

The gasket joint sealing compound when immersed for 30 days at ambient room temperature separately in 5% solution of caustic potash, a mixture of 5% hydrochloric acid, a 5% solution of sulfuric acid, and a saturated hydrogen sulfide solution shall show no visible deterioration.

The physical properties of the gasket joint sealing compound as shipped shall meet the following requirements:

	Minimum	Maximum
Specific Gravity @ 77ºF	1.2	1.35
Ductility @ 77ºF	50 mm	
Softening Point @ 77ºF	320ºF	
Penetration (0.1 mm) 77ºF @ (150 gms) five seconds	50	120

942-2.3 Certification: The manufacturer of the gasket material shall furnish the Engineer certified test results covering each shipment of material to each project.

942-3 Resilient Connectors for Sealing Precast Structures to Pipe Joints.

942-3.1 General: Resilient connectors shall meet the requirements of ASTM C-1478. The connectors shall also be compatible with the precast structure and pipe.

942-3.2 Qualified Products List (QPL): All resilient connectors shall be listed on the Department's Qualified Products List (QPL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6.

942-4 Profile Rubber Gaskets for Concrete Pipe Joints.

(a) Round Pipe: The gaskets shall meet the requirements of ASTM C-443.

(b) Elliptical Pipe: The gaskets shall meet the requirements of ASTM C-443.

Additionally, the gaskets used shall be of such cross sectional area and perimeter as to properly fit the space provided in the pipe joint in which it is to be used.

The gaskets shall be stored in as cool a place as practicable prior to use.

SECTION 943
CORRUGATED STEEL PIPE AND PIPE ARCH
(Including Underdrain)

943-1 General Requirements.

Corrugated steel pipe, including round culvert pipe, pipe arch and underdrain and coupling bands for each type shall conform to AASHTO M-36. Provide certification of the actual mean diameter of pipe shipped to the project. Include in the certification the minimum and maximum diameters used to certify the actual mean diameter. The certification shall be attested to by a person having legal authority to bind the manufacturing company.

In addition, except for underdrain corrugated steel pipe including pipe arch shall be fabricated with helical corrugations with a minimum of two annular corrugations formed on each end of each pipe to accommodate a coupling band. Annular fabrication is not permitted unless specifically called for in the plans or specifications.

Ensure that the pipe joints have been tested at the plant hydrostatically at the specified pressure using test methods in ASTM D-3212 with the exceptions of Sections 7.3 and 7.4. In lieu of Section 7.4, deflect one side of the pipe to a 5% reduction in internal diameter using the parallel plate testing methodology of ASTM D-2412. Load the deflected pipe to within 1/2 the actual pipe diameter from the centerline of the gasket or just beyond the end of the hugger band, whichever is greater. Ensure that the loading mechanism does not contact the hugger band or associated hardware. Testing shall be witnessed by the Engineer.

943-2 Round Culvert Pipe.

For round culvert pipe used as sidedrain, unless shown otherwise in the plans the minimum thickness of the metal (including galvanizing - AASHTO M-218, or aluminum coating - AASHTO M-274), shall be as specified below.

TABLE I
THICKNESS OF METAL FOR SIDEDRAIN PIPE

Nominal Diameter (Inches)	Metal Sheet Gauge No.	Mean Thickness Metal (Inches)
6	18	0.0516
8	16	0.0635
10	16	0.0635
12	16	0.0635
15	16	0.0635
18	16	0.0635
21	16	0.0635
24	16	0.0635
30	14	0.0785
36	14	0.0785
42	12	0.1084
48	12	0.1084

TABLE I THICKNESS OF METAL FOR SIDEDRAIN PIPE		
Nominal Diameter (Inches)	Metal Sheet Gauge No.	Mean Thickness Metal (Inches)
54	12	0.1084
60	10	0.1382
66	10	0.1382
72	10	0.1382
78	8	0.1681
84	8	0.1681
90	8	0.1681
96 and over	8	0.1681

TABLE II PERMISSIBLE VARIATION IN THICKNESS OF METAL FOR PIPE AND CONNECTING BANDS		
Metal Sheet Gauge No	Mean Thickness of Metal (Inches)	Permissible Variation (Inches)
18	0.0516	0.007
16	0.0635	0.007
14	0.0785	0.008
12	0.1084	0.009
10	0.1382	0.009
8	0.1681	0.009

943-3 Pipe Arch.

For corrugated metal pipe arch, in addition to the requirements shown in AASHTO M-36, thickness of the metal shall be as shown for the equivalent size round pipe in Tables I and II, above, and the fabrication of the pipe arch sections shall be such as to insure a substantially flat invert.

943-4 Alternate Connecting Bands.

In addition to the connecting bands as specified in AASHTO M-36, alternate types of connecting bands are specified in 430-8.1.3, for use with the types of installations as shown.

943-5 Bituminous Coating and Paved Invert. .

When bituminous coating is specified, the pipe, or pipe arch, shall be coated in accordance with the requirements of AASHTO M-190, for Type A (Fully Bituminous Coated).

When bituminous coated and paved invert are specified the pipe or pipe arch shall be coated and paved in accordance with AASHTO M-190, for Type C (Fully Bituminous Coated and Paved). The temperature of the asphalt at the time of coating and the duration of the pipe submerged time shall be optimized such that excess coating does not adhere to the pipe.

943-6 Paved Interior.

When bituminous coated and paved interior are called for, the coating and paving shall meet the requirements specified above for bituminous and paved invert (Type C), with the following additions and exceptions:

(a) The smooth pavement formed by the asphalt cement shall extend over the entire interior of the pipe.

(b) The exterior coating and the interior paving shall be applied.

(c) No markings will be required on the outside of the pipe to designate the center line of the top of the pipe.

(d) Lifting lugs shall be attached to the pipe, and shall be suitably placed to facilitate moving the pipe without damage to the exterior or interior bituminous material.

943-7 Basis of Acceptance of Bituminous Coating and Paving.

The acceptance of the bituminous coating, paved invert, and paved interior will be based on the manufacturer's certified mill tests.

943-8 Underdrain Pipe.

Corrugated metal pipe for underdrain shall conform to the requirements of AASHTO M-36 except that Class IV pipe, as specified in 18.1.1.4 therein, shall not be used.

SECTION 944
STRUCTURAL PLATE STEEL PIPE AND PIPE ARCH

944-1 Description.

This Section covers the materials for corrugated galvanized steel structural plate pipe and pipe arch, including the necessary bolts and nuts for connecting plates and for assembling the pipe or pipe arch at the point of destination when so specified. The sizes of the pipe or pipe arch shall be as shown in the plans.

944-2 Materials.

Structural plate pipe and pipe arch shall be of galvanized steel, complying with the requirements of AASHTO M-167, with the additional requirement that the minimum thickness of the plates shall be as shown in the plans.

944-3 Tolerance in Span and Height.

A tolerance of ±4% will be allowed in the specified span and height of pipe arches. A tolerance of -2 to +4 inches will be allowed in the specified diameter of round pipe.

944-4 Bituminous Coating.

When bituminous coating is specified, all plates shall be fully coated on both sides with asphalt cement. The bituminous coating shall conform to the requirements of AASHTO M-190, for Type A.

944-5 Mill Analysis and Guarantee.

Six certified copies of Mill Analysis and Guarantee shall be furnished to the Engineer, and acceptance of the pipe will be based on such reports.

944-6 Assembly Diagrams.

Diagrams for assembling shall be furnished unless the pipe or pipe arch is furnished completely assembled.

944-7 Fabrication.

The fabrication of the pipe and pipe arch shall comply with the applicable requirements of Section 23, of the AASHTO LRFD Bridge Construction Specifications. Unless otherwise specified, the pipe and pipe arch shall be of full section for the entire length.

944-8 Assembly.

When purchase contracts stipulate that the pipe be assembled, the dealer shall furnish the pipe and pipe arch completely assembled at the point of destination, or at the site, as specified, and in lengths as specified.

944-9 Direct Purchases by the Department.

When the Department purchases the pipe or pipe arch direct from the dealer, the quantity to be paid for shall be the number of feet of pipe and of pipe arch, as ordered, provided that sufficient materials meeting the requirements of these specifications shall be furnished to construct the pipe and pipe arch of the length and sizes shown.

The quantity shall be the net length as ordered, with no allowance for length in excess thereof.

The price per foot for direct purchases shall be full compensation for furnishing the complete materials for the pipe or pipe arch, including all bolts and nuts required for connecting the plates. When assembling of the pipe or pipe arch is specified, such price shall also include all labor, equipment, tools and incidentals required for completely assembling the pipe or pipe arch.

SECTION 945
ALUMINUM PIPE, INCLUDING UNDERDRAIN, PIPE ARCH AND STRUCTURAL PLATE PIPE AND PIPE ARCH

945-1 Corrugated Aluminum-Alloy Culverts and Underdrains.

Aluminum-alloy culvert pipe and underdrains shall meet the requirements of AASHTO M-196 and the additional provisions contained herein. Except for underdrain, corrugated aluminum pipe including pipe arch shall be fabricated with helical corrugations with a minimum of two annular corrugations formed into each end of each pipe to accommodate a coupling band. Annular fabrication is not permitted unless specifically called for in the plans or specifications. Provide certification of the actual mean diameter of pipe shipped to the project. Include in the certification the minimum and maximum diameters used to certify

the actual mean diameter. The certification shall be attested to by a person having legal authority to bind the manufacturing company.

For Sidedrains, unless shown otherwise in the plans the minimum thickness of the metal shall be as specified below.

NON SI UNITS		
TABLE I THICKNESS OF METAL FOR SIDEDRAIN PIPE		
Nominal Diameter or Equivalent (inches)	Sheet Gauge No.	Mean Thickness of Metal (inches)
6	18	0.048
8	16	0.060
10	16	0.060
12	16	0.060
15	16	0.060
18	16	0.060
21	16	0.060
24	16	0.060
30	14	0.075
36	14	0.075
42	12	0.105
48	12	0.105
54	12	0.105
60	10	0.135
66	10	0.135
72 and over	8	0.164

Where bituminous coated aluminum pipe is specified the bituminous coating shall meet the requirements as specified for corrugated steel pipe in 943-5. Bituminous coated and paved aluminum pipe shall meet the additional requirements specified in 943-6 and 943-7, as applicable.

Class IV pipe shall not be used.

Ensure that the pipe joints have been tested at the plant hydrostatically at the specified pressure using test methods in ASTM D-3212 with the exceptions of Sections 7.3 and 7.4. In lieu of Section 7.4, deflect one side of the pipe to a 5% reduction in internal diameter using the parallel plate testing methodology of ASTM D-2412. Load the deflected pipe to within 1/2 the actual pipe diameter from the centerline of the gasket or just beyond the end of the hugger band, whichever is greater. Ensure that the loading mechanism does not contact the hugger band or associated hardware. Testing shall be witnessed by the Engineer.

945-2 Aluminum Alloy Structural Plate Pipe, Pipe Arch and Arches.

945-2.1 General Requirements: Aluminum alloy structural plate pipe, pipe arch, and arches shall conform to AASHTO M-219, with the exceptions and

additions specified herein. The nominal thickness of the plate shall be as shown in the plans.

945-2.2 Bolts and Nuts: In lieu of shaped bolts and nuts, standard type bolts and nuts, with special shaped washers, may be used. For aluminum bolts and nuts the material shall conform to the chemical requirements shown in Table I of ASTM B-211, for Alloy 6061. Nuts shall be lubricated at the factory, with a suitable wax compound. The bolts may be sampled and tested before erection or may be accepted on the basis of the manufacturer's certification.

For steel bolts and nuts, the material shall meet the requirements of either ASTM A-307 or ASTM A-325, as appropriate, and shall be hot double-dipped galvanized. Aluminized steel bolts, or other equally suitable devices for connecting the plates, may be used if approved by the Engineer.

945-2.3 Certification of Tests: For all aluminum materials, test certifications as specified in 965-2, shall be furnished.

945-2.4 Direct Purchases by the Department: The provisions of 944-9, for the conditions of direct purchase of structural plate steel pipe and pipe arches, shall also apply to Departmental purchases of aluminum alloy structural plate pipe, pipe arches and arches.

945-2.5 Pipe Markings: In lieu of the coined markings required by AASHTO M-196, Section 14, information may be ink stamped on the pipe at the time of manufacture. The pipe fabricator's identity, date of corrugating or forming into pipe may be stamped onto the pipe using indelible ink and a suitably fashioned stamping device. The pipe markings must be clearly legible upon arrival at the jobsite and at the time of installation. Pipe with illegible or incomplete markings may be rejected.

SECTION 946
CAST IRON PIPE

946-1 Cast Iron Culvert Pipe.

Cast iron culvert pipe of diameter 12 inches and over shall conform with the requirements of AASHTO M-64, (including the requirements for the coating as specified in Article 7.1 of AASHTO M-64). Cast iron culvert pipe smaller than 12 inches in diameter shall meet ANSI Standard A21.51 and the joints shall meet ANSI Standard A21.11.

Unless a particular type or class of pipe is designated in the plans the Contractor may furnish any class included in the above specifications. Only one class or type shall be furnished for any one Contract. The pipe shall be smooth bore pipe.

946-2 Cast Iron Soil Pipe.

Cast iron soil pipe, for roof drains or for other purposes where such pipe is designated, shall meet the requirements of either of the following:

(1) ASTM A-74, for service-type pipe.

(2) The building code of the municipality or other governmental authority having jurisdiction within the area of the installation.

SECTION 948
MISCELLANEOUS TYPES OF PIPE

948-1 Polyvinyl-Chloride Pipe, or Acrylonitrite-Butadiene-Styrene Plastics Pipe.

948-1.1 For Bridge Drains: Polyvinyl-chloride pipe, for use in bridge drains which will be exposed shall conform to the requirements of ASTM D-1785, for Type II, Grade 1, Schedule 40 PVC pipe. For the portion of bridge drains encased in concrete, the pipe may be as specified in 948-1.4.

948-1.2 Pressure Pipe: Pressure pipe for direct burial under pavement shall conform to the requirements of ASTM D-1785, for Type I, Grade I, Schedule 40, for sizes up to and including 2 1/2 inches, and Schedule 80 for sizes up to 4 inches. Pressure pipe 4 inches in diameter and larger shall conform to the requirements of AWWA C900-75, DR18, and ASTM D-1785, Type I, Grade I or other types as may be specifically called for in the plans or special provisions.

948-1.3 Pipe Marking: All polyvinyl-chloride pipe shall be marked as required by Article 8 of ASTM D-1785, and acceptance of the pipe may be based on this data.

948-1.4 Nonpressure Pipe: Polyvinyl-chloride pipe and Acrylonitrite-butadiene-styrene pipe, intended for direct-burial or concrete encasement, shall meet the following requirements:

(a) PVC Pipe: ASTM D-3034, SDR-35, or ASTM F-949, profile wall without perforations.

(b) ABS Pipe: ASTM D-2680.

The manufacturer of the PVC or ABS pipe shall furnish to the Engineer six copies of mill analysis covering chemical and physical test results.

948-1.5 Underdrain: Polyvinyl-chloride pipe for use as underdrain shall conform to the requirements of ASTM F-758 or ASTM F-949. Also, PVC underdrain manufactured from PVC pipe meeting ASTM D-3034, perforated in accordance with the perforation requirements given in AASHTO M-36 or AASHTO M-196 will be permitted.

948-1.6 Edgedrain: Polyvinyl-chloride pipe for use as edgedrain shall conform to the requirements of ASTM F-758, ASTM F-949 or ASTM D-3034 pipe shall be perforated in accordance with the perforation requirements given in AASHTO M-36 or AASHTO M-196. Additional perforations will be required as indicated in the Design Standards, Index No. 286 for pipes designated under ASTM F-758 and ASTM D-3034. Polyvinyl chloride pipe intended for direct burial in asphalt shall meet the following requirements:

(a) ASTM D-3034, SDR-35, or ASTM F-949

(b) NEMA TC-2 (pipe material and compounds) and NEMA TC-3 (pipe fittings) for PVC (90ºC electrical conduit pipe) NEMA ECP-40 and NEMA ECP-80. Underwriter Laboratory Specifications referenced under NEMA specifications for electrical conductivity are not required.

(c) Pipe shall withstand asphalt placement temperatures specified without permanent deformation.

(d) Perforations shall be in accordance with AASHTO M-36 or AASHTO M-196.

948-1.7 Polyvinyl Chloride (PVC) Pipe (12 to 36 Inches): Polyvinyl Chloride (PVC) Pipe for side drain, cross drain, storm drain and other specified applications shall conform to AASHTO M-278 for smooth wall PVC pipe or ASTM F-949 for PVC ribbed pipe. Mitered end sections are not to be constructed of polyvinyl chloride. Use only concrete or metal mitered end sections as indicated in the Design Standards.

Provide certification of the actual mean diameter of pipe shipped to the project. Include in the certification the minimum and maximum diameters used to certify the actual mean diameter. The certification shall be attested to by a person having legal authority to bind the manufacturing company.

Ensure that the pipe joints have been tested at the plant hydrostatically at the specified pressure using test methods in ASTM D-3212 and witnessed by the Engineer.

948-2 Corrugated Polyethylene Tubing and Pipe.

948-2.1 General: For underdrain, Corrugated Polyethylene Tubing and fittings shall meet the requirements of AASHTO M-252. For edgedrain, Corrugated Polyethylene Tubing and fittings shall meet the requirements of AASHTO M-252, except as modified in 948-2.2. For storm drain side drain, french drain and cross drain corrugated Polyethylene Pipe shall meet the requirements of AASHTO M-294 and 948-2.3.2.

The tubing or pipe shall not be left exposed to sunlight for periods exceeding the manufacturer's recommendation.

948-2.2 Edgedrain (4 to 10 inches): The requirements for Edgedrain as specified in AASHTO M-252 are modified as follows:

(a) Coiling of tubing 6 inches in diameter or greater is not permitted. Tubing shall have a minimum pipe stiffness of 46 psi at 5% deflection.

948-2.3 Corrugated Polyethylene Pipe (12 to 60 inches):

948-2.3.1 General: Class I corrugated Polyethylene Pipe used for side drain, storm and cross drain or french drain shall meet the requirements of AASHTO M-294. Class II Corrugated Pipe shall meet the requirements of AASHTO M-294 and the additional requirements as specified herein. Corrugations may only be annular. Ensure that pipe resin conforms to ASTM D-3350 minimum cell classification 435400C except that cell class 435400E may be used if the combination of color and UV stabilizer provides the same or better UV protection than that of resin cell class 435400C. Mitered end sections are not to be constructed of polyethylene. Use only concrete or metal mitered end sections as indicated in the Design Standards.

Provide certification of the actual mean diameter of pipe shipped to the project. Include in the certification the minimum and maximum diameters used to certify the actual mean diameter. The certification shall be attested to by a person having legal authority to bind the manufacturing company.

Ensure that the pipe joints have been tested at the plant hydrostatically at the specified pressure using test methods in ASTM D-3212 and witnessed by the Engineer.

Ensure that each shipment of products to the job site includes a list of products and each product has an affixed legible stamp mark of the plant,

indicating its compliance with the requirements of the plant's Department approved Quality Control Plan and Contract Documents.

948-2.3.2 Additional Requirements for Class II Polyethylene Pipe: Meet the following requirements:

Table 1			
Stress Crack Resistance of Pipes			
Pipe Location	Test Method	Test Conditions	Requirement
Pipe Liner	FM 5-572, Procedure A	10% Igepal solution at 122°F and 600 psi applied stress, 5 replicates	Average failure time of the pipe liner shall be ≥18 hours, no single value shall be less than 13 hours.
Pipe Corrugation[1], (molded plaque)	ASTM F-2136	10% Igepal solution at 122°F and 600 psi applied stress, 5 replicates	Average failure time shall be ≥24 hours, no single value shall be less than 17 hours.
Junction	FM 5-572, Procedure B and FM 5-573	Full Test[2,3]: Test temperature 176°F and applied stresses of 650 and 450 psi. Test temperature 158°F and applied stress of 650 psi; 5 replicates at each test condition	Determine failure time at 500 psi at 73.4°F ≥ 100 years (95% lower confidence) using 15 failure time values[4]. The tests for each condition can be terminated at duration equal to or greater than the following criteria: 110 hr at 176°F 650psi 430 hr at 176°F 450 psi 500 hr at 158°F 650 psi
		Single Test[5]: Test temperature 176°F and applied stress of 650 psi.; 5 replicates	The average failure time must be equal to or greater than 110 hr

Table 1			
Longitudinal Profiles[6]	FM 5-572, Procedure C, and FM 5-573	Full Test[2,3]: Test temperature 176°F and applied stresses of 650 and 450 psi. Test temperature 158°F at applied stress of 650 psi; 5 replicates at each test condition	Determine failure time at 500 psi at 73.4°F ≥ 100 years (95% lower confidence) using 15 failure time values[4]. The tests for each condition can be terminated at duration equal to or greater than the following criteria: 110 hr at 176°F 650psi 430 hr at 176°F 450 psi 500 hr at 158°F 650 psi
		Single Test[5]: Test temperature 176°F and applied stress of 650 psi.; 5 replicates	The average failure time must be equal to or greater than 110 hr
Oxidation Resistance of Pipes			
Pipe Location	Test Method	Test Conditions	Requirement
Liner and/or Crown[7]	OIT Test (ASTM D- 3895)	2 replicates (to determine initial OIT value) on the as manufactured (not incubated) pipe.	25 minutes, minimum
Liner and/or Crown[7]	Incubation test FM 5-574 and OIT test (ASTM D-3895)	Three samples for incubation of 195 days at 176°F[8] and applied stress of 250 psi. One OIT test per each sample	Average of 3 minutes[9, 10] (no values shall be less than 2 minutes)
Liner and/or Crown[7]	MI test (ASTM D-1238 at 190°C/2.16 Kg)	2 replicates on the as manufactured (not incubated) pipe.	< 0.4 g/10 minutes
Liner and/or Crown[7]	Incubation test FM 5-574 and MI test (ASTM D-1238 at 190°C/2.16 Kg)	2 replicates on the three aged sampled after incubation of 195 days at 176°F[8] and applied stress of 250 psi	MI Retained Value[10, 11, 12] shall be greater than 80% and less than 120%.

Table 1
Note: FM = Florida Method of Test. 1. Required only when the resin used in the corrugation is different than that of the liner. 2. A higher test temperature (194º F) may be used if supporting test data acceptable to the State Materials Engineer is submitted and approved in writing. 3. Full test shall be performed on alternative pipe diameter of pipe based on wall profile design, raw material cell classification, and manufacturing process. Full test must be performed on maximum and minimum pipe diameters within a manufacturing process. 4. Computer program to predict the 100 year SCR with 95% lower confidence can be obtained from FDOT. 5. Single test for the junction and longitudinal profile may be used on alternating pipe sizes within a manufacturing process. Single point tests may not be used on maximum and minimum pipe sizes within a manufacturing process except by approval of the Engineer. Single point tests may be used for quality assurance testing purposes. 6. Longitudinal profiles include vent hole and molded lines. 7. OIT and MI tests on the crown are required when resin used in the corrugation is different than that of the liner. 8. The incubation temperature and duration can also be 136 days at 185oF. 9. Within each replicate set of tests, the discrepancy range shall be within 6%. If an out-of range discrepancy occurs, repeat the three OIT tests. 10. The tests for incubated and "as-manufactured" pipe samples shall be performed by the same lab, same operator, the same testing device, and in the same day. 11. Within each replicate set of tests, the discrepancy range shall be within 9%. If an out-of-range discrepancy occurs, repeat the two MI tests on the same pipe sample. If insufficient material is available, a repeat of one test is acceptable. 12. The MI retained value is determined using the average MI value of incubated sample divided by the average MI value of as-manufactured pipe sample.

948-2.3.3 Certification: Furnish to the Engineer certification from the manufacturer for each pipe diameter manufacturers LOT to be incorporated into the project that the pipe meets the requirements of these Specifications.

Manufacturers seeking evaluation of a product in accordance with Departmental procedures must submit test reports conducted by a laboratory deemed to be appropriately qualified by the Plastics Pipe Institute and acceptable to the State Materials Engineer. Submit this information to the Director, State Materials Office.

948-2.3.4 Verification Samples: Furnish verification samples as directed by the Engineer.

948-3 Filter Fabric Sock for Use with Underdrain.

For Type I Underdrain specified in the Design Standards, Index No. 286, filter sock shall be an approved strong rough porous, polyester or other approved knitted fabric which completely covers and is secured to the perforated plastic tubing underdrain in such a way as to prevent infiltration of trench backfill material.

The knitted fabric sock shall be a continuous one piece material that fits over the tubing like a sleeve. It shall be knitted of continuous 150 denier yarn and shall be free from any chemical treatment or coating that might significantly reduce porosity and permeability.

The knitted fabric sock shall comply with the following physical properties:

Weight, applied (oz./sq. yd.)	3.5 min	ASTM D-3887
Grab tensile strength (lbs.)	50 min.*	ASTM D-5034
Equivalent opening size (EOS No.)	25 min.**	Corps of Engineers CW-02215-77
Burst strength (psi)	100 min.**	ASTM D-3887
*Tested wet. **Manufacturer's certification to meet test requirement.		

The knitted fabric sock shall be applied to the tubing in the shop so as to maintain a uniform applied weight. The tubing with knitted fabric sock shall be delivered to the job site in such manner as to facilitate handling and incorporation into the work without damage. The knitted fabric sock shall be stored in UV-resistant bags until just prior to installation. Torn or punctured knitted fabric sock shall not be used.

948-4 Pipe Liner.

948-4.1 Cured-In-Place Pipe Liner: Cured-in-place pipe liner shall be continuous, resin impregnated, flexible tubing that meets the requirements of ASTM D-5813 and ASTM F-1216.

948-4.2 Deformed Pipe Liner: Deformed pipe liner shall be manufactured in an out of round state, usually collapsed circumferentially and folded on the long axis. After installation in a host pipe, the liner is rounded by means of heat and pressure to fit the host pipe. Deformed pipe liner, when installed, shall extend from one structure to the next in one continuous length with no intermediate joints.

(1) Polyethylene: Deformed polyethylene pipe liner shall meet the requirements of ASTM D-3350 or ASTM F-714 with a minimum cell classification of 335420c.

(2) Polyvinyl Chloride: Deformed polyvinyl chloride pipe liner shall meet the requirements of ASTM F-1504 and shall have a minimum cell classification of 12456b.

948-4.3 Discrete Pipe Liner: Discrete pipe liner shall be round, flexible or semi-rigid liner, manufactured in lengths that may be joined in a manhole or access pit before insertion in a host pipe.

(1) Polyethylene: Discrete polyethylene pipe liner shall meet the requirements of ASTM D-3550 or ASTM F-714 and shall have a minimum of cell classification of 335420c.

(2) High Density Polyethylene Profile Wall: Discrete high density polyethylene pipe liner shall meet the requirements of ASTM F-894 and shall have a minimum cell classification of 335420c.

(3) Polyvinyl Chloride: Discrete polyvinyl chloride pipe liner shall meet the requirements of ASTM F-789, ASTM F-794, or ASTM F-949 and shall have a minimum cell classification of 12456b.

(4) Fiberglass: Discrete fiberglass pipe liner shall meet the requirements of ASTM D-3262.

948-4.4 Spiral Wound Pipe Liner: Spiral wound pipe liner shall consist of coils of profile strips that are wound into a host pipe helically, after which a

cementitious grout is injected into the annular space between the liner and the host pipe, forming a rigid composite structure.

(1) Polyvinyl Chloride: Polyvinyl chloride spiral wound pipe liner shall meet the requirements of ASTM F-1697 or ASTM F-1698 and shall have a minimum cell classification of 12454b.

948-4.4.1 Machine Spiral Wound Pipe Liner: Machine spiral wound pipe liner shall consist of a continuous one piece profile strip wound directly into the deteriorated pipelines. The liner can be installed in close fit to the host pipe, or alternatively installed at a fixed diameter. Where the liner is installed at a fixed diameter, the annular space between the spiral wound liner pipe and the existing pipe is grouted.

(1) Polyvinyl Chloride: Polyvinyl chloride machine spiral wound pipe liner shall meet the requirements of ASTM F-1697 and shall have a minimum cell classification of 13354.

948-4.5 Paneled Pipe Liner: Paneled pipe liner consists of custom-cut flat or curved panels that are formed to the inside circumference of a host pipe.

(1) Polyvinyl Chloride: Polyvinyl chloride paneled pipe liner shall meet the requirements of ASTM F-1698 and shall have a minimum cell classification of 12454b.

948-4.6 Point Pipe Liner: Point pipe liner may consist of any materials covered by this specification when used to repair and rehabilitate an isolated portion of an existing storm drain pipe. Materials which are restricted (as primary components) to point repair are; steel, which shall meet the requirements of AASHTO M-167M, ASTM A-167, or ASTM A-240; aluminum, which shall meet the requirements of AASHTO M-196, and rubber; which shall meet the requirements of ASTM C-923.

948-4.7 Coated Pipe Liner: Coated pipe liner consists of liquid, slurry, foam or gel that is spread or sprayed over the interior surface of an existing pipe to rehabilitate it. Materials that may be used for coating are hydrophilic urethane gel, epoxy resin, polyester resin, gunite, shotcrete, low density cellular concrete, and cementitious grout.

SECTION 949
BRICK AND CONCRETE MASONRY UNITS FOR MANHOLES, INLETS AND OTHER STRUCTURES

949-1 Clay Brick and Shale Brick.

This brick shall meet the requirements of AASHTO M-114, for Grade MW.

949-2 Concrete Brick.

Concrete brick shall meet the requirements of ASTM C-55 for Grade S-II.

949-3 Concrete Masonry Units.

Concrete masonry units for use in manholes, inlets and similar structures shall meet the requirements of ASTM C-139.

When the masonry units are produced by a manufacturer exercising quality control procedures acceptable to the Department, such units may be accepted on

the basis of six test certificates furnished to the Department. Such certificates shall be signed by an authorized agent of the manufacturer, and identified by project number.

SECTION 951
INSPECTION OF TIMBER PRODUCTS

951-1 Control of Quality.

All timber products manufactured for incorporation into the work shall be produced by a producer/treater approved by the Department for such production. If approval is withdrawn by the Department during production for a construction project, it is the Contractor's responsibility to (a) obtain another approved producer/treater to produce the timber products, or (b) await reestablishment of approval of the disapproved producer/treater. Cost or delays associated with producer/treater approval or disapproval shall be borne by the Contractor.

The producer/treater of timber products shall exercise quality control through an approved Quality Control Plan conforming to Section 6-8. Products produced under this Quality Control Plan will not relieve the Contractor of his responsibility for unsuitable materials or workmanship, which might become apparent at the job site, nor of the necessity of his replacing any material which might be determined upon subsequent inspection to be unsuitable.

951-2 Preparations Prior to Requesting Inspection.

Prior to the requested time of inspection for approval of a producer/treater, the authorities of the treating plant shall become knowledgeable with the most current requirements of the Department's Specifications as appropriate to his production/treatment. The producer/treater shall make his facility totally accessible to appropriate Department's inspection personnel. Such access for inspection shall include, but not be limited to, all physical artifacts and processes, materials records and copies of certified shipping documents (such as a treatment certification, a treating report, and an assay report). All calls for inspections shall be made at least two weeks in advance.

Upon approval of a producer/treater facility, the Department will inspect the facility periodically for continued approval.

951-3 Certification.

Each order/shipment to the job site must be accompanied with a notarized certification indicating compliance to the appropriate specifications. The certification shall include: the project/order number, charge numbers, and assay retention results. The producer/treater shall maintain all pertinent documents for a period of three years. Each timber product must also have a preapproved producer/treater identification mark on every item delivered to the job site.

SECTION 952
STRUCTURAL TIMBER

952-1 General Specifications for All Structural Timber.

This Section specifies the requirements for pine timber to be used as structural members in the Department's work, including untreated timber as well

as timber to be treated. All such timber shall be manufactured and graded in accordance with the current edition of the Standard Grading Rules for Southern Pine Timber, of the Southern Pine Inspection Bureau. The requirements of No. 1 dense shall apply to this timber.

952-2 Timber for Other Specific Uses.

952-2.1 Specification Grade: For timber to be used for columns, sills, wheelguards, bulkhead, sheeting, bracing, fender wales, or any other purpose for which the grade is not specified otherwise, the specification grade shall be as follows:

Nominal Thickness	Nominal Width	Grade
1 to 1.5 inches	2 inches and wider	No. 1 Boards
2 to 4 inches	2 inches and wider	No. 1 Dimension
5 inches and larger	5 inches and larger	No. 2 Timbers

952-2.2 Permissible Knot Sizes for Fender Wales: For timber used as fender wales, the maximum permissible size of knot (at any point on any face) shall be as follows:

For nominal width of face of 10-3 3/4 inches.
For nominal width of face of 12-4 1/2 inches.

952-3 Untreated Pine Timber - Specific Requirement for Heartwood.

In addition to meeting all of the requirements of 952-1 and 952-2, pine timber which is to be used as untreated timber will be required to show at least 85% of heartwood on any girth.

SECTION 953
TIMBER PILING
(Including Timber Sheet Piling)

953-1 General.

Piles shall be of timber which will stand the driving for which they are intended. They shall be sound and solid. Piling cut from southern pine shall contain at least 30% of summer wood.

Cypress piles used for purposes other than as foundation piling shall have, at the butt, a diameter of red or black heart of at least 12 inches.

Douglas fir used for timber piling shall be Pacific Coast Douglas Fir.

Piles shall be cut above the ground swell, shall have a form taper, and shall not vary more than ±6 inches from the specified length.

Specific requirements for timber sheet piles are contained in 953-6, herein.

953-2 Diameter of Butt and Tip.

For round piles the minimum butt diameter shall be 12 inches, measured at a section 3 feet from the end.

For piles up to 50 feet in length the minimum tip diameter shall be 8 inches. For lengths in excess of 50 feet, a graduated reduction in tip diameter at the rate of 1 inch for each 10 feet of length in excess of 50 feet will be permitted. This reduction will correspond to 7 inch tips for 60 foot piles and 6 inch tips for 70 foot pile; at which length these allowable reductions shall cease. As an exception to the above, when so shown in the plans, 7 inch diameter tips on timber piles less than 60 feet in length will be accepted. No piles shall have tips less than 6 inches in diameter. The maximum diameter at the cut-offs shall be 20 inches.

953-3 Straightness Requirements.

A straight line drawn from the center of the butt to the center of the tip shall not, at any point, fall further away from the center of the pile than a distance equal to 1% of the length of the pile.

The surface of the pile shall not contain kinks greater than 1 inch in 5 feet, as measured by a straightedge.

953-4 Peeling and Trimming.

The pile shall be peeled soon after cutting. In the operation of removing the bark from the pile, not more than three annual rings of the solid wood shall be removed. All knots shall be trimmed close to the body of the pile.

953-5 Permissible Knots and Other Defects.

The diameter of sound knots shall not exceed one-third of the diameter of the pile at the point where the knot occurs.

In these specifications a sound knot shall be defined as a knot which is solid across its face, is as hard as the surrounding wood and shows no indication of decay. It may vary in color from red to black and may contain a pith hole not more than 1/4 inch in diameter.

An unsound knot may or may not be as hard as the surrounding wood, but contains decay, and will be allowed only in accordance with the restrictions in ASTM D-25.

Any defect, or combination of defects, which would be more injurious than the maximum allowable knot will not be acceptable.

Turpentine cuts will be allowed on all timber piles provided that no single cut shall exceed one-half of the circumference of the pile, and that the length of the cut shall not be more than 15% of the length of the pile. Piles to be used as outside piles in timber bents shall not have more than one turpentine cut.

953-6 Timber Sheet Piles.

Unless a particular species of timber is called for in the plans, timber sheet piles may consist of any species which will satisfactorily stand driving. They shall be sawn with square corners and shall be free from worm holes, loose knots, wind shakes, decayed or unsound portions, and other defects which might impair the strength or tightness.

The piles shall be of the dimensions shown in the plans and shall be treated in accordance with Section 955.

SECTION 954
TIMBER FENCE POSTS AND BRACES

954-1 Types of Timber, and Treating Requirements.

Timber fence posts and braces shall be of southern yellow pine and shall be treated in accordance with Section 955.

Prior to the treatment, all knots on the posts shall be trimmed close to the body of the post.

954-2 Requirements for Cutting.

Round or square posts will be permitted but all posts on a single project shall be the same. The posts shall be cut from sound and solid trees and shall contain no unsound knots. The butt shall be cut at a sufficient distance above the ground swell of the tree that there will be no abrupt change in cross-section of the post.

The butts shall be sawn square. The post tops shall be sawn neatly and at right angles to the vertical axis of the post.

954-3 Knots, etc.

Sound knots will be permitted provided the diameter of the knot does not exceed one third of the diameter of the piece at the point where it occurs.

Peck (in cypress posts) shall be limited as provided for knots; the area of permissible peck not exceeding the area occupied by permissible knots, and a combination of peck and knots not exceeding the aggregate of knots allowed.

The posts shall be free from decayed wood, rot, and red heart, and of ring shake or season checks which penetrate at any point more than one fourth the diameter of the piece, or are greater than 1/4 inch wide.

954-4 Peeling.

All posts shall be peeled for their full length, and all inner and outer bark removed, except that isolated strips of inner bark which do not exceed 1/2 inch in width or 3 inches in length will be permitted.

954-5 Straightness.

The straightness of the post shall be such that for any 8 foot post (or for any 8 feet of length, for longer posts) a straight line from the center of the tip to the center of the butt (or from center of the cross sections at the extremes of the 8 foot lengths) shall not fall outside the center of the mid-section of the 8 foot length by more than 2 inches.

954-6 Dimensions.

954-6.1 Minimum Lengths Allowable:

Line posts - 8 feet.

Corner and pull posts - 8 feet, 6 inches.

Braces - As required by plans.

(A tolerance of -1 inch +2 inches will be allowed in the lengths shown for the posts.)

954-6.2 Minimum Allowable Cross Section:

Round line posts - 4 inch diameter.

Round braces, corner and pull posts - 5 inch diameter.
Square line posts - 4 by 4 inches.
Square braces, corner and pull posts - 5 by 5 inches.

The minimum diameters specified for round posts are applicable before preservative treatment. When the treated post is inspected at the job site a tolerance of 3/8 inch under such diameters will be allowed, to compensate for shrinkage resulting from treatment and storage.

SECTION 955
TIMBER TREATMENT
(INCLUDING TREATING MATERIALS)

955-1 General.

The work specified in this Section is the treating of structural timber, timber piling and timber posts. The method of treatment for all such timber materials shall be in accordance with the American Wood Preservers' Association (AWPA) Use Category Standard (USC) - U1, with the exceptions and additions as specified herein.

955-2 Preservative.

955-2.1 Salt or Brackish Water Use: The treating of Southern Yellow Pine (SYP) lumber or timber for use in salt or brackish water environments shall be done with Chromated Copper Arsenate (CCA).

955-2.2 Above Ground or Ground Contact and Fresh Water Immersion Use: The treating of SYP lumber and timber for above round or ground contact and fresh water immersion applications, shall be done with Copper Azole-Type B (CA-B), Amine Copper Quat-Type D (ACQ-D), or CCA, with the following exceptions:

Treatment of the wood products of the pedestrian bridges, wood rails at buildings or rest areas, and fence posts shall be done either with Copper Azole-Type B (CA-B) or Amine Copper Quat-Type D (ACQ-D).

955-3 Process.

All timber and lumber items shall be treated in accordance with standard T1 of the AWPA manual.

955-4 Requirements for Preservative Materials.

Amine Copper Quat-Type D (ACQ-D), Chromated Copper Arsenate (CCA), Copper Azole-Type B (CA-B), Ammoniacal Copper Zinc Arsenate (ACZA) shall be in accordance with AWPA P5.

955-5 Requirements for Retainment.

955-5.1 Piling: A minimum of 2.50 lb/ft^3 of CCA oxides shall be retained in zone 1, outer 0.50 inch, and 1.5 lb/ft^3 in zone 2, outer 0.50 to 2 inches.

If ACZA is used, a minimum of 2.50 lb/ft^3 shall be retained in zone 1, outer 0.50 inch, and 1.5 lb/ft^3 in zone 2, outer 0.50 to 2 inches.

955-5.2 Structural Timber and Sheet Piles: When installation is not in a salt (or brackish) water environment, the minimum retention shall be 0.60 lb/ft^3 of CCA or ACQ-D or 0.31 lb/ft^3 CA-B, as determined by cores from the outer 0.60 inch. When installation is in a salt (or brackish) water environment, a minimum of 2.50 lb/ft^3 of CCA oxides shall be retained in the outer 0.60 inch.

All guardrail material (timber posts, blocks, wedges, etc.) shall retain a minimum of 0.40 lb/ft^3 of CCA or ACQ-D or CA-B at 0.21 lb/ft^3 in the outer 1 inch zone.

955-5.3 Posts: Round/sawn timber fence posts shall retain a minimum of 0.40 lb/ft^3 of ACQ-D or 0.21 lb/f^{3}of CA-B in the outer 1 inch zone.

955-5.4 Determination of Retention: Retention shall be determined by assay performed and certified by the treating company in accordance with the applicable AWPA standards.

955-6 Penetration Requirements.

955-6.1 For Structural Timber: The penetration of the treatment shall be in accordance with the applicable AWPA standards, with the exceptions as specified herein.

955-6.2 For Round Piles and Fence Posts: Any round pile or post, which does not show complete sapwood penetration will be rejected or shall be retreated to meet such penetration requirement.

955-6.3 Retreatment: The necessity for retreatment of structural timber, piling and posts shall be avoided as far as practicable and if it becomes apparent that due measures are not being taken to prevent such necessity, the acceptance of retreated materials may be withdrawn.

When retreatment is necessary the maximum limits for temperature of steam or preservative, and for preservative pressure, which apply to the original treatment shall not be exceeded during the retreatment.

955-6.4 Determination of Penetration: Sapwood penetration shall be determined by taking at least one increment boring core from each pile and cap, and other pieces of similar dimensions and, for other sizes of material, at least one boring from the charge for each 1,000 FBM in the charge. All bored holes shall be immediately plugged, with tight fitting treated plugs.

955-7 Handling Salt Treated Piling.

In handling of piles that have been treated with chromated copper arsenate or ammoniacal copper arsenate, cable slings shall be used. Mechanical grabbers or pointed tools shall not be permitted. Rough or careless handing shall be avoided at all times.

955-8 Identification of Treating Plants for Round Piling.

The treating plant shall brand, or place a distinctive permanent mark, on each round pile, approximately 6 feet from the butt end, such that the plant responsible for the treatment can be readily determined at any time during the service life of the piling.

SECTION 962
STRUCTURAL STEEL AND MISCELLANEOUS METAL ITEMS (OTHER THAN ALUMINUM)

962-1 Structural Steel.

962-1.1 Structural Steel Materials: Unless otherwise specified in the Contract Documents, provide structural steel for bolted or welded construction in accordance with Structural Steel for Bridges, ASTM A-709. If the grade is not shown in elsewhere in the Contract Documents, provide the grade as directed by the Engineer. All grades, as specified in the Contract Documents, are to conform to ASTM A-709, as shown in Table 962-2.1 below:

Table 962-2.1 – Structural Steel Materials

ASTM A-709 Grade	Product Form*	Yield Strength (ksi)	Tensile Strength (ksi)
36	P, S, B	36 min	58-80
50	P, S, B	50 min	65 min
50W	P, S, B	50 min	70 min
50S	S	50-65	65 min
HPS 50W	P, S	50 min	70 min
HPS 70W	P	70 min	85-110
100 [690](to 2-1/2 in) (over 2-1/2 in)	P	100 min 90 min	130 min 130 min
100W [690W](to 2-1/2 in) (over 2-1/2 in)	P	100 min 90 min	130 min 130 min

* P = plates, S = structural shapes, B = bars

962-1.2 Testing: For structural steel subjected to tensile stress used for main load-carrying members or components (as defined in Section 460), meet the ASTM A-709 impact test requirements in Table 9 (Non-Fracture Critical Tension Components) or Table 10 (Fracture Critical Tension Components) as specified in the Contract Documents. Meet the requirements for Zone 1 (Minimum Service Temperature 0ºF).

If not specified elsewhere in the Contract Documents, provide structural steel in accordance with Table 9 or Table 10 as directed by the Engineer.

962-2 Steel Castings.

962-2.1 Carbon Steel Castings: Provide carbon steel castings that conform to the requirements of ASTM A-27. Unless otherwise specified in the Contract Documents, all castings are to be Grade 65-35 or Grade 70-36.

962-2.2 Corrosion Resistant Steel Castings: Provide corrosion resistant Iron-Chromium or Iron-Chromium-Nickel castings that conform to the requirements of ASTM A-743. Unless otherwise specified in the Contract Documents, all castings are to be Grade CA 15M.

962-3 Steel Forgings.

Provide steel forgings from which pins, rollers, trunnions, shafts, gears, or other forged parts are fabricated that conform to ASTM A-668. Unless otherwise specified in the Contract Documents, all forgings are to be Class C, D, F, or G.

962-4 Iron Castings.

962-4.1 Gray Iron Castings: Provide gray iron castings that conform to the requirements of ASTM A-48. Unless otherwise specified in the Contract Documents, provide gratings, manhole covers and frames to Class 35B and machinery parts to Class 30. For manholes constructed within the area of vehicular traffic, the frames and gratings shall be machine ground so the irregularity of contact will be minimized and the grates will be rattle-proof.

962-4.2 Ductile Iron Castings: Provide ductile iron castings that conform to the requirements of ASTM A-536. Unless otherwise specified in the Contract Documents, provide castings to Grade 414-276-18. In addition to the specified test coupons, test specimens from parts integral with the castings, such as risers, are to be tested for castings with a mass more than 1,000 pounds to determine that the required quality is obtained in the castings in the finished condition.

962-4.3 Malleable Iron Castings: Provide malleable iron castings that conform to the requirements of ASTM A-47. Unless otherwise specified in the Contract Documents, provide castings to Grade 24118.

962-5 Bolts, Nuts and Washers Not Designated as High-Strength.

Provide bolts that conform to the requirements of ASTM A-307 or ASTM A-449. Provide nuts that conform to the requirements of ASTM A-563 and washers that conform to ASTM F-436, unless specified as ordinary rough or machine bolts as approved by the Engineer. Washers provided to ASTM F-844 and nuts to ASTM A-194 may be used with the Engineer's approval.

Use double nuts, when ordinary rough or machine bolts are specified in the Contract Documents.

962-6 High-Strength Bolts, Nuts, Washers and Direct-Tension-Indicator (DTI) Devices.

Use high strength bolts, nuts, washers and DTI devices meeting the following requirements:

Bolts: ASTM A-325 or A 490, Heavy Hex. Only use ASTM A-490 high strength bolts with the approval of the Engineer.

Nuts: ASTM A-563, Heavy Hex. Select nuts in accordance with ASTM A-325 (Subsection 3.2). If grade C, D or C3 nuts are selected, provide with a minimum Rockwell hardness of 89 HRB or a minimum Brinell hardness of 180 HB. Use nuts meeting the requirements of ASTM A-194 only when approved by the Engineer.

Washers: ASTM F-436 and ASTM A-325 (Subsection 3.3). Use washers meeting the requirements of ASTM F-844 only when approved by the Engineer.

Identifying Marks: in accordance with ASTM A-325, ASTM A-490 and ASTM A-563.

DTI devices: meeting the requirements of ASTM F-959. Furnish plain DTI devices for use with plain bolts if the finish coat of paint is applied after installation and testing of the DTI device and will cover the remaining gap. Otherwise, coat the DTI device in accordance with the manufacturer's recommendations.

When the Contract Documents call for uncoated weathering steel in any component of the connected part, provide Type 3 bolts and washers, and nuts with weathering characteristics. If one side of the assembly is coated and the other exposed weathering steel, coat the fastener assembly on the coated side similarly (Such as the case for weathering steel tub girders coated on the inside only).

Ensure that fastener assemblies are properly lubricated in accordance with ASTM A-563 Supplementary Requirements S1 and S2.

962-7 Anchor Rods and Bridge Bearing Materials.

Provide anchor rods, washers, masonry plates, bearings and other miscellaneous metal components that conform to the following requirements:

Provide anchor rods that conform to the requirements of ASTM F-1554 unless the Engineer approves the use of anchor rods meeting the requirements of ASTM A-307, with nuts that meet the requirements of ASTM A-563, Hex Nuts, Heavy and with a finish consistent with the rod. Nuts meeting the requirements of ASTM A-194 may be used only with the Engineer's approval.

Use washers meeting the requirements of ASTM F-436, with a finish consistent with the rod. Washers meeting the requirements of ASTM A-844 may be used only with the Engineer's approval.

962-8 Miscellaneous Metal Items.

Unless otherwise specified in the Contract Documents, provide the following specific materials.

962-8.1 Pipe Railings: Provide steel pipe conforming to the requirements of ASTM A-53 for Standard Weight Pipe.

962-8.2 Steel Sheet Piling: Provide steel sheet piles conforming to the requirements of ASTM A-328 or ASTM A-709, Grade 50. Provide ASTM A-572 with the approval of the Engineer.

962-8.3 Steel Sign Supports and Accessories: Provide steel members for sign supports that meet the material requirements specified in the Contract Documents.

962-8.4 Structural Tubing:

962-8.4.1 Materials: Provide steel structural tubing as one of the following:

Cold-formed, welded or seamless conforming to the requirements of ASTM A-500, Grade B or C, coated in accordance with the Contract Documents;

Hot-formed, welded or seamless tubing conforming to the requirements of ASTM A-501, coated in accordance with the Contract Documents;

ASTM A-847 when weathering characteristics are required; or

As indicated elsewhere in he Contract Documents.

962-8.4.2 Testing: Structural steel tubing subjected to tensile stresses used in main load carrying members or components (as defined in Section 460) shall meet the requirements of ASTM A-709 Table 9 (Non-Fracture Critical Members) or Table 10 (Fracture Critical Members) for Zone 1. Minimum Average energy shall be: 15 ft-lbf at 70°F (Table 9); or 25 ft-lbf at 70°F (Table 10).

962-8.5 Steel for Concrete Reinforcement: Requirements for concrete reinforcement are contained in Section 931.

962-8.6 Steel Guardrail: Requirements for steel guardrail are contained in Section 967.

962-8.7 Field Splice Filler Materials: Provide field splice filler materials in accordance with the Contract Documents. If unspecified and less that 3/16 inch thick provide ASTM A-606 or ASTM A-1011.

962-8.8 Steel Pipe Piling: Provide seamless, or longitudinal or helical welded pipe conforming to the requirements of API 5L Grade L320, X46 or higher, or ASTM A-252 Grade 3. Provide longitudinal or helical welded pipe with only complete joint penetration (CJP) welds conforming to the requirements of API 5L or AWS D1.1.

962-9 Galvanizing.

962-9.1 Plates, Structural Shapes, Bars, and Strip: When galvanizing is specified in the Contract Documents for ferrous metal products, other than fasteners and hardware items, provide galvanizing in accordance with the requirements of ASTM A-123, Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

962-9.2 Fasteners and Hardware: When zinc coating is required in the Contract Documents, fasteners and hardware items shall be galvanized in accordance with the requirements of ASTM A-153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware, except for high strength fasteners as noted below:

1. Do not galvanize ASTM A-490 bolts.
2. Mechanically galvanize ASTM A-325 Type 1 bolts in accordance with ASTM B-695, Class 50.
3. For all anchor rods and hardware treat the coated rods, nuts and washers with chromate after coating in a water solution containing 0.2% sodium dichromate 3 ounces/10 gallons. Coat the bolt, nut and washer used in the fastener assembly by the same zinc process, and provide a test report on the zinc coating thickness.
4. For anchor rods fabricated from material having a yield strength greater than 80,000 psi apply an electroplated zinc coating SC 3, Type II in accordance with ASTM B-633.

962-9.3 Qualifications of Galvanizer: Use Galvanizer's listed on the Department's Qualified Providers List. Listing must occur prior to commencing the work.

962-10 Certifications and Verification.

962-10.1 General: Supply a Certified Mill Analysis to the Engineer for all metal materials to be used in fabrication, including but not limited to plates, bars, shapes, and fasteners in accordance with their respective ASTM or AASHTO specification. Show or attach the full and complete designation of the project for which the materials are intended for use and specifically cross-identify each furnished piece to the order material.

Material meeting equivalent AASHTO and ASTM specifications may be supplied under either specification. Provide materials in accordance with the latest edition of the specifications shown below, as approved by the Engineer.

962-10.2 Conformance: The Certified Mill Analysis will indicate that the material is in conformance with the applicable material specification and will include actual values from required tests. Check the Certified Mill Analysis against the appropriate specification to ensure that materials conform to Contract Documents.

962-10.3 Certified Mill Analysis Source: The Certified Mill Analysis must originate from the producer of the material and not from a supplier. Material from stock may only be accepted if it can be positively identified and the appropriate documentation is provided.

962-10.4 Verification Samples: Provide verification samples in accordance with Section 6.

962-11 Heat Treatments.

Provide procedures and perform heat treatments in accordance with Section 460.

SECTION 965
GENERAL PROVISIONS FOR ALUMINUM ITEMS
(Including Welding)

965-1 Surface Appearance and Protection.

The exterior surfaces of aluminum castings, pipes, tubes, formed sheets, and structural shapes shall, when placed in the work, have a clean, uniform silvery appearance, free of dark streaks and discoloration.

Aluminum members (including specifically aluminum light poles and signs poles) which are of such size or shape that the surfaces might be marred during transit and prior to their being installed, shall be appropriately and adequately protected against such damage, by wrapping with paper or by other effective means.

965-2 Certification and Mill Analysis.

For aluminum materials used, submit to the Engineer, prior to installation, a certified mill analysis and certification by the producer that the parts and components are of the alloys specified and comply with the requirements of this Section.

965-3 Welding Aluminum Sign Structures.

The proportioning of weld details and the operation of welding, for aluminum sign structure, shall be in accordance with Section 5 of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals; ANSI and AWS D1.2 "Structural Welding Code - Aluminum", including the requirements for qualifications of procedures and welders, as specified therein.

(a) Alloys: The aluminum alloys to welded under these specifications may be any of the following alloys:

Wrought Nonheat-treatable Alloys:

Alloy 3003
Alloy Alclad 3004
Alloy 5052
Alloy 5083
Alloy 5086
Alloy 5456

Wrought Heat-treatable Alloys:

Alloy 6061
Alloy 6063
Cast Heat-treated Alloy
Alloy SG-70A (ASTM Designation)

(b) Filler Metals: The filler metals to be used with particular base metals shall be as shown in the table below except that other filler metals may be used if approved by the Engineer.

Base Metal	Filler Metal
3003 to 3003	ER1100
Alclad 3004 to Alclad 3004	ER4043
5052 to 5052	ER5356*
5083 to 5083	ER5183
5086 to 5086	ER5356*
5456 to 5456	ER5556
6061 to 6061	ER5356*
6063 to 6063	ER5356*
SG-70A to 6061	ER4043
SG-70A to 6063	ER4043
*ER5183, ER5356, and ER5556 may be used interchangeably for these base metals.	

965-4 Welding Aluminum Structures Other Than Sign Structures.

The welding of aluminum structures, other than sign structures, such as aluminum bridge and railing structures and their aluminum components, shall be in accordance with ANSI and AWS D1.2 "Structures Welding Code-Aluminum", including the requirements for qualifications of procedures and welders, as specified therein.

SECTION 967
RAIL ELEMENTS FOR GUARDRAIL

967-1 Steel Guardrail.

Steel guardrail materials shall meet the requirements of AASHTO M-180, (except as specified below), and for either Class shown. Type 2 zinc coating will be required.

As an exception to the requirements of AASHTO M-180, the coating properties, sampling, test methods, inspection, and certification related to galvanizing regardless of the method of galvanization of the rail elements shall meet the requirements of ASTM A-123.

All supports, fastenings and other accessories, including bolts, nuts, washers, etc., (and including the steel trailing end-anchorage rods required to be used with aluminum guardrail) shall be galvanized as specified in ASTM A-153.

Acceptance of steel guardrail materials shall be based on manufacturer's certified mill analysis of test results meeting the specification limits of the ASTM or AASHTO designation as stated above. Certification of these test values, representing each shipment of guardrail materials, shall be provided to the Engineer for each project.

SECTION 970
MATERIALS FOR RAISED RETRO-REFLECTIVE PAVEMENT MARKERS AND BITUMINOUS ADHESIVE

970-1 Raised Retro-Reflective Pavement Markers.

970-1.1 Composition: The marker shall consist of materials conforming to ASTM D-4280.

970-1.2 Physical Requirements: The physical size of the RPM shall conform to the requirements of ASTM D-4280. Laboratory and field samples for RPMs and bituminous adhesives shall meet the requirements of ASTM D-4280 and include the following requirements:

The minimum area of each reflective face shall be 2.5 in^2. The minimum base size shall be 12 in^2.

970-1.2.1 Designation of Marker Type, Color and Classification: The marker description shall be in order of type, color and reflective surface condition in accordance with ASTM D-4280 and the following chart.

RPM Class			
Class	Description	Expected Normal Service	ASTM Surface Designation
A	Temporary marker	Up to six months	none
B	Permanent marker	Long life	H, hard abrasion resistant lens
D	Work zone marker	Per project requirement	none
E	Temporary work zone	Up to five days	none

970-1.3 Performance Requirements: The RPM shall meet the performance requirements specified in ASTM D-4280, Section 6.2, for luminous intensity, flexural strength, compressive strength, resistance to cracking, and thermal cycling, as modified herein. Test method FM 5-566 will be used to evaluate marker performance.

970-1.3.1 Class A Markers: Meet the coefficient of luminous intensity requirements of ASTM D-4280. Abrasion treatment is not required for Class A Markers.

970-1.3.2 Class B (Abrasion Resistant) Markers: Meet the coefficient of luminous intensity requirements of ASTM D-4280 after abrasion. Each marker shall be marked as abrasion resistant by the manufacturer.

970-1.3.3 In-service Minimum Reflective Intensity: The Class B reflective pavement marker shall retain a minimum coefficient of luminous intensity for 18 months of not less than 30% of the values shown in Table 1 of ASTM D-4280, and a minimum luminous intensity of 0.2 cd/fc at the end of two years.

970-1.4 Application Properties: Application properties shall meet the requirements of Section 706.

970-1.5 Packaging and Labeling: Shipment shall be made in containers which are acceptable to common carriers and packaged in such a manner as to ensure delivery is in perfect condition. Each package shall be clearly marked as to the name of the manufacturer, type, color, quantity enclosed and date of manufacture. Show the designation of the marker in accordance with ASTM D-4280.

970-2 Bituminous Adhesive for Pavement Markers.

970-2.1 General: Bituminous adhesive as recommended by the marker manufacturer shall be used for bonding the markers to the pavement.

970-2.2 Specific Requirements for Bituminous Adhesives: The bituminous adhesive shall meet the properties of adhesives per ASTM D-4280 Section A1, including filler-free and filler alone properties.

970-2.3 Performance Requirements: The performance of the adhesive shall be determined in accordance with the test methods listed in ASTM D-4280.

970-3 Product Acceptance on the Project.

Acceptance will be made in accordance with the requirements of Section 706. Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6.

SECTION 971
TRAFFIC MARKING MATERIALS

971-1 General Requirements.

971-1.1 Packaging and Labeling: All traffic marking materials shall be shipped in strong containers plainly marked with the weight in pounds per gallon, the volume of traffic marking materials content in gallons, the color, user information, date of manufacture, LOT, batch and DOT code number. Each batch manufactured shall have a unique number. A true statement of the percentage composition of the pigment, the proportion of pigment to vehicle, and the name and address of the manufacturer, also shall be shown. The label shall warn the user of any special handling or precautions of the material, as recommended by the manufacturer. Any package not so marked will not be accepted for use under these specifications.

Preformed thermoplastic materials and permanent tape products shall be marked with content, color, date of manufacture and lot number.

971-1.2 Storage: Any traffic marking materials which, although inspected and approved at the point of manufacture, hardens or livers in the containers so that it cannot be readily broken up with a paddle to a smooth, uniform painting consistency, will be rejected. All materials shall have a container storage life of one year from date of manufacture. Any traffic marking materials not acceptable for proper application will be rejected, even though it conforms to these Specifications in all other respects.

971-1.3 Mixing: All paints shall be delivered to the project completely mixed, and ready to be used without additional oil or thinner. Gasoline shall not be used for thinner under any circumstances.

971-1.4 Qualified Products List: All traffic marking materials shall be one of the products listed on the Qualified Products List (QPL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6 accompanied by a copy of the infrared identification curve (2.5 to 15 μm) for the vehicle component. Products may only be used for applications recommended by the manufacturer. A notation of the number of coats and the thickness of each coat at which the product passes testing may be placed on the QPL. When listed, this will be the minimum criteria for application of the traffic marking material.

971-1.5 Samples: Field samples will be obtained in accordance with the Department's Sampling, Testing and Reporting Guide Schedule.

971-1.6 Color: Materials for pavement markings shall meet the following performance requirements.

The initial daytime chromaticity for yellow materials shall fall within the box created by the following coordinates:

Initial Daytime Chromaticity Coordinates (Corner Points)

	1	2	3	4
X	0.530	0.510	0.455	0.472
Y	0.456	0.485	0.444	0.400

The in-service daytime chromaticity for yellow materials shall fall within the box created by the following coordinates:

In-Service Daytime Chromaticity Coordinates (Corner Points)

	1	2	3	4
X	0.530	0.510	0.435	0.449
Y	0.456	0.485	0.429	0.377

The nighttime chromaticity for yellow materials shall fall within the box created by the following coordinates:

Nighttime Chromaticity Coordinates (Corner Points)

	1	2	3	4
X	0.575	0.508	0.473	0.510
Y	0.425	0.415	0.453	0.490

971-1.7 Additional Requirements: Traffic stripe materials shall be characterized as non-hazardous as defined by Resource Conservation and Recovery Act (RCRA) Subarticle C rules, Table 1 of 40 CFR 261.24 "Toxicity Characteristic". Traffic stripe materials shall contain no more than 3.0 ppm lead by weight in a cured state when tested by EPA methods 050 and 6010.

The material shall not exude fumes which are hazardous, toxic or detrimental to persons or property.

971-2 Glass Spheres.

971-2.1 General Requirements: Glass spheres shall be of a composition designed to be highly resistant to traffic wear and to the effects of weathering for the production of a reflective surface, creating night visibility of the pavement markings without altering day visibility of the marking. The general requirements of 971-1 apply to glass spheres.

The glass spheres shall conform to the requirements of AASHTO M-247 and FP 96.

971-2.2 Specific Properties: The large (Type 3 or larger) glass spheres used for drop on beads shall have an adhesion coating. Type 1 glass spheres used for drop on beads shall have a dual coating. Beads used in the intermix of materials are not required to be coated.

The following physical requirements apply:

Property	Test Method	Specification
Gradation	ASTM D-1214	AASHTO M-247 & FP
Roundness	ASTM D-1155	Min: 70 % true spheres by weight per sieve size
Refractive Index	Becke Line Method (25+/-5C)	1.5 minimum

Sieve Size	Percent by Mass Passing Designated Sieve (ASTM D-1214)			
	Grading Designation			
	Type 1 (AASHTO)	Type 3 (FP 96)	Type 4 (FP 96)	Type 5 (FP 96)
No. 8				100
No. 10			100	95 – 100
No. 12		100	95 – 100	80 – 95
No. 14		95 – 100	80 – 95	10 – 40
No. 16	100	80 – 95	10 – 40	0 – 5
No. 18		10 – 40	0 – 5	0 – 2
No. 20	95 - 100	0 – 5	0 – 2	
No. 25		0 – 2		
No. 30	75 – 95			
No. 40				
No. 50	15 – 35			
No. 80				
N0. 100	0 – 5			

Provide the Engineer Certified test reports from the manufacturer confirming that all glass spheres conform to the requirements of this Section.

971-2.3 Sampling:

971-2.3.1 Sampling: A random 50 lb sample of glass spheres shall be obtained for each 50,000 lb shipped. Upon arrival, the quantity of material will be reduced in a sample splitter to a size of approximately 1 quart by the Engineer, or one 50 lb unopened bag.

971-2.3.2 Containers: The spheres shall be furnished in new 50 lb moisture-proof bags. All containers shall meet ICC requirements for strength and type and be marked in accordance with AASHTO 247 Part 5.

971-3 Fast Dry Traffic Paint - Water Borne.

971-3.1 General: Fast dry traffic paints intended for use under this Specification shall include water reducible products that are single packaged and ready mixed. Upon curing, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The material shall have the capability of being cleaned and flushed from the striping machines using regular tap water and any required rust inhibitors. The manufacturer shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification and Section 710 shall apply regardless of the type of formulation used. The material shall be free from all skins, dirt and foreign objects.

971-3.2 Composition:

Component	Test Method	Criteria
Total Solids, by weight	ASTM D-2369	minimum 75%
Pigments, by weight	ASTM D-3723	minimum 57%
Vehicle Solids % on Vehicle*		minimum 40%
TiO_2, Type II Rutile (white paint only)	ASTM D-476	minimum 1.5 lb/gal
Volatile Organic Content, (VOC)	ASTM D-3960	maximum 150 g/L
* % total solids - % pigment 100 - % pigment		

971-3.3 Physical Requirements: The material shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Density	ASTM D-1475	13.5 ± 1.4 lb/gal	-
Consistency at 77ºF	ASTM D-562	80 KU	100 KU
Fineness of Grind	ASTM D-1210	2(HS)	3(HS)
Dry Opacity at 5 mils WFT	Fed Std 141a Method 4121	0.96	-
Bleed Ratio	Fed Spec TT-P-85D	0.95	-
Flexibility	Fed Spec TT-P-115D	Pass	-
Abrasion Resistance	971-3.3.2	Pass	-

971-3.3.1 Set To Bear Traffic Time: The material shall set to bear traffic in not more than two minutes.

971-3.3.2 Abrasion Resistance: Test four samples per LOT using a Taber Abrader. The paint shall be applied to specimen plates using a drawdown blade having a clearance of 26 mils. Air dry each sample for 30 minutes and bake at 220ºF for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 500 g weights and CS-10 wheels. Clean the samples with a soft brush and weigh again. The average weight loss for the four plates shall not exceed 50 mg per plate.

971-3.3.3 Retroreflectivity: The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m^2 and 250 mcd/lx·m^2. The retroreflectance of the white and yellow pavement markings at the end of the six month service life shall not be less than 150 mcd/lx·m^2.

971-3.4 Packaging and Labeling: The traffic paint shall be placed in 55 gallon open-end steel drums with a re-usable multi-seal sponge gasket. No more than 50 gallons of material shall be placed in any drum to allow for expansion during transport and storage.

971-4 Fast Dry Solvent Traffic Paint.

971-4.1 General: Fast dry traffic paints intended for use under this Specification shall include products that are single packaged and ready mixed. Upon curing, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification and Section 710 shall apply regardless of the type of formulation used. The material shall be free from all skins, dirt and foreign objects.

971-4.2 Composition:

Component	Test Method	Criteria
Total Solids, by weight	ASTM D-2369	75% minimum
Pigments, by weight	ASTM D-3723	57% minimum
Vehicle Solids, % on Vehicle*		40% minimum
TiO_2, Type II Rutile (white paint only)	ASTM D-476	1.5 lb/gal minimum
Volatile Organic Content, (VOC)	ASTM D-3960	150 g/L maximum

971-4.3 Physical Requirements: The material shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Density	ASTM D-1475	13.5 ± 0.37 lb/gal	N/A
Consistency at 170ºF	ASTM D-562	80 KU	100 KU
Fineness of Grind	ASTM D-1210	2 (HS)	3(HS)

Property	Test Method	Minimum	Maximum
Dry Opacity at 5 mils WFT	Fed Std 141a Method 4121	0.96	-
Bleed Ratio	Fed Spec TT-P-85D	0.95	-
Flexibility	Fed Spec TT-P-115D	Pass	-
Abrasion Resistance	971-4.3.2	Pass	-

971-4.3.1 Set To Bear Traffic Time: The material shall set to bear traffic in not more than two minutes.

971-4.3.2 Abrasion Resistance: Test four samples per LOT using a Taber Abrader. The paint shall be applied to specimen plates using a drawdown blade having a clearance of 26 mils. Air dry each sample for 30 minutes and bake at 220ºF for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 1.1 lb weights and CS-10 wheels. Clean the samples with a soft brush and weigh again. The average weight loss for the four plates shall not exceed 0.178 oz per plate.

971-4.3.3 Retroreflectivity: The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m^2 and 250 mcd/lx·m^2, respectively. The retroreflectance of the white and yellow pavement markings at the end of the six month service life shall not be less than 150 mcd/lx·m^2.

971-4.4 Application Properties: Application properties shall meet the requirements of Section 710.

971-4.5 Packaging and Labeling: The traffic paint shall be placed in 55 gallon open-end steel drums with a re-usable multi-seal sponge gasket. No more than 50 gallons of material shall be placed in any drum to allow for expansion during transport and storage.

971-5 Thermoplastic Materials for Traffic Stripes.

971-5.1 General: Upon cooling to normal pavement temperature, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall utilize alkyd based materials only and shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification and Section 711 shall apply regardless of the type of formulation used. The pigment, glass spheres, and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

971-5.2 Composition:

Component	Test Method	White	Yellow
Binder		20.0% minimum	20.0% minimum
TiO_2, Type II Rutile	ASTM D-476	10.0% minimum	-

Component	Test Method	White	Yellow
Glass Spheres	AASHTO T-250	40.0% minimum	40.0% minimum
Yellow Pigment		-	% minimum per manufacturer
Calcium Carbonate and Inert Filler (-200 mesh sieve)		30.0% maximum	37.5% maximum
Percentages are by weight.			

The alkyd/maleic binder must consist of a mixture of synthetic resins (at least one synthetic resin must be solid at room temperature) and high boiling point plasticizers. At least one-half of the binder composition must be 100% maleic-modified glycerol of rosin and be no less than 15% by weight of the entire material formulation.

971-5.3 Glass Spheres: The glass spheres in the intermix shall consist of 50% Type 1 and 50% Type 3. Glass spheres shall meet the requirements of 971-2.

971-5.4 Sharp Silica Sand: Sharp silica sand used for bike lane symbols and pedestrian crosswalk lines shall meet the following gradation requirements:

Sieve Size	% Passing
20	100
50	0 to 10

971-5.5 Physical Requirements: Laboratory samples shall be prepared in accordance with ASTM D-4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D-570	-	0.5%
Softening Point	ASTM D-36	195ºF	-
Low Temperature Stress Resistance	AASHTO T-250	Pass	-
Specific Gravity	Water displacement	1.9	2.3
Indentation Resistance	ASTM D-2240* Shore Durometer, A2	40	75
Impact Resistance	ASTM D-256, Method A	1.0 N·m	-
Flash Point	ASTM D-92	475ºF	-
*The durometer and panel shall be at 110ºF with a 4.4 lb load applied. Instrument measurement shall be taken after 15 seconds.			

971-5.5.1 Set To Bear Traffic Time: The thermoplastic shall set to bear traffic in not more than two minutes.

971-5.5.2 Retroreflectivity: The white and yellow pavement markings shall attain an initial retroreflectance of not less than 450 mcd/lx·m^2 and not less than

350 mcd/lx·m^2, respectively. The retroreflectance of the white and yellow pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m^2.

971-5.5.3 Durability: Durability is the measured percent of thermoplastic material completely removed from the pavement. The thermoplastic material line loss must not exceed 5.0% at the end of the service life.

971-5.6 Application Properties: Application properties shall meet the requirements of Section 711.

971-5.7 Packing and Labeling: The thermoplastic material shall be packaged in suitable biodegradable or thermo-degradable containers which will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lb. The label shall warn the user that the material shall be heated in the range as recommended by the manufacturer.

971-6 Thermoplastic Material-Hot Spray.

971-6.1 General: This work shall consist of furnishing and applying thermoplastic material when the project requires refurbishing existing thermoplastic stripes. The manufacturer shall utilize alkyd based materials only and shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification and Section 711 shall apply regardless of the type of formulation used.

971-6.2 Composition:

Component	White	Yellow
Binder	25.0% minimum	25.0% minimum
TiO_2 (ASTM D-476 Type II Ructile)	10.0% minimum	-
Glass Spheres	35.0% minimum	35.0% minimum
Yellow Pigment	-	% minimum per manufacturer
Calcium Carbonate and Inert Filler (No. 200 sieve)	30.0% maximum	40.0% maximum

971-6.3 Binders: The manufacturer shall have the option of formulating the material according to his own specifications. However, the physical and chemical properties contained in this Specification shall apply regardless of the type of formulation used. The pigment, beads and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

971-6.4 Physical Requirements: Sample specimens shall be prepared in accordance with ASTM D-4960.

Procedure shall meet the following requirements:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D-570	-	0.5%
Softening Point	ASTM D-36	190ºF	-

Property	Test Method	Minimum	Maximum
Low Temperature Stress Resistance	AASHTO T-250	Pass	-
Specific Gravity	Water displacement	1.87	2.3
Indentation Resistance	ASTM D-2240* Shore Durometer, A2	5	30
Impact Resistance	ASTM D-256, Method A	1.0 N·m	-
Flash Point	ASTM D-92	475ºF	-
*The durometer and panel shall be at 110ºF with a 4.4 lb load applied. Instrument measurement shall be taken after 15 seconds.			

971-6.4.1 Set To Bear Traffic Time: The thermoplastic shall set to bear traffic in not more than two minutes.

971-6.4.2 Retroreflectivity: The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m^2 and not less than 250 mcd/lx·m^2, respectively. The retroreflectance of the white and yellow pavement markings at the end of the one year service life shall not be less than 150 mcd/lx·m^2.

971-6.4.3 Durability: Durability is the measured percent of thermoplastic material completely removed from the pavement. The thermoplastic material line loss must not exceed 5.0% at the end of the one year service life.

971-6.5 Glass Spheres: Glass spheres shall be Type 1 and meet the requirements of 971-2.

971-6.6 Sharp Silica Sand: Sharp silica sand used for bike lane symbols and pedestrian crosswalk lines shall meet the following gradation requirements:

Sieve Size	% Passing
20	100
50	0 to 10

971-6.7 Application Properties: The thermoplastic material shall readily apply and adhere to the existing traffic stripe at temperatures as recommended by the manufacturer from equipment approved by the Engineer to produce a line which shall be continuous and uniform in shape having clear and sharp dimensions at a minimum thickness as identified in the plans. No signs of moisture shall be visible on the pavement surface as determined in accordance with the binder manufacturer's recommendations.

The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of the same material. Such new material shall bond itself to the old line in a manner such that no splitting or separation occurs.

Overlay stripe thicknesses shall be measured as specified in Section 711 for refurbishing of thermoplastic stripes.

971-6.8 Packing and Marking: The thermoplastic material shall be packed in suitable biodegradable or thermo-degradable containers which will not adhere

to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lb. The label shall warn the user that the material shall be heated in the range as recommended by the manufacturer.

971-7 Preformed Thermoplastic Materials for Traffic Stripes.

971-7.1 General: Upon cooling to normal pavement temperature, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification and Section 711 shall apply regardless of the type of formulation used. The pigment, glass spheres, and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

971-7.2 Composition: The preformed thermoplastic shall consist of high quality materials, pigments and glass spheres or other reflective material uniformly distributed throughout their cross-sectional area, with a reflective layer of spheres or other reflective material embedded in the top surface.

971-7.3 Glass Spheres: Material shall contain no less than 30% glass spheres by weight.

971-7.4 Color: Materials shall meet the performance requirements specified in 971-1 and the following additional requirements. The initial luminance factor, Cap Y, shall not be less than 55. The in-service luminance factor at the end of the three year service life shall not be less than 35 when measured outside the wheel paths.

971-7.5 Physical Requirements: Laboratory samples shall be prepared in accordance with ASTM D-4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Softening Point	ASTM D-36	195ºF	-
Low Temperature Stress Resistance	AASHTO T-250	Pass	-
Indentation Resistance	ASTM D-2240* Shore Durometer, A2	40	75
Impact Resistance	ASTM D-256, Method A**	1.0 N·m	-

*The durometer and panel shall be at 110ºF with a 4.4 lb load applied. Instrument measurement shall be taken after 15 seconds.
**The test specimen for ASTM D-256 shall be 1 in. x 1 in. x 6 in. and shall not be notched.

971-7.5.1 Retroreflectivity: The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m^2. The retroreflectance of the white pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m^2. All pedestrian crosswalks, bike lane symbols and messages in a proposed bike lane shall attain initial retroreflectivity of not less than 275 mcd/lx·m^2.

971-7.5.2 Skid Resistance: The surface of the stripes and markings shall provide a minimum skid resistance value of 35 BPN (British Pendulum Number)

when tested according to ASTM E-303. Bike lane symbols and pedestrian crosswalks shall provide a minimum skid resistance value of 55 BPN.

971-7.5.3 Durability: Durability is the measured percent of thermoplastic material completely removed from the pavement. The thermoplastic material line loss must not exceed 5.0% at the end of the service life.

971-7.6 Application Properties: Application properties shall meet the requirements of Section 711.

971-7.7 Packing and Labeling: The thermoplastic material shall be packaged in suitable biodegradable or thermo-degradable containers which will not adhere to the product during shipment and storage.

971-8 Permanent Tape Materials for Pavement Stripes and Markings.

971-8.1 General: The materials for pavement stripes and markings shall consist of white or yellow weather-resistant reflective film as specified herein. The markings are divided into two classes: Standard and High Performance. The classes are differentiated by their durability and retroreflectivity. The pigment, glass spheres, and filler shall be well dispersed in the resin. However, the requirements delineated in this Specification and Section 713 shall apply. The material shall be free from all skins, dirt and foreign objects.

971-8.2 Composition: The pavement stripes and markings shall consist of high-quality plastic materials, pigments, and glass spheres uniformly distributed throughout their cross-sectional area, with a reflective layer of spheres embedded in the top surface.

971-8.3 Skid Resistance: The surface of the stripes and markings shall provide a minimum skid resistance value of 35 BPN (British Pendulum Number) when tested according to ASTM E-303. Bike lane symbols and pedestrian crosswalks shall provide a minimum skid resistance value of 55 BPN.

971-8.4 Thickness: The QPL will list the specified thickness of each approved product.

971-8.5 Durability and Wear Resistance: When properly applied, the material shall provide neat, durable stripes and markings. The materials shall provide a cushioned resilient substrate that reduces sphere crushing and loss. The film shall be weather resistant and, through normal wear, shall show no significant tearing, rollback or other signs of poor adhesion. Durability is the measured percent of pavement marking material completely removed from the pavement. The pavement marking material line loss must not exceed 5.0% of surface area at the end of its service life.

971-8.6 Conformability and Resealing: The stripes and markings shall be capable of conforming to pavement contours, breaks and faults under traffic at pavement temperatures recommended by the manufacturer. The film shall be capable of use for patching worn areas of the same types of film in accordance with the manufacturer's recommendations.

971-8.7 Tensile Strength: The stripes and markings shall have a minimum tensile strength of 40 psi when tested according to ASTM D-638. A rectangular test specimen 6 by 1 by 0.05 minimum thickness shall be tested at a temperature range of 40 to 80ºF using a jaw speed of 0.25 inch/min.

971-8.8 Elongation: The stripes and markings shall have a minimum elongation of 25% when tested in accordance with ASTM D-638.

971-8.9 Plastic Pull Test: The stripes and markings shall support a dead weight of 4 lb for not less than five minutes at a temperature range of 70 to 80ºF. Rectangular test specimen size shall be 6 by 1 by 0.05 inch minimum thickness.

971-8.10 Pigmentation: The pigment shall be selected and blended to provide a material which is white or yellow conforming to standard highway colors through the expected life of the stripes and markings.

971-8.11 Glass Spheres: The stripes and markings shall have glass retention qualities such that, when at room temperature a 2 by 6 inches specimen is bent over a 0.5 inch diameter mandrel axis, a microscopic examination of the area on the mandrel shall show no more than 10% of the spheres with entrapment by the material of less than 40%. The bead adhesion shall be such that spheres are not easily removed when the film surface is scratched firmly with a thumbnail.

971-8.12 Standard Markings: The preformed materials for pavement stripes and markings shall have a service life of three year. The materials shall attain an initial retroreflectance of not less than 300 mcd/lx·m^2 for white and contrast markings and not less than 250 mcd/lx·m^2, for yellow markings. The retroreflectance of the white, yellow and contrast pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m^2. All pedestrian crosswalks, bike lane symbols and messages in a proposed bike lane shall attain initial retroreflectivity of not less than 275 mcd/lx·m^2.

971-8.13 High Performance Markings: The preformed materials for pavement stripes and markings shall have a service life of five years. The materials shall attain an initial retroreflectance of not less than 450 mcd/lx·m^2 for white and contrast markings and not less than 350 mcd/lx·m^2 for yellow markings. The pavement stripes and markings shall retain a minimum retroreflectance for two years of not less than 300 mcd/lx·m^2 for white and contrast markings and not less than 250 mcd/lx·m^2 for yellow markings. The retroreflectance of the white, yellow and contrast pavement markings at the end of the five year service life shall not be less than 150 mcd/lx·m^2.

971-9 Two Reactive Component Materials For Traffic Stripes And Markings.

971-9.1 General: Two reactive component materials intended for use under this Specification shall include, but not be limited to, epoxies, polyesters and urethanes. Upon curing, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall have the option of formulating the material according to his own specifications. However, the criteria outlined in this Specification and Section 709 shall apply regardless of the type of formulation used. The material shall be free from all skins, dirt and foreign objects.

971-9.2 Composition:

Component	Test Method	Criteria
TiO_2, Type II Rutile (white material only)	ASTM D-476	minimum 10% by weight

Component	Test Method	Criteria
Volatile Organic Content, (VOC)	ASTM D-3960	maximum 150 g/L

971-9.3 Physical Requirements: The material shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Adhesion to Concrete	ASTM D-4541	Pass	-
Hardness	ASTM D-2240	75	-
Flexibility	Fed Spec TT-P-115D	Pass	-
Abrasion Resistance	971-9.5.2	Pass	-

971-9.3.1 Set To Bear Traffic Time: The material shall set to bear traffic in not more than two minutes.

971-9.3.2 Abrasion Resistance: Test four samples per LOT using a Taber Abrader. The material shall be applied to specimen plates using a drawdown blade having a clearance of 26 mils. Air dry each sample for 30 minutes and bake at 220ºF for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 1.1 lb weights and CS-10 wheels. Clean the samples with a soft brush and weigh again. The average weight loss for the four plates shall not exceed 0.178 ounce per plate.

971-9.3.3 Retroreflectivity: The white and yellow pavement markings shall attain an initial retroreflectance of not less than 450 mcd/lx·m^2 and not less than 350 mcd/lx·m^2, respectively. The retroreflectance of the white and yellow pavement markings at the end of the one year service life shall not be less than 150 mcd/lx·m^2.

971-9.4 Application Properties: Application properties shall meet the requirements of Section 709.

971-9.5 Packaging and Labeling: The two reactive component material shall be placed in 55 gallon open-end steel drums with a re-usable multi-seal sponge gasket. No more than 50 gallons of material shall be placed in any drum to allow for expansion during transport and storage. Other containers will be used for applicable products. Each container shall designate the color, generic type (e.g. epoxy), user information, manufacturer's name and address, batch number and date of manufacture. Each batch manufactured shall have a unique number. The label shall warn the user of hazards associated with handling or using the material.

971-10 Thermoplastic Material for Audible and Vibratory Traffic Stripes.

971-10.1 General: Upon cooling to normal pavement temperature, the thermoplastic material shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall utilize alkyd based materials only and shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this

Specification shall apply regardless of the type of formulation used. The pigment, glass spheres, and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

971-10.2 Composition:

Component	Test Method	White	Yellow
Binder		20.0% minimum	20.0% minimum
TiO_2, Type II Rutile	ASTM D-476	10.0% minimum	-
Glass Spheres	AASHTO T-250	40.0% minimum	40.0% minimum
Yellow Pigment		-	% minimum per manufacturer
Calcium Carbonate and Inert Filler (-200 mesh sieve)		% minimum per manufacturer	% minimum per manufacturer
Percentages are by weight.			

The alkyd/maleic binder must consist of a mixture of synthetic resins (at least one synthetic resin must be solid at room temperature) and high boiling point plasticizers. At least one-half of the binder composition must be 100% maleic-modified glycerol of rosin and be no less than 15% by weight of the entire material formulation.

971-10.3 Glass Spheres: The glass spheres in the intermix shall be Type 1 and meet the requirements of 971-2.

971-10.4 Physical Requirements: Laboratory samples shall be prepared in accordance with ASTM D-4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D-570	-	0.5%
Softening Point	ASTM D-36	210ºF	-
Low Temperature Stress Resistance	AASHTO T-250	Pass	-
Specific Gravity	Water displacement	1.9	2.3
Indentation Resistance	ASTM D-2240* Shore Durometer, A2	65	-
Impact Resistance	ASTM D-256, Method A	1.0 N·m	-
Flash Point	ASTM D-92	475ºF	-
*The durometer and panel shall be at 80ºF, but not exceeding 90ºF with a 4.4 lb load applied. Instrument measurement shall be taken after 15 seconds.			

971-10.4.1 Set To Bear Traffic Time: The thermoplastic shall set to bear traffic in not more than 10 minutes at ambient air temperatures of 80ºF or

less and in not more than 15 minutes for ambient air temperatures exceeding 80ºF.

971-10.4.2 Retroreflectivity: The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m^2 and not less than 250 mcd/lx·m^2, respectively. The retroreflectance of the white and yellow pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m^2.

971-10.4.3 Durability: Durability is the measured percent of thermoplastic material completely removed from the pavement. The thermoplastic material line loss must not exceed 5.0% at the end of the three year service life. Durability shall also include flattening of the profile or raised portions of the line. The flattening of the profile or raised portion of the line shall not exceed 25% at the end of the three year service life.

971-10.5 Application Properties: Application properties shall meet the requirements of Section 701.

971-10.6 Packing and Labeling: The thermoplastic material shall be packaged in suitable biodegradable or thermo-degradable containers which will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lb. The label shall warn the user that the material shall be heated in the range as recommended by the manufacturer.

SECTION 972
RECYCLED PLASTIC PRODUCTS

972-1 Description.

Recycled plastic products used shall be included on the Qualified Products List. Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6 and include certified test reports from an approved independent test laboratory that shows the material meets all specifications herein and the manufacturer shall certify the following:

a. The source of the recycled plastic waste, including the state (FL, GA, etc.) from which the recycled plastic was obtained, and type of waste (consumer or industrial).

b. The total percent of recycled plastic in the final product.

972-2 Definitions.

972-2.1 Recycled Plastic: Those plastics composed of post-consumer material or recovered industrial material only, or both, that may or may not have been subjected to additional processing steps designed to afford products such as regrind or reprocessed or reconstituted plastics.

972-2.2 Post-Consumer Materials: Those products generated by a business or consumer that have served their intended end use and that have since been separated or diverted from solid waste for the purpose of collection, recycling, and re-disposition.

972-2.3 Recovered Material: Materials and by-products that have been recovered or diverted from solid waste, but not including those materials and by-

products generated from, and commonly used within, an original manufacturing process.

972-3 Materials.

The materials used for recycled plastic products shall consist of a minimum of 70% by weight of recycled plastic. The products shall exhibit good workmanship and shall be free of burns, discoloration, contamination, and other objectionable marks or defects which affect appearance or serviceability. Only chemicals, including fillers and colorants, designed to inhibit photo degradation, biological/biochemical decomposition, insect infestation, or burning will be permitted to enhance durability. The use of sufficient additives to inhibit photo degradation over the lifetime of the product is required.

972-3.1 Fence Posts: The posts shall be brown, approximating tree bark, to blend with the surroundings. They shall have no cracking, chipping, flaking, peeling or splintering in the final product. The product shall contain no more than 20% voids, by weight, over its length.

972-3.2 Delineator Posts: The product shall contain no more than 51% voids, by weight, over its length.

972-4 Physical Requirements.

972-4.1 Line Post Physical Requirements:

972-4.1.1 Minimum dimensions for line posts:

Length: 8 feet.
Cross-section (Round post): 4 inch diameter;
Cross section (Square post): 4 by 4 inch minimum.

972-4.1.2 Straightness: The straightness of the post shall comply with 954-5 for timber fence posts.

972-4.1.3 Flexural Strength: The post shall meet the requirements of the latest edition of the Southern Pine Inspection Bureau's Standard Grading Rules for Southern Pine Lumber for No. 2SR Stress Rated Grade Timber.

972-4.1.4 Surface Finish: The post shall exhibit a homogeneous and smooth surface finish and be relatively free of indents or other surface imperfections.

972-4.2 Delineator Post Physical Requirements:

972-4.2.1 Marking: The top of the post on the side away from traffic shall be date stamped showing the month and year of fabrication. The numerals shall be at least 1/2 inch in height and shall be either die stamped or legibly stamped with permanent ink.

972-4.2.2 Dimensions: The post shall have a minimum width of 3 inches facing traffic and of such length to generally provide a height of 48 inches above the pavement surface.

972-4.2.3 Color: The post shall be opaque white. The yellowness index shall not exceed 12 when tested in accordance with ASTM D 1925 or ASTM E 313. The daylight 45 degree, 0 degree luminous directional reflectance shall be a minimum of 70 when tested in accordance with ASTM E 1347.

972-4.2.4 Retroreflective Sheeting: The reflective sheeting shall be Types III, IV, V or VII and meet the requirements of Section 994. The reflective

sheeting shall have a minimum width of 3 inches and have a minimum area of 30 $inch^2$.

972-4.2.5 Heat Resistance: The post shall be conditioned a minimum of two hours in an oven at 140 ± 30ºF. The conditioned post shall be capable of straightening itself within 30 seconds when bent 180 degrees at the midpoint for each of four bends. The test on each post shall be completed within two minutes of removal from oven.

972-4.2.6 Cold Resistance: The post shall be conditioned a minimum of two hours at -5 ± 3ºF in an environmentally controlled test chamber. Testing shall be performed in the environmental chamber.

972-4.2.7 Impact Resistance:

(1) The post shall not be adversely affected when a device approximately at the center of the post, bends the free half of the post to a 90 degree angle with the remaining section being held stationary. The post shall return to its original shape within 60 seconds for each of four separate bends.

(2) A steel ball weighing 2 pounds shall be dropped a distance of 5 feet through a virtually frictionless vertical guide to impact the surface of the post. The surface of the post being struck by the steel ball shall be in a horizontal position with the post supported and held in position at both ends. The post shall be subjected to five impact tests concentrated near the middle of the post. Fracturing, cracking or splitting of the post shall constitute failure.

972-4.2.8 Impact Performance: The post, installed according to manufacturer's recommendations, shall be capable of returning to a vertical position ±5 degrees and remain serviceable after receiving ten vehicle impacts at 55 mph at a 20 degree angle. The ambient temperature must be no less than 40ºF.

972-4.2.9 Resistance to Herbicides: The posts shall be sprayed or receive a coating of the herbicide(s) currently being used by the Department, and this coating shall remain on the posts for a minimum of 48 hours and then thoroughly rinsed. The posts shall show no significant change in color, flexibility, nor integrity when subjected to this herbicide exposure.

972-5 Predicted Service Life.

In-service line posts shall provide a minimum acceptable performance life of 35 years. Conditions to be considered in establishing the minimum acceptable performance life shall include, but are not limited to, the following:

a. Insect infestations, especially by fire ants and termites causing a weight reduction resulting in a loss in strength exceeding 10% of its original strength.

b. Rotting or erosion due to soil micro-organisms.

c. Any cracks, breaks or stress cracks.

d. Water uptake exceeding 10% by weight of its original weight over its predicted lifetime.

e. Non-flammability-retarded susceptibility to burning via appropriate additives.

f. Straightness as noted in 972-4.2.

The test methods to comply with the above shall be in accordance with FM 5-557.

972-6 Sampling.

One additional product per 1,000, or a minimum of one per order shall be included in the order for Department testing.

SECTION 973
STRUCTURAL PLASTICS

973-1 Description.

This work covers structural plastic (SP) components including fiberglass structurally reinforced composite piles (CP), fiberglass structurally reinforced composite lumber (SCL) and smaller dimensional fiberglass fiber reinforced composite lumber (FFRCL).

973-2 Product Acceptance.

Use only products listed on the Department's Qualified Products List (QPL). Manufacturers seeking evaluation of products must submit an application in accordance with Section 6 and include independently certified test reports that the material meets the requirements of this section.

In accordance with Section 6, provide manufacturer's certification that the material meets the requirements of this section.

973-3 Materials.

Use polyethylene made from recycled post consumer or post industrial thermoplastics. Mix the plastic with appropriate colorants, UV inhibitors, hindered amine light stabilizers and antioxidants so that the resulting product meets the material property requirements specified in Tables 1 and 2. Structural Plastic must not corrode, rot, warp, splinter or crack. The outer skin must be smooth and black in color unless otherwise specified in the Contract Documents.

Manufacture Structural Plastic as one continuous piece with no joints or splices to the dimensions and tolerances in accordance with Table 3 and consisting of a dense outer skin surrounding a less dense core. Interior voids shall not exceed 3/4 inch in diameter. Structural Plastic shall be free of twist and curvature.

Reinforce 10"x10" fiberglass structurally reinforced composite lumber for use in heavy duty and medium duty fender systems with a minimum of four 1 1/2 inch reinforcing rods placed in the corners of the section. Reinforce 10"x10" fiberglass structurally reinforced composite lumber for use in light duty fender systems with a minimum of four 1 inch reinforcing rods placed in the corners of the section. Reinforce 16" O.D. Components including fiberglass structurally reinforced composite piles for use in heavy duty fender systems with a minimum of sixteen 1 1/2 inch fiberglass reinforcing rods. Reinforce 16" O.D. Components including fiberglass structurally reinforced composite piles for use in medium duty fender systems with a minimum of sixteen 1 inch fiberglass reinforcing rods.

Reinforcing rods must be continuous and offer a minimum flexural strength of 70.0 ksi when tested in accordance with ASTM D-4476 and a minimum

compressive strength of 40.0 ksi when tested in accordance with ASTM D-695. Steel reinforcing rods are not permitted.

Reject any sections of structural plastic containing cracks or splits. Also, inspect the ends of the reinforcing rods and reject any sections containing reinforcing rods with voids or cracks.

Add a minimum of 15% (by weight) chopped fiberglass reinforcement to the polyethylene used for fiberglass structurally reinforced composite lumber, a minimum of 5% (by weight) chopped fiberglass reinforcement for components including fiberglass structurally reinforced composite piles and a minimum of 15% (by weight) chopped fiberglass reinforcement for smaller dimensional fiberglass fiber reinforced composite lumber. The fiberglass reinforcement may be reduced when other means of controlling cracking are specified with test results which show long term cracking is nonexistent.

Fiberglass structurally reinforced composite lumber must meet the minimum structural properties listed in Tables 4A and 4B.

Smaller dimensional fiberglass fiber reinforced composite lumber must meet the minimum physical properties listed in Table 5.

Components including fiberglass structurally reinforced composite piles must meet the structural properties listed in Tables 6A and 6B.

Table 1
Plastic Material Properties- CP and SCL

Density	ASTM D-792	Skin	55-63 pcf
Density	ASTM E-12	Core	34-48 pcf
Water Absorption	ASTM D-570		
		Skin	2 hrs:<1.0% weight increase 24 hrs:<3.0% weight increase
Brittleness	ASTM D-746	Skin	No break at -40°F at 5 ft-lbs/in
Impact Resistance	ASTM D-746 Modified	Skin	Greater than 4 ft-lbs/in
Hardness	ASTM D-2240	Skin	44-75 (Shore D)
Ultraviolet	ASTM D-4329 (B Lamp)	Skin Core	500 hours<10% change in Shore D Durometer Hardness 500 hours<10% change in Shore D Durometer Hardness
Abrasion	ASTM D-4060	Skin	Weight Loss: <0.02 oz Wear Index: 2.5 to 3.0 Cycles=10,000 Wheel=CS17 Load-2.2 lb
Chemical Resistance	ASTM D-543	Skin/Core Sea Water Gasoline No. 2 Diesel	 <1.5% weight increase <7.5% weight increase <6.0% weight increase
Tensile Properties	ASTM D-638	Skin/Core	Minimum 500 psi at break
Compressive	ASTM D-695	Skin/Core	Minimum 40 ksi

Modulus			
Static Coefficient of Friction	ASTM F-489-03		Maximum 0.25, wet
Nail Pull-Out	ASTM D-1761	Skin/Core	Minimum 60 lb

Table 2 Plastic Material Properties FFRCL		
Density	ASTM D-6111	50-65 pcf
Brittleness	ASTM D-746	No break at -40°F at 5 ft-lbs/n
Impact Resistance	ASTM D-746 Modified	Greater than 4 ft-lbs/in
Hardness	ASTM D-2240	44-75 (Shore D)
Ultraviolet	ASTM D-4329 (B Lamp)	500 hours <10% change in Shore D Durometer Hardness
Abrasion	ASTM D-4060	Weight Loss: <0.02 oz Wear Index: 2.5 to 3.0 Cycles = 10,000 Wheel = CS17 Load -2.2 lb
Chemical Resistance	ASTM D-543 Sea Water Gasoline No. 2 Diesel	 <1.5% weight increase <7.5% weight increase <6.0% weight increase
Tensile Properties	ASTM D-638	Minimum 3000 psi at break
Static Coeffecient of Friction	ASTM C-1028 (Neolite-wet)	Minimum 0.50, wet or dry
Nail Pull-Out	ASTM D-1761	Minimum 250 lb
Screw Withdrawal	ASTM D-6117	Minimum 450 lb

Table 3 Dimensions and Tolerances		
Structural Plastic	Dimension	Tolerance
Length	Per order (80 ft Maximum)	0/+6 inch
Width	See Contract Plans	±1/4 inch
Height	See Contract Plans	±1/4 inch
Corner Radius – SCL Corner Radius – FFRCL	1 3/4 inch 1/4 inch	±1/4 inch ±1/16 inch
Outer Skin Thickness	3/16 inch	±1/8
Distance from outer surface to center rebar elements (SCL)	2 inches	±1/4 inch
Distance from outer		

surface to center rebar elements CP)	1 3/8 inches	±1/4 inch
Straightness (gap, bend or inside while lying on a flat surface)		<1 1/2 inches per 10 feet

Table 4A Structural Properties for Heavy Duty and Medium Duty SCL	
Member Size	10 inches x 10 inches
Modulus of Elasticity as derived below	521 ksi
Stiffness, E.I.	4.05E+08 lb-inch^2
Yield Stress in Bending	5.8 ksi
Weight	30-37 lb/ft

Table 4B Structural Properties for Light Duty SCL	
Member Size	10 inches x 10 inches
Modulus of Elasticity as derived below	307 ksi
Stiffness, E.I.	2.39E+08 lb-inch^2
Yield Stress in Bending	3.4ksi
Weight	28-35 lb/ft

Determine the Modulus of Elasticity of a full size specimen by conducting a three point bend test with a load applied in the center of a simply supported 14-foot span, at a deflection rate of 0.25 inch per minute. The Modulus is to be taken at a strain of 0.01 inch per inch, where strain equals (6) x (depth of cross section) x (deflection) / (span length squared) and where Modulus of Elasticity equals (load) x (span length cubed) / [(48) x (deflection) x (moment of inertia)].

Table 5 Properties for FFRCL	
Modulus of Elasticity ASTM D-6109	306,000 psi
Flexural Strength ASTM D-6109	2,500 psi
Compressive Strength ASTM D-6108	1,960 psi
Compressive Strength Parallel to gain ASTM D-6112	3,500 psi
Compressive Strength Perpendicular to gain ASTM D-6112	700 psi

Table 6A Structural Properties for Heavy Duty CP	
Member Size	16 inch O.D.
Modulus of Elasticity as derived below	1,146 ksi
Stiffness, E.I.	3.69E+09 lb-inch^2
Yield Stress in Bending	9.1 ksi

Weight	68-83 lb/ft

Table 6B Structural Properties for Medium Duty CP	
Member Size	16 inch O.D.
Modulus of Elasticity as derived below	622 ksi
Stiffness, E.I.	2.0E+09 lb-inch2
Yield Stress in Bending	4.9 ksi
Weight	61-74 lb/ft

Determine the modulus of elasticity for composite piles using the following test:

Place a 54-foot long plastic composite marine fender piling of manufacturer's standard commercial type horizontally in a clamping device so that 6 feet of the piling will be firmly fixed and unable to move and the other end simply supported. Gradually apply a vertical (downward) load to a point 12 feet from the simply-supported end. Measure the deflection along the length of the piling at the load point, and 3 equidistant locations. Use the load and deflection data to calculate the flexural modulus of elasticity, maximum outer fiber stress, stiffness (EI), and the bending stress. The flexural modulus of elasticity is calculated by dividing EI by the moment of inertia of the cross section of the product.

Calculate the properties in Tables 6A and 6B utilizing standard elastic beam flexure formulas (as found in references such as Machinery's Handbook; and Formulas for Stress and Strain, by Roark and Young). Report the Stiffness (EI) as the average of the stiffness at all measurement locations, between zero load and half the load corresponding to the specification yield stress. The specified minimum yield stress in bending shall be reached before failure of the product. Calculate the stress at the load point, on the tension side of the plastic composite marine piling.

As stated, conduct the tests on a full-scale product of the specified size. The results of these tests may be extended through engineering calculations, to a product of another size only if the other size has the same or smaller cross section than the tested product. Do not use smaller cross sections to predict the performance of larger cross sections.

Components including fiberglass structurally reinforced composite piles shall exhibit recoverable deflection with not more than a 5% reduction in bending stiffness (EI) when cyclically load tested. Upon request, the manufacturer of the composite piles must provide cyclical, flexural load test results from an independent test laboratory ensuring the tests were conducted under four point load conditions with a minimum 30.5 feet clear span and a minimum 15 feet shear span. They must have also been conducted on a minimum of a 13 inch O.D. Structural Plastic pile, for a minimum of 200 load cycles with the applied load producing a minimum of 40% of the composite pile's bending moment at yield, as determined by the formula $M = f (I / c)$ where:

M = bending moment at yield (in-lbs)

f = yield stress in bending (lb/in^2)

I = moment of inertia of cross-section (in^4)
c = distance from neutral axis to point where stress is desired (inches)

SECTION 975
STRUCTURAL COATING MATERIALS

975-1 General Requirements.

975-1.1 General: Upon curing, all coatings and/or coating systems must produce an adherent coating that is visually uniform and capable of performing according to its designated purpose for an extended service life of greater than 20 years. The composition of the coating is left to the discretion of the manufacturer but the finished product must meet all requirements of this Section. All coatings must be designed for a marine, coastal environment and must be self-curing. Coatings that are multi-component must be prepackaged in required ratios for ease of mixing. Any coating not meeting these Specifications will be rejected by the Engineer.

975-1.2 Environmental Requirements: Coating materials and their waste projects must be characterized as non-hazardous as defined by Resource Conservation and Recovery Act (RCRA) Subarticle C rules, Table 1 of 40 CFR 261.24 Toxicity Characteristic.

Volatile Organic Compounds (VOC shall be less than 3.5 lb/gal when tested in accordance with AASHTO R-31.

975-2 Materials.

975-2.1 Qualified Products List: All coating materials and coating systems must be listed on the Departments Qualified Products List (QPL). Submit an application in accordance with Section 6.

975-2.2 Packaging and Labeling: Ship materials in strong containers plainly marked with user information and lot or batch number, and QPL number. Each lot or batch manufactured must have a unique number. The name and address of the manufacturer also must be shown.

975-3 Product Testing and Certification.

975-3.1 General: The Contractor shall provide the Engineer a certification conforming to the requirements of Section 6 from the manufacturer of the coatings materials confirming that the requirements of this Section are met. Each certification shall cover only one batch of coating.

975-3.2 Information to Accompany Samples: Manufacturer's submitting QPL applications shall furnish product information according to AASHTO R-31, Section 6 and applicable section within this Specification. Use Federal Color Standard No. 595B, Table VIII, Shade No. 36622 for the finish coat color on test panels.

975-4 Galvanizing Compounds for Field Metallizing and Touch up Repair.

975-4.1 General: Galvanizing compound materials must produce an adherent coating capable of preventing corrosion and specifically intended for use over mechanically-cleaned or blasted steel. All coatings must possess physical properties and handling characteristics that are compatible with the use and application requirements of Section 560 and 562. Furnish product testing information according to AASHTO R-31, Section 8; the coating should not blister, soften or loosen bond at the end of the test period; there will be no primer creep, blistering or loss of adhesion relative to a scribed line applied prior to testing exceeding 0.05 inch at any point at the scribe and no corrosion in the field per ASTM D-610.

975-4.2 Composition Requirements for Zinc Coatings: Zinc coatings must contain a minimum of 83% zinc dust pigment by weight in the primer. The zinc dust pigment used in the formulation must be Type II in accordance with ASTM D-520.

975-4.3 Composition Requirements for Aluminum Mastic Coatings: Aluminum mastic coatings must contain aluminum pigment and minimum 80% volume solids.

975-4.4 Field Qualification: Attain a numerical rating of not less than 9 in accordance with ASTM D-610 and ASTM D-1654 and 9F in accordance with ASTM D-714 when applied to KTA composite test panels prepared according to AASHTO R-31 and exposed at the Department's beach corrosion test site or applied at a test location. The coatings will be evaluated initially following an exposure period of 18 months. The coatings must continue to provide acceptable protection and performance for a period of 5 years. Application characteristics must be judged acceptable prior to beach testing.

975-5 Structural Steel Coatings.

975-5.1 General: Structural steel coatings and coating systems must produce an adherent coating capable of preventing corrosion and specifically intended for use over mechanically-cleaned steel. All coatings must possess physical properties and handling characteristics that are compatible with the application requirements of Section 560. Furnish product testing information according to AASHTO R-31, Section 8; the coating should not blister, soften or loosen bond at the end of the test period; there will be no primer creep, blistering or loss of adhesion relative to a scribed line applied prior to testing exceeding 0.05 inch at any point at the scribe and no corrosion in the field per ASTM D-610; color retention, $\Delta E \leq 3$, in accordance with ASTM D-2244; and 10% max gloss loss in accordance with ASTM D-523.

Additional Laboratory Performance and Tests		
Property	Test Method	Limits
Impact Resistance	ASTM D-2794, 30 inch/lbs	Pass
Elongation	ASTM D-522, 1/2 inch cylindrical mandrel	No cracking

Additional Laboratory Performance and Tests		
Property	Test Method	Limits
Chemical Resistance	ASTM G-20, 180 days: 5% Ammonia, 5% Urea, and Diesel fuel	The Coating should not blister, soften or loosen at the end of the test period.

All coatings and coating systems that perform as finish coats must create a finished surface that is resistant to color and gloss degradation. The default finish coat must meet Federal Color Standard No. 595B, Table VIII, Shade No. 36622, unless otherwise specified by the Engineer.

975-5.2 Composition Requirements for Primer Coatings: Meet the requirements of 975-4 galvanizing compounds.

975-5.3 Composition Requirements for Intermediate Coatings (Tie Coat): An intermediate coating is optional for a coating system. Coatings must be suitable as an intermediate tie coat between the primer and finish coat. Intermediate coatings must contain a minimum of 40 percent solids by volume as per ASTM D-5201.

975-5.4 Composition Requirements for Finish Coatings: Finish coatings must provide the final coating containing color and gloss for the coating system. A finish coat may be comprised of a single pigmented coating or a pigmented coating with a clear coat.

975-5.5 Composition Requirements for Clear Coating: When used, the clear coating must be suitable as a final coating over a finish coat and the two coatings used together will constitute the finish coat.

The clear coat must contain a UV degradable color for inspection purposes. UV degradable color must dissipate in a reasonable time period to allow inspection but not detract from visual impact of the structure.

975-5.6 Joint Sealants: Manufacturer's of coating systems must identify joint sealants that are compatible with their coating system. Sealants must be self-curing. If not top coated, the caulking must match the color of the joint surface being caulked.

975-5.7 Field Qualification: Attain a numerical rating of not less than 9 in accordance with ASTM D-610 and ASTM D-1654 and 9F in accordance with ASTM D-714; the coating should not blister, soften or loosen bond at the end of the test period; there will be no corrosion in the field per ASTM D-610; color retention, $\Delta E \leq 3$, in accordance with ASTM D-2244; and 10% max gloss loss in accordance with ASTM D-523 when applied to KTA Composite test panels prepared according to AASHTO R-31 and exposed at the Department's beach corrosion test site or applied at a test location. The coatings will be evaluated initially following an exposure period of 18 months. The coatings must continue to provide acceptable protection and performance for a period of 5 years. Application characteristics must be judged acceptable prior to beach testing.

975-6 Class 5 Applied Finish Coatings for Concrete.

975-6.1 General: Use a commercial product designed specifically for this purpose, which upon curing is capable of accommodating the thermal and elastic expansion ranges of the substrate without cracking.

All coatings must possess physical properties and handling characteristics that are compatible with the application requirements of Section 400.

The default finish coat will meet Federal Color Standard No. 595B, Table VIII, Shade No. 36622 unless otherwise specified by the Engineer.

975-6.2 Material Tests: Meet the following requirements:

Laboratory Performance and Tests		
Property	Test Method	Limits
Resistance to Wind Driven Rain	ASTM D-6904	No visible water leaks, and if the rear face of the block is damp, the average gain in weight of the three 8 by 16 by 2 inch blocks must be less than 0.2 lb.
Freeze thaw resistance	AASHTO R-31	The coating should not blister, soften or loosen bond at the end of the test period.
Water Vapor Permeance	ASTM D-1653; Method B, Condition C	WVT≥10 perms
Abrasion Resistance	ASTM D-968, 3,000 liters of sand	No loss of coating thickness ASTM D 1005
Salt Spray (fog) resistance	ASTM B-117, 5,000 hours	The coating should not blister, soften or loosen bond at the end of the test period.
Impact Resistance	ASTM D-2794, 30 inch/lbs	Pass
Elongation	ASTM D-522, 1/2 inch cylindrical mandrel	No cracking
Chemical Resistance	ASTM G-20, 180 days: 5% Ammonia and 5% Urea	The coating should not blister, soften or loosen bond at the end of the test period.
Accelerated Weathering	AASHTO R-31	The coating should not blister, soften or loosen bond at the end of the test period.
Fungal Resistance	ASTM D-3273	Rating of 10, ASTM D 3274
Dirt Pick-up	ASTM D-3719	Rating of 10, ASTM D 3274

975-6.3 Field Qualification: Attain a numerical rating of not less than 9F in accordance with ASTM D 714 when applied to concrete test panels prepared and

exposed at the FDOT beach corrosion test site or applied at a test location. The coatings will be evaluated initially following an exposure period of 18 months. The coatings must continue to provide acceptable protection and performance for a period of 5 years. Application characteristics must be judged acceptable prior to beach testing.

975-7 Painting Strain Poles, Mast Arms and Monotube Assemblies.

Paint systems used on galvanized steel strain poles, galvanized steel mast arms and galvanized steel monotube assemblies shall meet the color requirements as specified in the Contract Documents and shall exhibit no loss of adhesion or loss of color greater than 8ΔEs for five years after final acceptance as specified in 5-11. A steel signal mast arm assembly or monotube assembly that exhibits a cumulative surface area of delamination in excess of 100 square inches will constitute an adhesion failure. Delamination shall be defined as any area of exposed metal surface subsequent to hand tool cleaning in accordance with SSPC-SP2. A change in the coating color in excess of 8ΔEs per the CIE L*a*b* 1976 will constitute a color retention failure. The Department will measure the CIE 1976 color chromaticity coordinates for the color of the top coat of the two sample coupons provided with a BYK-Gardner Handicolor colorimeter using D65 illuminant and 2 degree geometry settings. The Department measured L*a*b* chromaticity coordinates shall define the initial color and will used for resolution of color retention failures and the resolution of color retention disputes. All paint systems must possess physical properties and handling characteristics that are compatible with the application requirements of Section 649. Materials must be specifically intended for use over galvanized steel.

975-8 Elastomeric Coatings.

975-8.1 General: Use an elastomeric coating system to provide a waterproof barrier over post-tensioning anchorages or other areas designated in the plans. The components of the coating system must be supplied by a single manufacturer and sold as a waterproof coating system. The surface preparation and application of the coating system must be applied in strict accordance with the manufacturer's specifications.

975-8.2 Physical Properties: The use of an epoxy prime coat is dependent upon the requirements of the manufacturer's waterproofing system. The polyurethane chemistry may be either waterborne aromatic (moisture-curing) or aromatic (moisture-sensitive). The minimum thickness of the system must not be less than 30 mils. The cured coating system must meet the following requirements:

Property	Test Value	Test Method
Hardness, Shore A	Between 60 and 90	ASTM D-2240
Tensile Strength	≥750 psi	ASTM D-412
Elongation	≥400%	ASTM D-412
Tear Strength	>70 pli	ASTM C-957

Property	Test Value	Test Method
Abrasion Resistance H-18 wheels 1,000 gm/wheel	≤350 mg loss / 1,000 revs.	ASTM C-957
Crack Bridging 1,000 Cycles	System Passes	ASTM C-957
Elongation Recovery	≥94%	ASTM C-957

975-8.3 System Modifications for Use on Bride Substructure: Supply the elastomeric coating system with an aliphatic polyurethane top coating.

975-8.4 Field Qualification: Attain a numerical rating of not less than 9 in accordance with ASTM D-610 and ASTM D-1654 and 9F in accordance with ASTM D-714; the coating should not blister, soften or loosen bond at the end of the test period; there will be no corrosion in the field per ASTM D-610; color retention, $\Delta E \leq 3$, in accordance with ASTM D-2244; and 10% max gloss loss in accordance with ASTM D-523 when applied to test location and exposed at the Department's beach corrosion test site or applied at a test location. The coatings will be evaluated initially following an exposure period of 18 months. The coatings must continue to provide acceptable protection and performance for a period of 5 years. Application characteristics must be judged acceptable prior to beach testing.

975-9 Anti-Graffiti Coating Materials.

975-9.1 General Requirements: Anti-graffiti coatings intended for use under this specification shall be of a composition to be capable of preventing the adhesion of graffiti and/or facilitating the removal of graffiti. All anti-graffiti coatings must possess the physical and handling characteristics that are compatible with the requirements of Section 563.

Anti-graffiti coatings shall contain less than [5.0 lb/gal] volatile organic compounds (VOC) as defined by 40 CFR Part 59, Subpart D.

The manufacturer will supply the following additional information:

a. Cleaning instructions and materials, as applicable. Surfaces must be cleanable with nonproprietary cleaners as defined in ASTM D-6578.

b. Sacrificial Coating Removal instructions, as applicable.

c. Recommended base coat, as applicable.

d. Identification of coating system and type, as applicable.

e. Clear coats must contain a UV degradable color for inspection purposes. UV degradable color must dissipate in a reasonable time period to allow inspection but not detract from visual impact of the structure.

975-9.2 Material Tests: Meet the following requirements:

Additional Laboratory Performance and Tests		
Test	Method	Limits
Cyclic Weather Testing	AASHTO R-31	No blistering, cracking, checking, chalking, or delamination; color change less than 3 Delta E CIE LAB units; Retention of 60^{o} Gloss ratio >= 0.80

Additional Laboratory Performance and Tests		
Test	Method	Limits
Abrasion Resistance	ASTM D-968, 1,000 liters of sand	No loss of coating thickness per ASTM D-1005
Impact Resistance	ASTM D-2794	Minimum of 30 inch-pounds
Graffiti Resistance	ASTM D-6578, Use identified marking materials; initial and recleanability; and after exposure initial and recleanability	Cleanability Level 1, 2, or 3.
Sacrificial Coating removability	Per Manufacturer's specifications: 6 months exposure at FDOT test site	Complete removal of material from substrate
MEK Double Rub	ASTM D-5402; 50 rubs	No coating wear through (4 minimum rating)
Fluid Resistance	ASTM D-1308; Paint Thinner, Gasoline	No blistering, discoloration, softening or adhesion loss.

SECTION 981
TURF MATERIALS

981-1 General.

The types of seed and sod will be specified in the Contract Documents. All seed and sod shall meet the requirements of the Florida Department of Agriculture and Consumer Services and all applicable state laws, and shall be approved by the Engineer before installation.

All seed, sod and mulch shall be free of noxious weeds and exotic pest plants, plant parts or seed listed in the current Category I "List of Invasive Species" from the Florida Exotic Pest Plant Council (FLEPPC, www.fleppc.org). Any plant officially listed as being noxious or undesirable by any Federal Agency, any agency of the State of Florida or any local jurisdiction in which the project is being constructed shall not be used. Furnish to the Engineer, prior to incorporation onto the project, a certification from the Florida Department of Agriculture and Consumer Services, Division of Plant Industry, stating that the seed, sod or mulch materials are free of noxious weeds. Any such noxious or invasive plant or plant part found to be delivered in seed, sod or mulch will be removed by the Contractor at his expense and in accordance with the law.

All materials shall meet plant quarantine and certification entry requirements of Florida Department of Agriculture & Consumer Services, Division of Plant Industry Rules.

981-2 Seed.

The seed shall have been harvested from the previous year's crop. All seed bags shall have a label attached stating the date of harvest, LOT number, percent purity, percent germination, noxious weed certification and date of test.

Each of the species or varieties of seed shall be furnished and delivered in separate labeled bags. During handling and storing, the seed shall be cared for in such a manner that it will be protected from damage by heat, moisture, rodents and other causes.

All permanent and temporary turf seed shall have been tested within a period of six months of the date of planting.

All permanent and temporary turf seed shall have a minimum percent of purity and germination as follows:

1. All Bahia seed shall have a minimum pure live seed content of 95% with a minimum germination of 80%.
2. Bermuda seed shall be of common variety with a minimum pure live seed content of 95% with a minimum germination of 85%.
3. Annual Type Ryegrass seed shall have a minimum pure live seed content of 95% with a minimum germination of 90%.

981-3 Sod.

981-3.1 Types: Unless a particular type of sod is called for in the Contract Documents, sod may be either centipede, bahia, or bermuda at the Contractor's

option. It shall be well matted with roots. Where sodding will adjoin, or be in sufficiently close proximity to, private lawns, other types of sod may be used if desired by the affected property owners and approved by the Engineer.

981-3.2 Dimensions: The sod shall be taken up in commercial-size rectangles, or rolls, preferably 12 by 24 inch or larger, except where 6 inch strip sodding is called for, or as rolled sod at least 12 inches in width and length consistent with the equipment and methods used to handle the rolls and place the sod. Sod shall be a minimum of 1 1/4 inch thick including a 3/4 inch thick layer of roots and topsoil. Reducing the width of rolled sod is not permitted after the sod has been taken up from the initial growing location. Any netting contained within the sod shall be certified by the manufacturer to be bio-degradable within a period of three months from installation.

981-3.3 Condition: The sod shall be sufficiently thick to secure a dense stand of live turf. The sod shall be live, fresh and uninjured, at the time of planting. It shall have a soil mat of sufficient thickness adhering firmly to the roots to withstand all necessary handling. It shall be planted within 48 hours after being cut and kept moist from the time it is cut until it is planted. No sod which has been cut for more than 48 hours may be used unless specifically authorized by the Engineer. A letter of certification from the turf Contractor as to when the sod was cut, and what type, shall be provided to the Engineer upon delivery of the sod to the job site.

The source of the sod may be inspected and approved by the Engineer prior to being cut for use in the work.

981-4 Mulch.

The mulch material shall be compost meeting the requirements of Section 987, hardwood barks, shavings or chips; or inorganic mulch materials as approved by the Engineer; or hydraulically applied wood fiber mulch or bonded fiber matrix (BFM).

981-5 Source Requirements for Sod and Mulch.

The Contractor shall comply with all current restrictions in regard to movement of sod and mulch material, as required by the Division of Plant Industry, Florida Department of Agriculture and Consumer Services (www.doacs.state.fl.us/pi/plantinsp/pi_reg_summary.html).

SECTION 982
FERTILIZER

982-1 Fertilizers.

Fertilizers shall comply with the State fertilizer laws.

The numerical designations for fertilizer indicate the minimum percentages (respectively) of (1) total nitrogen, (2) available phosphoric acid, and (3) water-soluble potash, contained in the fertilizer. At least 50% of the nitrogen shall be from a slow-release source.

982-2 Certification.

The Contractor shall provide the Engineer a certified test report from the manufacturer of the commercial fertilizer confirming that the requirements of this Section are met. The certified test report shall conform to the requirements of Section 6 and include test results for total nitrogen, available phosphoric acid, water-soluble potash, and sulfur. Each certification shall cover one batch per type for dry type fertilizer.

982-3 Fertilizer Rates.

Soil laboratory fertilization recommendations are based on the amount (lbs) of nutrients (N, P_2O_5, K_2O) to apply per given area (usually 1,000 sq. ft.). From this recommendation it is necessary to select an appropriate fertilizer grade and then determine how much of this fertilizer to apply to the area.

If a complete fertilizer (containing all three primary nutrients) is not available in the ratio of N-P-K necessary to match the ratio required in the fertilizer recommendation, mixed-grade or single-nutrient fertilizers should be used to satisfy each nutrient requirement.

To calculate fertilizer rates:

1. Measure the area to be fertilized in square feet.
2. Select fertilizer(s) to be used based on the soil testing laboratory recommendations by matching the ratio of nutrients recommended to the fertilizer grades available.
3. Determine the amount of fertilizer to apply to a given area (1,000 sq. ft.) by dividing the recommended amount of nutrient by the percentage of the nutrient (on a decimal basis) in the fertilizer. Apply no more than 0.25 lbs P_2O_5/1000 sf per application prior to planting.
4. Adjust the amount of fertilizer to the project area.

SECTION 983
WATER FOR GRASSING

The water used in the grassing operations may be obtained from any approved source. The water shall be free of any substance which might be harmful to plant growth. Effluent water shall meet all Federal, State and local requirements.

SECTION 985
GEOTEXTILE FABRICS

985-1 Fabric.

985-1.1 General: Geotextiles shall be woven or nonwoven fabrics that will allow the passage of water. Geotextiles shall be packaged in a protective covering sufficient to protect it from sunlight, dirt, and other debris during

shipment and storage, upon which the manufacturer's name, product name, style number, roll dimensions and LOT numbers are clearly labeled.

985-1.2 Application: The applications of geotextile fabrics are divided into the following three main classes:

1. Drainage- under all rubble riprap, including cyclopean stone and under gabions; wrapped around drains, pipe joints, and edge-drains; filter behind walls, etc.

2. Erosion Control- silt fence, staked silt barrier, plastic erosion mat.

3. Stabilization- separator between embankment and soft subsoil, reinforcement and pipe bedding.

985-2 Physical Requirements.

Unless restricted in the plans or specifications, the geotextile fabric shall be a woven or non woven fabric consisting of long-chain polymeric filaments or yarns such as polypropylene, polyethylene, polyester, polyamides or polyvinylidene chloride formed into a stable network such that the filaments or yarns retain their relative position to each other. The base plastic shall contain stabilizers and/or inhibitors to make the filaments resistant to deterioration due to ultra-violet light (except for subsurface and stabilization classification), heat exposure and potential chemically damaging environment. The fabric shall be free of any treatment which may significantly alter its physical properties. The edges of the fabric shall be selvaged or otherwise finished to prevent the outer yarn from pulling away from the fabric. The fabric shall conform to the physical requirements on Design Standards, Index No. 199 according to its application.

985-3 Overlaps and Seams.

Overlaps shall be as specified in the plans, specifications, or Design Standards for each particular application. To reduce overlaps, the geotextile fabric may be sewn together. Seams of the fabric shall be sewn with thread meeting the chemical requirements and minimum seam strength requirements given for the fabric and application as shown on Design Standards, Index No. 199.

985-4 Certification.

Furnish two certified copies of a test report from the manufacturer certifying that the geotextile to be incorporated into the completed project meets the requirements of this Specification and the Design Standards, Index No. 199. The certified test reports shall be attested to by a person having legal authority to bind the manufacturing company. Also, furnish two (4 by 8 inch) samples of the geotextile for product identification. The manufacturer shall maintain test records as required by this Specification. These records shall be made available to the Department upon request.

SECTION 987
PREPARED SOIL LAYER MATERIALS

987-1 Description.

All material shall be suitable for plant growth. The organic matter content of the prepared soil layer after mixing shall be a minimum of 2.5%, a maximum of 10%, in accordance with FM 1-T-267 and have a pH value of 4.5 or greater and less than or equal to 8.5 as determined in accordance with ASTM E 70. The organic matter content shall be created using any of the following materials.

987-2 Materials.

Prepared soil layer materials may be obtained from either, or a combination of, the following sources:

(1) Excavation within the limits of construction on the project. Such material may be stockpiled or windrowed on the project in areas approved by the Engineer.

(2) Designated borrow pits for the project.

(3) From other sources of organic soil materials provided by the Contractor.

987-2.1 Organic Soil: This may consist of muck, mucky peat and peat and shall have an organic matter content of 30% or more if the mineral fraction is more than 50% clay, or more than 20% organic matter if the mineral fraction has no clay.

987-2.2 Blanket Material: Meet the material classification shown on the plans and Design Standards, Index No. 505.

987-2.3 Compost: Meet the requirements of Florida Department of Environmental Protection Rule 62.709.550 Type Y (yard waste), Type YM (yard waste and manure), Type A (municipal solid waste compost) or Rule 62.640.850 Type AA (composted biosolids) and have unrestricted distribution.

987-2.3.1 Compost for use as a Soil Amendment: If the electrical conductivity (EC) value of the compost exceeds 4.0dS (mmhos/cm) based on the saturated paste extract method, the compost shall be leached with water prior to application.

987-2.3.2 Compost for use as a Mulch: The compost shall contain no foreign matter, such as glass, plastic or metal shards. The compost shall be slightly coarse to coarse in nature (over half of the solids shall be from particles 1/2 inch in size and no greater than 6 inches). Preference shall be given to compost or mulch made from uncontaminated woody waste materials.

SECTION 990
TEMPORARY TRAFFIC CONTROL DEVICES MATERIALS

990-1 General.

This Section specifies the material requirements for Temporary Traffic Control Devices.

990-2 Reflective Sheeting for Temporary Traffic Control Signs and Devices.

990-2.1 Qualified Products List: Sheeting for use on Temporary Traffic Control Signs and Devices shall be one of the products listed on the Qualified Products List (QPL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6.

990-2.1.1 Sign Panels, Vertical Panels, Barricades and other Devices: Sign Panels, Vertical Panels, Barricades and other Devices shall meet the requirements of ASTM D-4956 for Type III or higher retroreflective sheeting materials identified in Section 994 except for mesh signs shall meet the color, daytime luminance and nonreflective property requirements of Section 994, Type VI.

990-2.1.2 Collars for Traffic Cones and Bands for Tubular Markers: Collars for Traffic Cones and Bands for Tubular Markers shall meet the requirements of ASTM D-4956 Type VI.

990-2.1.3 Drums: Drums shall meet the requirements of ASTM D-4956 for Type III or higher retroreflective sheeting materials identified in Section 994 including Supplementary requirements for Reboundable Sheeting.

990-3 Portable Devices (Arrow Boards, Changeable (Variable) Message Signs, Regulatory Signs and Radar Speed Display Units).

990-3.1 General: All portable devices shall meet the physical display and operational requirements of the MUTCD and be listed on the QPL. Manufacturers seeking approval of their portable devices shall provide a working sample to be evaluated by the Department that meets all requirements specified herein.

990-3.1.1 Electrical Systems:

990-3.1.1.1 Diesel Engine: The Diesel Engine shall meet the following:

(a) The power supply and electrical system shall be self-contained within the unit.

(b) The engine shall have an electrical starting system.

(c) The power source furnished shall be of sufficient size to provide the required maximum load energy plus 25%.

(d) The electrical system shall meet the National Electrical Code where applicable.

(e) A backup power system that will operate the unit for a minimum of three hours automatically when the motor driven generator fails to operate.

(f) The starting batteries and back-up power supply system batteries shall be automatically charged when the generator is operating.

(g) The engine shall be supplied with an ammeter and the generator shall be supplied with a voltmeter showing voltage to the sign assembly.

990-3.1.1.2. Solar Powered Unit: The Solar Powered Unit shall meet the following:

(a) The unit shall provide automatic recharging of power supply batteries to normal operating levels with meters showing charge.

(b) Solar array recovery time for Arrow Boards and Regulatory Signs shall be accomplished in a maximum of three hours.

(c) Arrow Boards and Changeable Variable Message Signs shall be designed to provide 180 days of continuous operation with minimum onsite maintenance.

990-3.1.1.3 Battery Life Test: Meet the following:

(a) The photovoltaic unit shall be designed to provide 21 days of continuous operation without sunlight with a minimum of onsite maintenance for arrow boards and changeable message signs, or 10 days of continuous operation without sunlight with a minimum of onsite maintenance for regulatory signs and radar speed display units.

(b) The battery shall be equipped with a battery controller to prevent overcharging and over-discharging. An external battery level indicator shall be provided.

(c) The battery, controller, and power panel shall be designed to be protected from the elements and vandalism.

(d) Automatic recharging of power supply batteries shall be provided with charge indicator meter.

(e) An AC/DC battery charger unit shall be provided.

990-3.1.2 Display Panel and Housing:

(a) The display housing assembly shall be weather-tight.

(b) All nuts, bolts, washers and other fasteners shall be of corrosion resistant material.

(c) The display assembly shall be equipped with an automatic dimming operational mode capable of a minimum of 50% dimming and a separate manual dimmer switch

(d) The display panel background and frame for the display assembly shall be painted flat black and shall meet Federal Specification TT-E-489.

(e) The display panel for arrow boards and changeable message signs, when raised in the upright position, shall have a minimum height of 7 feet from the bottom of the panel to the ground, in accordance with the MUTCD. The display panel for radar speed display units, when raised in the upright position, will have a minimum height of 5 feet from the bottom of the panel to the ground.

(f) The regulatory speed sign panel for regulatory signs and radar speed display units, when raised in the upright position, shall have a minimum height of 7 feet from the bottom of the regulatory sign panel to the ground.

(g) The unit shall have an accessible mechanism to easily raise and lower the display assembly. A locking device shall also be provided to ensure the display panel will remain in the raised or lowered position.

990-3.1.3 Controller: The Controller shall meet the following:

(a) Controller and control panel shall be housed in a weather, dust, and vandal resistant lockable cabinet.

(b) Controller and associated on-board circuitry shall meet the requirements of the Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise by Class A digital devices.

(c) For Changeable Variable Message Signs and Arrow Boards ensure that the sign control software provides an on-site graphical representation that visibly depicts the message displayed on the sign face.

(d) For Changeable Variable Message Signs, if remote communication is included, meet the following National Transportation Communications for ITS Protocol (NTCIP) requirements: Ensure that the sign controller software implements all mandatory objects as defined in the FDOT Standard Global MIB v01 in Appendix A, all mandatory objects as defined in the FDOT Standard DMS MIB v01 in Appendix B, and all mandatory objects as defined in the FDOT Specific DMS MIB v01 in Appendix C. Ensure that additional objects implemented by the software do not interfere with the standard operation of mandatory objects.

990-3.1.4 Support Chassis: The Support Chasis shall meet the following:

(a) The support chassis shall be self-contained and self-supporting without the use of additional equipment or tools.

(b) Both trailer and truck-mounted units are allowed for arrow panels. Trailer mounted units are required for changeable message signs, regulatory signs and radar speed display units.

(1) Trailer mounted unit:

(a) The sign, power supply unit and all support systems shall be mounted on a wheeled trailer.

(b) The trailer shall be equipped with class-A lights, using a plug adaptor.

(c) The trailer shall be equipped with adjustable outrigger leveling pads, one on each of the four frame corners.

(d) The trailer shall be designed to be set up at the site with its own chassis and outriggers, without being hitched to a vehicle.

(e) The trailer shall be equipped with fenders over the tires and shall be made from heavy-duty material sufficient to allow a person to stand and operate or perform maintenance on the unit.

(f) The trailer shall meet all equipment specifications set forth in Chapter 316 of the Florida Statutes, and by such rule, regulation or code that may be adopted by the Department of Highway Safety and Motor Vehicles.

(g) The trailers should be delineated on a permanent basis by affixing retroreflective material, known as conspicuity material, in a continuous line on the face of the trailer as seen by oncoming road users.

(2) Truck mounted unit:

(a) The truck-mounted assembly shall be designed to fit on a 1/2 ton or greater duty truck.

(b) The unit shall be self-contained with its own power supply, controls, raising and lowering device and shall be capable of being operated by one person.

(c) The unit shall be secured in the vehicle for normal operation.

990-3.1.5 Other Requirements: Meet the following:

(a) The portable device assembly shall be designed to function in dry, wet, hot or cold weather (ambient temperature ranges from-30 to 165ºF. Other environmental requirements shall be as specified in Section A-615 of the Minimum Specifications for Traffic Control Signal Devices, which can be located at the following URL: www.dot.state.fl.us/TrafficOperations/Traf_Sys/terl/minspec/A615.pdf , Sections A 615-4 Temperature and Humidity, A 615-5 Vibration, and A 615-6 Shock.

(b) The controller shall not be affected by mobile radio, or any other radio transmissions.

(c) An operator's manual shall be furnished with each unit.

(d) The manufacturer's name and FDOT approval number shall be affixed on the equipment.

990-3.2 Portable Arrow Board:

990-3.2.1 Arrow Board Matrix:

(a) The minimum legibility distance for various traffic conditions are based on the decision-sight distance concept. The minimum legibility distance is the distance at which a driver can comprehend the arrow panel message on a sunny day or a clear night. The arrow panel size that is needed to meet the legibility distance is listed as follows:

Type	Minimum Size	Minimum Number of Panel Lamps	Minimum Legibility Distance
B	30 by 60 inches	13	3/4 mile
C	48 by 96 inches	15	1 mile

For use on the state highway system, the Types "B" or "C" advance warning arrow boards may be used for low to intermediate (0 to 50 mph) facilities and for maintenance or moving operations on high-speed roadways. Type "C" arrow boards shall be used on high-speed (50 mph and up).

(b) Devices shall meet all arrow board displays identified in the MUTCD.

(c) The lamp lens should be 5 3/4 inches in diameter. Smaller lamp lens diameters are permissible only if they provide an equivalent or greater brightness indication and meet the legibility criteria in Section (a) of this Specification.

(d) The color of the light emitted shall be in accordance with the MUTCD.

(e) There shall be a 360-degree hood for close-up glare reduction.

(f) For solar powered arrow boards the bulbs shall provide a 350-candle power intensity for day use and an automatic reduction or dimming

capacity for night use. The dimmed night operation shall provide adequate indication without excessive glare.

(g) The flashing rate of the lamps shall not be less than 25 nor more than 40 flashes per minute as required in the MUTCD.

(h) The minimum lamp "on time" shall be 50% for the flashing arrow and 25% for the sequential chevron.

990-3.3 ChangeableVariable Message Sign:

990-3.3.1 Message Matrix:

(a) Message matrix panel shall be a maximum height of 7 feet by a maximum width of 10 feet.

(b) The message matrix panel shall contain three separate lines. Each line shall consist of eight characters, equally spaced a minimum of 3 inches. Each character shall contain 35 pixels in a five by seven horizontal to vertical grid arrangement.

(c) Each message line of the 7 foot by 10 foot PCMS shall provide for characters 13 inches in width by 18 inches in height minimum and variable graphic and symbol sizes to a minimum of 18 inches in height.

(d) For flip disk matrix signs, the disk elements shall be coated on the display side with a highly reflective florescent yellow Mylar material, and on the back with a flat black to blend in with the flat black background.

(e) Similar components shall be interchangeable.

990-3.3.2 Operation and Performance:

(a) The message shall be displayed in upper case except when lower case is project specific and is allowed by the MUTCD.

(b) The message matrix panel shall be visible from 1/2 mile and legible from a distance of 650 feet under both day and night conditions. Under variable light level conditions the sign shall automatically adjust its light source to meet the 650 feet visibility requirement. The message panel shall have adjustable display rates, so that the entire message can be read at least twice at the posted speed.

(c) The control panel shall have the capability to store a minimum 50 pre-programmed messages.

(d) The controller in the control panel shall be able to remember messages during non-powered conditions.

(e) The controller shall allow the operator to generate additional messages on site via the keyboard.

(f) For a PCMS using Flip-Disk technology, the controller shall have the capability to provide a stipulated default message upon loss of controller function.

(g) All messages shall be flashed or sequenced. In the sequence mode, the controller shall have the capability to sequence three line messages during one cycle.

990-3.4 Portable Regulatory Signs:

990-3.4.1 Sign Panel Assembly: The sign panel assembly shall consist of a 24 by 30 inches "SPEED LIMIT XX" sign panel and a "WHEN FLASHING" sign panel, intended to notify oncoming traffic the speed limit

where workers are present. The sign panel assembly shall meet the following minimum physical requirements:

(a) all nuts, bolts, washers, and other fasteners shall be of corrosion resistant material.

(b) the sign panel shall fold down and be pinned in place for towing. Maximum travel height shall be 80 inches.

(c) construct the sign panel and light housing to allow the unit to be operated in the displayed position at speeds of 30 mph. Design the sign panel assembly to withstand transport speeds of 65 mph.

(d) construct the sign panel such that, when in the raised position, the sign panel will have a height of seven feet from the bottom of the lowest panel to the ground, in accordance with the MUTCD.

(e) provide the unit with a mechanism to raise and lower the sign panel. Provide the unit with a device to lock the sign panel in the raised and lowered position.

990-3.4.2 Flashing Lights: Provide a pair of hooded PAR 46 LED advance warning flashing lamps on each side of the top of the sign panel. These lamps shall be visible day or night at a distance of one mile with a flash rate of approximately 55 flashes per minute.

The lamp lens should be at least 5 3/4 inches in diameter. Smaller diameter lens are permissible if they provide an equivalent or greater brightness indication and meet the legibility criteria above.

The color of the light emitted shall be in accordance with the MUTCD. For solar powered units, the bulbs shall provide a 350 candlepower intensity for day use and an automatic reduction or dimming capacity for night use. The dimmed night operation shall provide adequate indication without excessive glare.

990-3.5 Radar Speed Display Unit:

990-3.5.1 Display Unit Panel and Housing: Meet the requirements of 990-3.1.2 and the following physical requirements as a minimum:

(a) Provide capability to mount a 24 by 30 inches regulatory sign with interchangeable numbers showing the posted speed limit above the message display.

(b) Provide legend “YOUR SPEED” either above or below the message display.

990-3.5.2 Message Display: The message Display shall meet the following physical requirements as a minimum:

(a) Provide a bright LED, two digit speed display on a flat black background with bright yellow LEDs.

(b) Each digit shall contain either a seven-segment layout or matrix-style design. Each digit shall measure a minimum 18 inches in height.

(c) Speed display shall be visible from a distance of at least 1/2 mile and legible from a distance of at least 650 feet under both day and night conditions.

(d) Display shall adjust for day and night operation automatically with a photocell.

990-3.5.3 Radar: The radar unit shall not be affected by normal radio transmissions and meet the following physical requirements as a minimum:

(1) Approach-Only sensor.

(2) Equipped with a low power K-Band transmitter.

(3) Part 90 FCC acceptance, 3 amps, 10.8 to 16.6 vdc. Fuse and reverse polarity protected.

(4) Range of 1,000 feet for mid-size vehicle, capable of accurately sensing speeds of 10 to 99 mph with over speed function that operates when a vehicle approaches over the posted speed limit.

990-3.5.4 Traffic Counter: The unit shall be fitted with a device, which counts the number of vehicles passing the Radar Speed Display Unit. The counter device shall be capable of:

(1) Digital readout of the number of vehicles passing the radar speed display unit.

(2) Digital readout of the number of vehicles exceeding the speed shown on the radar speed display unit.

990-4 Removable Tape.

990-4.1 Composition: The pavement stripes and markings shall consist of high quality plastic materials, pigments, and glass spheres or other retroreflective materials uniformly distributed throughout their cross-sectional area, with a reflective layer of spheres or other retroreflective material embedded in the top surface. No foil type materials shall be allowed.

990-4.2 Skid Resistance: The surface of the stripes and markings shall provide a minimum skid resistance value of 35 BPN (British Pendulum Number) when tested according to ASTM E-303. Bike lane symbols and pedestrian crosswalks shall provide a minimum skid resistance value of 55 BPN.

990-4.3 Thickness: The Qualified Products List will list the specified thickness of each approved product.

990-4.4 Durability and Wear Resistance: When properly applied, the material shall provide neat, durable stripes and markings. The materials shall provide a cushioned resilient substrate that reduces sphere crushing and loss. The film shall be weather resistant and, through normal wear, shall show no significant tearing, rollback or other signs of poor adhesion. Durability is the measured percent of pavement marking material completely removed from the pavement. The pavement marking material line loss must not exceed 5.0% of surface area.

990-4.5 Conformability and Resealing: The stripes and markings shall be capable of conforming to pavement contours, breaks and faults under traffic at pavement temperatures recommended by the manufacturer. The film shall be capable of use for patching worn areas of the same types of film in accordance with the manufacturer's recommendations.

990-4.6 Tensile Strength: The stripes and markings shall have a minimum tensile strength of 40 psi when tested according to ASTM D 638. A rectangular test specimen 6 by 1 by 0.05 inch minimum thickness shall be tested at a temperature range of 40 to 80ºF using a jaw speed of 0.25 inch/minute.

990-4.7 Elongation: The stripes and markings shall have a minimum elongation of 25% when tested in accordance with ASTM D-638.

990-4.8 Plastic Pull test: The stripes and markings shall support a dead weight of 4 lb for not less than five minutes at a temperature range of 70 to 80ºF. Rectangular test specimen size shall be 6 by 1 by 0.05 inch minimum thickness.

990-4.9 Adhesive: Precoat removable tape with a pressure sensitive adhesive capable of being affixed to asphalt concrete and portland cement concrete pavement surfaces without the use of heat, solvents, and other additional adhesives or activators. Ensure that the adhesive does not require a protective liner when the removable tape is in rolled form for shipment. Ensure that the adhesive is capable of temporarily bonding to the roadway pavement at temperatures of 50ºF and the above without pick-up distortion by vehicular traffic.

990-4.10 Color: Meet the requirements of 971-1.7.

990-5 Work Zone Raised Pavement Markers.

Work Zone Raised Pavement Markers (WZRPM's) shall meet the requirement of 970-1.2.1 and are certified as meeting the following except for Class E markers as noted below:

(a) Composition: Use markers made of plastic, ceramic or other durable materials. Markers with studs or mechanical attachments will not be allowed.

(b) Dimensions: Marker minimum and maximum surface dimensions is based on an x and y axis where the y dimension is the axis parallel to the centerline and the x axis is 90 degrees to y. Class E markers shall be 4 inch (W) by 2 inch (H) by 1 inch (D).

The x and y dimension of Class D markers shall be a maximum of 5 inches. The x dimension shall be a minimum of 4 inches and the minimum y dimension will be 2.25 inches.

The maximum installed height of Class D markers shall be 1 inch. The maximum installed height of Class E markers shall be 2 inches. Use Class D markers having a minimum reflective face surface of 0.35 in^2. Use Class E markers having a minimum reflective surface area of 1 in^2.

The marker's reflective face shall be completely visible and above the pavement surface after installation, measured from a line even with the pavement perpendicular to the face of the marker.

(c) Optical Performance: Ensure that the specific intensity of each white reflecting surface at 0.2 degrees observation angle shall be at least the following when the incident light is parallel to the base of the marker:

Horizontal Entrance Angle	Specific Intensity
0 degrees	3
20 degrees	1.2

For yellow reflectors, the specific intensity shall be 60% of the value for white.

For red reflectors, the specific intensity shall be 25% of the value for white. Reflectivity of all WZRPM's shall not be less than 0.2 Specific Intensity (SI) any time after installation.

(d) Strength requirements: Markers shall support a load of 5,000 pounds. Three markers per lot or shipment will be randomly tested as follows:

Position the marker base down between the flat parallel platens of a compression testing machine. Place on top of the marker a flat piece of 65 durometer rubber 6 by 6 by 0.375 inch centered on the marker. Apply the compressive load through the rubber to the top of the marker at a rate of 0.2 in/s.

Either cracking or significant deformation of the marker at any load less than 5,000 pounds will constitute failure.

(e) Adhesion: Use bituminous adhesive materials recommended by the marker manufacturer for bonding the markers to the pavement. The adhesive used shall be one of the products included on the QPL.

(f) Removability: Ensure that the pavement marker is removable from asphalt pavement and portland cement concrete pavement intact or in substantially large pieces, either manually or by mechanical devices at temperatures above 40°F, and without the use of heat, grinding or blasting.

(g) Replacement Requirements: Replace markers any time after installation when more than two markers in a skip, or more than three consecutive markers on an edgeline are missing at no expense to the Department. Replace all failed markers in a timely manner as directed by the Engineer.

990-6 Temporary Glare Screen.

990-6.1 Design and Installation: Meet the following requirements:

(a) Glare screen units shall be manufactured in lengths such that when installed the joint between any one modular unit will not span barrier sections. Color shall be green, similar to Federal Color Standard 595-34227.

(b) Blades, rails and/or posts shall be manufactured from polyethylene, fiberglass, plastic, polyester or polystyrene, and be ultraviolet stabilized and inert to all normal atmospheric conditions and temperature ranges found in Florida.

(c) For paddle type designs, the blade width shall not be more than 9 inches. Blades or screen for individual or modular systems shall be 24 to 30 inches high and capable of being locked down at an angle and spacing to provide a cut-off angle not less than 20 degrees.

(d) For glare screen mounted on temporary barrier wall, a strip (6 by 12 inches) of reflective sheeting as specified in 994-2 shall be placed on a panel, centered in each barrier section (at a spacing not to exceed 15 feet) and positioned in such a manner as to permit total right angle observation by parallel traffic. When glare screen is utilized on temporary concrete barriers, warning lights will not be required.

(e) Prior to approval an impact test shall be performed by the manufacturer to verify the safety performance of the proposed system. The minimum impact strength of the posts, blades, rail and the barrier attachment design shall be sufficient to prevent the unit from separating from the barrier when impacted by a 3 inches outside diameter steel pipe traveling at 30 mph and impacting mid-height on the glare screen assembly.

(f) All hardware shall be galvanized in accordance with ASTM A-123 or stainless steel in accordance with AISI 302/305.

Alternative designs for temporary glare screen may be submitted as a Value Engineering Change Proposal (VECP) in accordance with 4-3.9.

990-6.2 Qualified Products List: Manufactured glare screen systems may be modular or individual units listed on the QPL.

990-7 Temporary Traffic Control Signals.

990-7.1 General: Meet the physical display and operational requirements of conventional traffic signal described in the MUTCD for portable traffic signals. The standard includes but is not limited to the following:

(a) Use signal heads having three 12 inch vehicular signal indications (Red, Yellow and Green). Ensure there are two signal heads for each direction of traffic.

(b) The traffic signal heads on this device will be approved by the Department.

(c) Department approved lighting sources will be installed in each section in accordance with the manufacturer's permanent directional marking(s), that is, an "Up Arrow", the word "UP" or "TOP," for correct indexing and orientation within a signal housing.

(d) The masts supporting the traffic signal heads will be manufactured with the lowest point of the vehicular signal head as follows:

(1) Eight feet above finished grade at the point of their installation for "pedestal" type application or

(2) Seventeen to 19 feet above pavement grade at the center of roadway for "overhead" type application.

(e) The yellow clearance interval will be programmed three seconds or more. Under no condition can the yellow clearance interval be manually controlled. It must be timed internally by the controller as per Department specifications.

(f) The green interval must display a minimum of five seconds before being advanced to the yellow clearance interval.

(g) The controller will allow for a variable all red clearance interval from 0 to 999 seconds.

(h) Portable traffic control signals will be either manually controlled or traffic actuated. Indicator lights for monitoring the signal operation of each approach will be supplied and visible from within the work zone area.

(i) When the portable traffic control signals are radio actuated the following will apply:

(1) The transmitter will be FCC Type accepted and not exceed 1 watt output per FCC, Part 90.17. The manufacturer must comply with all "Specific limitations" noted in FCC Part 90.17.

(2) The Controller will force the traffic signal to display red toward the traffic approach in case of radio failure or interference.

(j) The trailer and supports will be painted construction/maintenance orange enamel in accordance with the MUTCD color.

(k) The device will meet NEMA environmental standard. The test report certified by an independent laboratory will be provided.

(l) Ensure the certification number is engraved or labeled permanently on equipment.

(m) Ensure the device has an external, visible, water resistant label with the following information: "Certification of this device by the Florida Department of Transportation allows for its use in Construction Zones Only."

SECTION 992
HIGHWAY LIGHTING MATERIALS

992-1 Design Criteria.

992-1.1 General: The light poles and bracket arms shall be in accordance with the requirements of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, the FDOT Structures Manual and with the specific requirements contained in this Section.

992-1.2 Wall Thickness of Steel High Mast Poles: The minimum wall thickness for galvanized steel poles shall be 0.1793 inch (7 gauge).

992-1.3 Light Pole Assembly: The light pole assembly shall conform to the applicable requirements of IES, EEI, and NEMA (Illuminating Engineering Society, Edison Electric Institute, and National Electrical Manufacturers Association).

992-2 Light Poles.

992-2.1 Galvanized Steel: Galvanized steel high mast poles shall be continuous-tapered, round or minimum of 12 sided poles. Each section shall be manufactured from one length of steel sheet, formed in continuous tapered tube, with one continuous arc-welded vertical seam. They shall be galvanized in accordance with ASTM A-123.

992-2.2 Aluminum: Aluminum light poles shall be round, one piece, continuous-tapered, high-strength aluminum, and of an approved alloy meeting the requirements of the Design Standards.

992-2.3 Length: The poles shall be of such length as to provide the approximate luminaire mounting height shown in the plans or directed by the Engineer.

992-2.4 Bases: Transformer base poles shall have a grounding lug in the transformer base. A heavy cast base shall be attached to the lower end of each shaft by a continuous arc weld, inside and outside of the shaft, or by a combination of arc welding and a press fit, subject to the approval of the Engineer. The base shall be arranged for anchoring to a transformer base or a concrete foundation with four anchor bolts 1 inch (minimum size), unless otherwise shown in the plans.

992-2.5 General: The lighting pole assembly shall conform to the applicable requirements of IES, EEI and NEMA. The base shall be provided with the necessary anchorage, hardware, and bolt covers. An ornamental cap shall be provided to fit over the top of the pole to exclude moisture. All poles not located

behind guardrail or bridge rail, or that are not wall mounted, shall be frangible, except as shown in the plans.

992-3 Bracket Arms.

Bracket arms shall be aluminum, truss-type construction, consisting of upper and lower members with vertical struts, and shall have the luminaire end formed to accommodate a 2 inch pipe slipfitter. The bracket arms shall meet the design requirements of 992-1.1 and 992-1.3. Bracket arms shall be attached to aluminum poles, with machine bolts and pole adapters, unless approved otherwise.

992-4 Luminaires, Ballasts, etc.

Luminaires shall consist of a precision-cast aluminum housing and reflector holder, a refractor-holder latch on the street side, and a hinge with a safety catch on the house side of the luminaire; also a slipfitter suitable for attaching to a 2 inch mounting bracket, gasketing between the reflector and the refractor and the socket entry, an adjustable bracket capable of producing the specified IES type light distributions, and a heat-resistant, high-transmission glass prisomatic refractor. Luminaires may be induction, metal halide, or high pressure sodium vapor, as indicated in the plans.

Unless otherwise indicated in the plans, the luminaires shall have internal ballasts of the regulated output (constant wattage) type, suitable for operating on the circuits shown in the plans. The ballasts shall be pre-wired to the lamp socket and terminal board, requiring only connection of the power-supply leads to the ballast primary terminals. The ballast shall have a power factor of at least 90%. The ballast shall provide for regulation within ±6% variation in lamp watts at a primary voltage variation of ±10% for lamps of 400w or less and provide for regulation within ±13% variation in lamp watts at a primary voltage variation of ±10% for lamps of 750w or greater.

The luminaires shall meet the requirements shown in the plans.

992-4.1 Induction Sign Fixtures: The fixture shall be rated for 100,000 hours with a minimum lamp efficiency of 70% of lumen output at 60,000 hours. The housing shall be precision cast aluminum with a corrosive resistant polyester powder coat finish. The standard color shall be gray. The cover shall be attached to the housing utilizing stainless steel bolts, and the housing shall be sealed to provide an IP 55 rating or greater. The mounting assembly for a sign light shall be a slipfitter type to accommodate a 1 1/2 inches schedule 40 steel pipe connection. The luminaire manufacturer shall place a permanent tag on the luminaire housing on which the following is imprinted: the luminaire voltage, lamp wattage and a blank area for the Contractor to inscribe the installation date. The refractor shall be tempered clear or microprismatic glass. The generator/ballast may be internal or external to the fixture. If the generator is internal to the fixture, the maximum operating temperature shall not exceed 130°F when measured at the base point. If the fixture is not compatible with the circuit voltage, step-down transformers or other equivalent circuitry shall be provided by the fixture manufacturer to provide for a complete installation. The manufacturer shall provide a five year non-prorated warranty to the Department. The warranty shall begin on the installation date.

992-4.2 Certification: The Contractor shall provide the Engineer a certification conforming to the requirements of Section 6 from the manufacturer of the luminaries and electrical ballasts confirming that the requirements of this Section are met. Each certification shall cover only one LOT for luminaries and/or electrical ballasts.

992-5 Conductors.

The conductors shall be color-coded and, unless otherwise shown in the plans, the conductors shall be as called for below.

Service conductors shall be stranded copper, single-conductor cable, Type RHW or THW and shall not be smaller than No. 6 AWG.

Direct-burial cable shall meet the same classification requirements as the service conductors except it shall be approved for direct burial.

Pole and bracket cable shall be a stranded cable, Type RHW or THW, and shall not be smaller than No. 10 AWG.

Roadway lighting cable shall meet the same classification requirements as the service conductors.

Underdeck structure lighting conductors shall be Type RHW or THW and shall not be smaller than No. 12 AWG.

Bonding ground conductor shall be bare (or have a green jacket) and shall be No. 6 AWG or larger.

992-6 Conduit.

992-6.1 General: Conduit shall, in general, be rigid steel. Polyvinyl-chloride conduit may be used in lieu of rigid steel when the conduit is embedded in concrete, and elsewhere if called for or if specifically approved by the Engineer.

992-6.2 Rigid Steel: Rigid steel conduit shall be hot-dip galvanized and each 10 foot length shall carry the Underwriter's seal of approval.

992-6.3 Polyvinyl-Chloride: Polyvinyl-chloride conduit shall be high-impact, Schedule 40, and each 10 foot length shall carry the Underwriter's seal of approval.

992-6.4 Electrical Grounds: The electrical ground rods shall be made of corrosion-resistant clad steel or other material as may be permitted by the plans or approved by the Engineer.

992-7 Ducts.

992-7.1 Type I Duct: Type I duct is a light wall duct. It shall be made by a recognized manufacturer, specifically for use in concrete-encased electrical duct work. The duct material may be asphalt-impregnated fibers or a plastic material such as styrene. The joints shall be watertight and the bore smooth. The concrete encasement shall be of Class I Concrete, at least 3 inches in thickness.

992-7.2 Type II Duct: Type II duct is a heavy wall duct, which shall be made by a recognized manufacturer, specifically for use as a direct-burial duct. The materials and workmanship shall be as noted for Type I duct but the walls shall be thicker to withstand the greater pressure and impact.

992-8 Fittings, Pull-boxes, and Bends.

Fittings, pull-boxes, bends and miscellaneous hardware shall be in accordance with the National Electrical Code and shall be compatible with the adjacent conduit and materials.

992-9 Wooden Service Poles.

992-9.1 General: Wooden service poles shall meet the requirements of ANSI (ASA) and shall be at least 35 feet in length. The pole shall be Class 5 unless otherwise specified on the plans or in the specifications.

992-9.2 Treatment: Poles shall be treated in accordance with ASTM D-1760, Pressure Treatment of Timber Products, with the exceptions and additions as specified herein. Pressure treatment shall be with creosote oil, pentacholorophenol solution, or salt preservative meeting the requirements of 955-4 with the restriction that poles treated with pentachlorophenol solution shall not be used in a salt water nor brackish water environment.

992-9.3 Retention of Preservative:

992-9.3.1 Creosote Oil: Retention shall be at least 9 lb/ft^3 of wood.

992-9.3.2 Pentachlorophenol Solution: Minimum retention shall be 0.45 pound of dry pentachlorophenol chemicals per cubic foot of wood.

992-9.3.3 Salt Preservative (Chromated Copper Asenate): Minimum retention shall be 0.60 pound of CCA oxide per cubic foot of wood.

992-9.3.4 Measuring Retention: With all preservatives, retention shall be by assay of sample from the 0.50 to 2.00 inch zone, performed and certified to by the treating company.

992-9.4 Penetration of Preservative:

992-9.4.1 Determination: Penetration shall be determined as specified in 955-6.4.

992-9.4.2 Sapwood Penetration: Sapwood penetration shall be as specified in 955-6.2.

992-9.5 Retreatment: Retreatment, when necessary, shall be as specified in 955-6.3.

992-9.6 Mounting Height: Mounting height of all equipment and lines shall meet the requirements of the latest edition of the National Safety Code, the local ordinances, and the specifications of the connecting utility.

992-10 Protection of Light Poles.

Each metal pole shall be appropriately and adequately protected by “tire wrapping” with heavy paper, or by some other effective means, so that no chipping, gouging, or other significant surface damage will be incurred during transit or installation. The poles, when installed, shall be clean and uniformly free from dark streaks and discoloration.

992-11 Concrete Foundations for Light Poles.

The concrete foundations for the light poles shall be of Class I concrete unless otherwise shown in the plans. They may be either precast or cast-in-place. The foundation design shall be as recommended by the pole manufacturer and as approved by the Engineer.

992-12 Pole Cable Distribution System.

992-12.1 Conductor Splices: Unless otherwise authorized by the Engineer, splices shall be made with split bolt connectors. The connector shall be sealed in silicone gel that easily peels away leaving a clean connection. The gel will be contained in a closure that when snapped around the split bolt will provide a waterproof connection without the use of tools or taping. This closure will be UV resistant, impact resistant and abrasion resistant.

992-12.2 General (Roadway Lighting): These requirements are applicable for all systems rated up to and including 600 V.

The installed system shall be in compliance with the Design Standards, Index No. 17500, or as an alternate, shall meet the following requirements:

A modular color coded cable system consisting of rubber cords with integrally molded watertight submergible connectors, inline fuses, submergible surge arrestor and breakaway connectors shall be installed. The cables shall extend from a underground junction box near the base of the pole to the luminaires at the top of the pole. A cable system shall be required at each pole.

The cable system shall consist of the following described components:

Distribution Block: The red molded body shall contain a three wire female outlet integrally molded to a 24 inch length of 12/3 SOWA cable with an end molded to the body and the other end shall be spliced in the field to the distribution cable that feeds through the underground junction box near the base of the pole. The block shall be watertight and submergible when the integrally fused plug on the power cable is engaged and fully seated. Dimensions shall be approximately 2 by 3 by 3 inches. The size is important because of limited space.

Surge Arrestor Cable: Provide a 12 inch length of 10/2 SOWA cable with a red male plug to match the red female connector cable extending from the fused plug on the power cable. The other end of the surge arrestor cable shall be integrally molded to a MOV submergible surge arrestor. The red male plug shall make a submergible connection when mated to the red female connector on the power cable.

Power Cable: This cable feeds the Luminaire Cable and the Surge Arrestor Cable from the load side of its integrally fused red male plug end. The red fused plug shall contain FNQ 10 amp 600 volt fuses (13/32 by 1 1/2 inch) or equal. A solid copper slug shall be installed on neutral side for line to neutral service. Both lines shall be fused for line to line service. The section that feeds the Luminaire Cable shall be a 10 foot section of 14/3 SOWA cable with an orange female connector molded to the end extending up into the base of the pole. This female connector shall pass easily through a standard size 35 PVC elbow and make a submergible connection when mated with the orange male plug on the Luminaire Cable. The section that feeds the Surge Arrestor Cable shall be 12 inches in length of 10/2 SOWA cable with a red female connector on the end. The red female connector shall make a submergible connection when mated to the red male plug on the Surge Arrestor Cable.

Luminaire Cable: This cable is a variable length of 14/3 SOWA cable with an orange male molded plug molded to match the orange female end of the Power Cable. The connector shall require 25 pounds of force to mate or disengage from the female end. When engaged, the connection shall be

watertight and submergible. The cable strain relief shall extend approximately 2 inches from the connector. The length of the cable shall be the length of the pole and support arm plus 5 feet.

The Distribution Block and each connector shall be made of thermosetting synthetic polymer which is non-flame supporting and which remains flexible over a temperature range of -40 to 190ºF. Hardness of the molded rubber shall be 65 durometer.

992-12.2.1 Testing and Performance Criteria: The system shall pass the following performance criteria in accordance with NEC 110 2:

Dielectric Test - No breakdown shall occur with a test potential of 1,960 volts applied between the primary conductors (tied together) and the protective ground for a period of one minute.

Leakage Current Test - Leakage current shall be measured on the mated connectors between the primary conductors and the protective ground conductor. When tested at the rated operating voltage, the leakage current shall not exceed 0.5 mA. The mated connectors shall then be wrapped in aluminum foil and the leakage current measured between the primary conductors and the foil wrap. When tested at the rated operating voltage, the leakage current shall not exceed 0.5 mA.

Flame Retardant Test - Flammability tests shall be conducted on the cable, the molded body of the connectors, and the molded protective caps. These materials shall be subjected to five flame applications on for l5 seconds and off for l5 seconds. The materials shall self-extinguish within one minute upon removal of the flame and not burn through.

Internal Temperature Test - The internal temperature rise of the contact area of the mated connectors shall not exceed a temperature rise of 54ºF referenced to 73ºF ambient temperature when operated at the maximum current rating.

External Temperature Test - The external temperature rise of the mated connectors and cable shall not be greater than 54ºF referenced to 73ºF ambient temperature when operated at the maximum current rating.

Fault Test - The mated connectors shall be fault tested by applying a test current of .l,000 amperes, 60 HZ, for a minimum of 3 cycles (50 ms). The mated connectors shall then satisfactorily pass the dielectric test.

Drop Test - The connectors shall not break, crack or suffer other damage when subjected to eight consecutive drop tests from 3 feet above the concrete floor with the connectors having been rotated 45 degrees between each drop.

Crushing Test - No breakage or deformation shall result when the mated and unmated connectors are subjected to a crushing force of 500 pounds for one minute. Following the crush test, the dielectric test shall be satisfactorily passed.

Impact Resistance Test - No breakage or deformation shall result when the connectors are subjected to an impact caused by dropping a cylindrical 10 pound weight having a flat face 2 inches in diameter from a height of 18 inches.

Flex Test - No detachment or loosening shall result when each connector is subjected to a 5,000 cycle flex test at the cable/bond area back and forth in a plane through an angle of l80 degrees. Following the flex test the dielectric test shall be satisfactorily passed.

No Load Endurance Test - No excessive wear shall result when the male and female connectors and protective cap and female connector were subjected to 2,000 cycles of complete insertion and withdrawal.

Rain Test - The mated and capped connectors shall be subjected to a continuous water spray (simulating worst case outdoor rain down pour) for at least one hour at a rate of at least 18 inches per hour at an operating pressure of 5 psi. The dielectric and leakage current tests shall be satisfactorily passed. The connectors shall be unmated and caps removed. Inspection shall indicate that water had been successfully prevented from reaching the contact areas of the connectors.

Watertight (Immersion) Tests - The mated and capped connectors shall be immersed in water for one hour in which the highest point of the test samples is at least 3 feet below the water level. Immediately following the immersion, a satisfactory dielectric and leakage current tests shall be performed. The connectors shall be unmated and caps removed. Inspection shall indicate that water had been successfully prevented from reaching the contact areas of the connectors.

Exposure to Deteriorating Liquids - The cable and connectors shall be dried at 212ºF for one hour. The samples shall then be immersed in ASTM Reference Oil No. l and ASTM Reference Fuel C liquids for one hour. The samples shall show no evidence of bubbling, cracking or corrosion. Within one hour after being removed from the fluids, the test samples shall satisfactorily pass the flammability test.

992-12.2.2 Qualified Products List: Pole Cable Distribution Systems installed as alternates to the Design Standards, Index No. 17500, shall be one of the products listed on the QPL. Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6.

992-12.3 General (Highmast Lighting): These requirements are applicable for all systems rated up to and including 600 V.

A modular cable system consisting of rubber covered cables with watertight connectors, and surge arrestor shall be installed. The cables shall extend from an underground junction box near the base of the pole to the luminaires at the top of the pole. A cable system shall be required at each highmast pole.

Power Cable: This cable shall be a 15 foot section of 10/3 SOWA cable that is wired to the line side of the Circuit Breaker in the pole and the other end shall be spliced to the distribution cable that feeds through the underground junction box near the base of the pole.

Circuit Breaker Cable: This cable is a 8 foot length of 10/3 SOWA cable with no connector at the end that is fed from the load side of the circuit breaker and a female connector on the other end. This female connector shall mate with the male plug on the pole cable, the male flanged receptacle on the ring junction box, and also the male plug on the lowering hoist.

Pole Cable: The length of this cable is the mounting height of the pole plus 6 feet. The cable shall be 10/3 SOWA with a male plug on one end that mates with the connector on the circuit breaker cable. The other end fits under the lugs in junction box mounted on the fixture ring at the top of the pole.

Junction Box Cable: This cable is a 3 foot length of 10/3 SOWA cable with a female connector on one end that fits the male flanged receptacle on the ring mounted junction box. The other end shall fit under the same lugs as the pole cable.

Junction Box Male Flanged Receptacle: This male flanged receptacle shall mate with the junction box cable. The back of the flanged receptacle shall be wired to the fixture bus in the junction box.

The plugs, connectors and receptacles in the highmast system shall meet the requirements of NEMA 6 or IP 67.

Surge Arrestor: The surge arrestor shall be installed in the circuit breaker panel.

992-12.4 General (Wall Mounted Lighting): These requirements are applicable for all bridge mounted and barrier wall mounted systems rated up to and including 600V.

A cable system consisting of rubber covered cables, in-line fuses and a surge arrestor shall be installed. The cables shall extend from a junction box in the wall to the luminaire at the top of the pole.

A 14/3 SOWA cable shall be spliced to the distribution cable in the junction box and feed in-line fuses and a surge arrestor located in the junction box. The fuses shall be FNQ 10 amp 600 volt fuses. A solid copper slug shall be installed on the neutral side for line to neutral service. Both lines shall be fused for line to line service. The surge arrestor shall be connected on the load side of the fuses. The cable shall continue to the luminaire at the top of the pole.

SECTION 993
OBJECT MARKERS AND DELINEATORS

993-1 Object Markers.

993-1.1 General: Object markers shall meet the general requirements outlined in the Manual of Uniform Traffic Control Devices (MUTCD). For uniformity, all Type 1 markers shall be either OM1-1 or OM1-3 style markers, all Type 2 markers shall be either OM2-1V or OM2-2V style markers and all end of road markers shall be either OM4-1 or OM4-3 style markers.

993-1.2 Retroreflectors: The reflectors shall be of acrylic plastic and shall be a minimum of 3 inches in diameter. They shall be mounted in a heavy-duty housing with a back plate.

The reflector shall consist of a clear and transparent plastic lens, which shall be red or amber as specified, and a plastic back of the same material, fused to the lens under heat and pressure around the entire perimeter, in such manner as to form a homogeneous unit, permanently sealed against dust, water, and water vapor.

The lens shall consist of a smooth front surface, free from projections or indentations (other than for identification or orientation) and a rear surface bearing a prismatic configuration such that it will effect total internal reflection of light.

The acrylic plastic shall be of a type meeting the requirements of Federal Specification L-P-380, Type I, Class 3, and, in order that the Department can readily check the suitability of the raw material used, the manufacturer shall stipulate the raw material and the particular molding compound to be furnished.

993-1.2.1 Durability Tests for Retroreflectors: Seal Test: The following test will be used to determine if a reflector is adequately sealed against dust and water.

Submerge 20 samples in water bath at room temperature. Subject the submerged samples to a vacuum of 10 inches gauge for five minutes. Restore atmospheric pressure and leave samples submerged for five minutes, then remove and examine the samples for water intake. Failure of more than two of the 20 samples tested shall be cause for tentative rejection of the LOT.

993-1.2.2 Optical Requirements: The initial specific intensity of object markers shall be at least equal to the minimum values shown below. Failure to meet the required specific intensity shall constitute failure of the reflector being tested.

Observation Angle	Entrance Angle	Specific Intensity candelasr/foot-candle		
		Crystal	Yellow	Red
0.1 degree	0 degree	40	24	10
0.1 degree	20 degree	16	10	4

The reflector to be tested shall be spun so as to have an average orientation effect, and shall be placed at a distance of 100 feet from a single light source having an effective diameter of 2 inches. The light source shall be operated at approximately normal efficiency. The return light from the reflector shall be measured by means of a photo-electric photometer having a minimum sensitivity of 1 by 10^7 foot-candles per mm scale division. The photometer shall have a receiving aperture of 1/2 inch diameter, shielded to prevent the entry of stray light. The distance from light source center to aperture center shall be 2.1 inches for the 0.1 degree observation angle.

If a test distance other than the stipulated 100 feet is used, the source and the aperture dimensions, and the distance between source and aperture shall be modified directly as the test distance.

993-1.2.3 Reflector Housing: The reflector shall be mounted in a housing fabricated of aluminum alloy No. 3003-H 14 (or other alloy approved as equal for the purpose), and having a thickness of 0.064 inch.

993-1.3 Retroreflective Sheeting:

993-1.3.1 Retroreflective Sheeting: The retroreflective sheeting for object markers shall meet the requirements of Section 994, sheeting Types III, IV, or VII. The retroreflective area shall be in accordance with the MUTCD. The retroreflective sheeting shall be permanently adhered to 0.040 inch sheet

aluminum for Type 2 markers and 0.080 inch sheet aluminum for Type 1, 3 and end of the road markers. Aluminum shall be of 6061-T6 (ASTM B-209) prepared in accordance with recommendations of the sheeting manufacturer.

993-1.3.2 Assembly: Type 2 and 3 markers shall be mounted directly to the post by two holes on the face of the marker. The mounting holes shall be 1/4 inch square holes to receive 1/4 inch carriage bolts, or other 1/4 inch bolts and shall be spaced to fit holes on the post spaced at 1 inch centers.

993-1.4 Posts: The marker posts shall be of steel or aluminum as shown in the Design Standards or plans. Steel posts shall be 2.5#/Ft. flanged U-Channel meeting the requirements of 700-2.3. Round aluminum posts shall meet the requirements of Index 11860.

993-2 Delineators.

993-2.1 General: Delineators shall be classified into four types: recycled flexible post delineators, nonflexible post delineators, high visibility median separator delineators, and high performance delineators.

993-2.2 Recycled Flexible Post Delineators: Meet the requirements of Section 972.

993-2.3 Nonflexible Post Delineators:

993-2.3.1 Posts: The post shall be 1.1 #/Ft. steel U-Channel posts meeting the requirements of 700-2.3.

993-2.3.2 Retroreflective Sheeting: The retroreflective sheeting shall be Types III, IV, V or VII sheeting and meet the requirements of Section 994. The reflective sheeting shall have a minimum width of 4 inches and have a minimum area of 32 square inches. The retroreflective sheeting shall be permanently adhered to 0.040 inch sheet aluminum.

993-2.4 High Visibility Median Separator Delineators:

993-2.4.1 Dimensions: The delineator shall have a minimum height of 42 inches above the surface of the separator.

993-2.4.2 Post Base: The base shall be manufactured to accommodate the replacement of the post. The base shall be mechanically anchored to the separator and be capable of withstanding ten vehicle impacts without damage.

993-2.4.3 Color: The plastic post shall be opaque white. The yellowness index shall not exceed 12 when tested in accordance with ASTM D-1925 or ASTM E-313. The daylight 45 degree, 0 degree luminous directional reflectance shall be a minimum of 70 when tested in accordance with ASTM E 1347 or ASTM E-1164.

993-2.4.4 Retroreflective Sheeting: The reflective sheeting shall be Types III, IV, V or VII and meet the requirements of Section 994. The reflective sheeting shall have a minimum width of 8 inches and have a minimum area of 230 square inches facing the approach to the separator.

993-2.4.5 Impact Performance: The post, installed according to manufacturer's recommendations, shall be capable of returning to a vertical position ±5 degrees when tested according to National Testing Product Evaluation Program (NTPEP). The NTPEP requirement of one-half of the hits at 32 F is waived. All hits may be at 65 F or greater. NTPEP data or independent test lab data shall be submitted for product approval.

993-2.5 High Performance Delineators:

993-2.5.1 Dimensions: The delineator shall have a minimum height of 48 inches above the pavement surface and have a minimum dimension of 2 inches.

993-2.5.2 Post Base: The base shall be manufactured to accommodate the replacement of the post. The base shall be mechanically anchored to the pavement and be capable of withstanding fifty vehicle impacts without damage.

993-2.5.3 Color: The plastic post shall be opaque white. The yellowness index shall not exceed 12 when tested in accordance with ASTM D-1925 or ASTM E-313. The daylight 45 degree, 0 degree luminous directional reflectance shall be a minimum of 70 when tested in accordance with ASTM E-1347 or ASTM E-1164.

993-2.5.4 Retroreflective Sheeting: The reflective sheeting shall be Type V abrasion resistant sheeting and meet the requirements of Section 994. The reflective sheeting shall have a minimum omni directional area of 30 square inches.

993-2.5.5 Impact Performance: The post, installed according to manufacturer's recommendations, shall be capable of returning to a vertical position ±5 degrees with no delaminating after receiving fifty vehicle impacts when tested according to National testing Product Evaluation Program (NTPEP). The NTPEP requirement of one-half of the hits at 32° F is waived. All hits shall be at 65° F or greater. NTPEP data or independent test lab data shall be submitted for product approval. For acceptance purposes there should be no post failures and no more than two posts may list between 5°and 10°after receiving fifty vehicle impacts.

993-3 Retroreflector Units for Guardrail and Concrete Barrier Wall.

993-3.1 General: Retroreflector units for use on guardrail and concrete barrier wall installations shall consist of retroreflective sheeting permanently adhered to 0.090 inch minimum thick body. The body shall have a flexible hinge which allows the reflector to fold down and spring back to an upright position after impact. Guardrail reflectors shall be designed for mounting to the web of steel posts or designed for mounting to wood posts. Barrier wall reflectors shall be designed for mounting to the top of the barrier wall.

993-3.2 Retroreflective Sheeting: The sheeting for these reflector units shall be Type IV, V, or VII meeting the requirements of Section 994. The sheeting shall be yellow or white, depending on the locations of use for each. The dimensions of the reflective sheeting shall be 3 wide by 4 inches high. The sheeting shall be installed by the reflector manufacturer.

993-3.3 Installation: The reflector units shall be capable of being installed on the top of guardrail posts or the top of the barrier wall.

993-4 Product Acceptance on the Project.

Acceptance will be made in accordance with the requirements of Section 705. Manufacturers seeking evaluation of their product must submit an application in accordance with Section 6.

SECTION 994
RETROREFLECTIVE AND NONREFLECTIVE SHEETING FOR TRAFFIC CONTROL DEVICES

994-1 Description.

994-1.1 General: This Section specifies the requirements for retroreflective and nonreflective sheeting materials, transparent and opaque process inks for retroreflective sheeting materials and film overlays for traffic control devices. The sheeting materials used shall be one of the products included on the Qualified Products List (QPL), as specified in 6-1.

994-1.2 Classification: Retroreflective sheeting material Types III, IV, V, and VI shall be classified in accordance with ASTM D-4956. In addition, a special classification, Type VII (Special) is added for super high intensity retroreflective sheeting. This special classification shall include materials classified as Type VII and above in accordance with ASTM D-4956. A special classification for Type VI fluorescent pink is also added.

994-2 Materials.

Retroreflective sheeting, screen processing inks and film overlay materials used for any of the applications described herein shall be one of the products included on the QPL, as specified in 6-1. The retroreflective sheeting shall meet the requirements of Types III, IV, V, VI in ASTM D-4956 or Type VII (Special) and fluorescent pink listed below in accordance with their approved usage. Samples shall be taken in accordance with the Department's Sampling, Testing and Reporting Guide Schedule and on a random basis at the discretion of the Engineer.

994-3 Performance Requirements.

994-3.1 Testing: The retroreflective sheeting shall be tested in accordance with ASTM D-4956 and the Florida Test Method for retroreflective and nonreflective sheeting, FM 5-571. For retroreflectivity, the sheeting materials shall meet the minimum requirements as stated for 0.2 degree and 0.5 degree observation angles in ASTM D-4956. Evaluation of test samples shall be field tested in accordance with FM 5-571 for each color.

994-3.2 Retroreflective Intensity: The retroreflective sheeting shall meet the minimum initial requirements as stated for 0.2 degree and 0.5 degree observation angles in ASTM D-4956. Type VI fluorescent pink sheeting and Type VII (Special) sheeting shall meet the minimum retroreflectivity requirements listed below.

994-3.3 Color: The retroreflective and nonreflective sheeting or film shall conform to both the daytime and nighttime color requirements of ASTM D-4956, In addition to ASTM D-4956, the fluorescent pink initial color shall meet the following x, y chromaticity coordinates:

Fluorescent Pink	1	2	3	4
x	.450	.590	.644	.536
y	.270	.350	.290	.230

The daytime luminance factor shall meet ASTM D-4596 except for fluorescent pink sheeting which shall have a minimum luminance factor of 25.

994-3.3.1 Accelerated Outdoor Test: The retroreflective and nonreflective materials shall meet the ASTM D-4956 Accelerated Outdoor Table weathering requirements for performance except Type VI fluorescent pink and fluorescent yellow.

994-3.4 Adhesive Backing: The adhesive backing of the retroreflective and nonreflective sheeting or film shall be either Class 1, Class 2 or Class 5 per ASTM D-4956. The retroreflective and nonreflective sheeting or film, after application, shall tightly adhere to the application surface and show no discoloration, cracking, crazing, blistering or dimensional change.

994-3.5 Physical Properties: The retroreflective and nonreflective sheeting or film material shall meet the ASTM D-4956 minimum requirements for colorfastness, shrinkage, flexibility, liner removal, adhesion, impact resistance and specular gloss.

994-3.6 Color Processibility: The retroreflective sheeting shall permit color processing with compatible transparent and opaque process inks as approved by the sheeting manufacturer and listed on the QPL.

Type VII (Special) Sheeting										
Minimum Coefficient of Retroreflection (cd/foot-candle·ft2)(cd/fc·ft2)										
Observation/Entrance Angle (degree)	White	Yellow	Red	Orange	Blue	Green	Brown	Fluorescent Orange	Fluorescent Yellow	Fluorsecent Yellow/Green
0.2/-4	380	304	95	250	19	38	19	180	220	360
0.5/-4	250	195	55	100	12	25	8	60	145	235
0.2/30	220	176	48	110	11	22	9	85	125	205
0.5/30	135	105	30	50	7	14	3	33	75	125

Type VI Sheeting	
Minimum Coefficient of Retroreflection (cd/foot-candle·ft^2)(cd/fc·ft^2)	
Observation/Entrance Angle	Fluorescent Pink
(degree)	
0.2/-4	160
0.5/-4	100
0.2/30	100
0.5/30	40

994-4 Direct and Reverse Screen Processing.

994-4.1 General: The transparent and opaque process inks furnished for direct and reverse screen processing shall be of a type and quality formulated for retroreflective sheeting materials as listed on the QPL and applied in accordance with the manufacturer's instruction. Screen processing in accordance with the techniques and procedures recommended by the manufacturer shall produce a

uniform legend of continuous stroke width of either transparent or opaque ink, with sharply defined edges and without blemishes on the sign background that will affect the intended sign use. The process inks shall be one of the products listed on the QPL.

994-4.2 Color: The daytime color of the finished transparent process inks shall conform to the requirements as specified in 994-3.3.

994-5 In-Service Minimum Requirements.

The retroreflective sheeting and screen processed retroreflective sheeting shall have the minimum coefficient of retroreflection as shown in ASTM D-4956, Outdoor Weathering Photometric Requirements for All Climates except Type VI fluorescent pink and fluorescent yellow. In addition, Type VII (Special) classified sheeting materials shall have a minimum coefficient of retroreflection of 80% of the values listed in the above table. Only the observation angle of 0.2 degrees and an entrance angle of -4 degrees shall be used in measuring in-service minimums. The in-service life for opaque overlay films, black processing inks and opaque lettering shall equal the life of the reflective sheeting to which it is applied.

994-6 Packaging and Labeling.

Shipment shall be made in containers which are acceptable to common carriers and packaged in such a manner as to ensure delivery is in perfect condition. Each package shall be clearly marked as to the name of the manufacturer, series, color, quantity enclosed and date of manufacture.

994-7 Certification.

For permanently installed signs, the Contractor shall be required to furnish to the Engineer one material certification from the sheeting manufacturer documenting that the retroreflective sheeting meets the requirements of this Section. Each certification shall cover only one type of retroreflective or non reflective sheeting or film. The certification shall meet the requirements in Section 6.

Certification shall not be required for signs and devices used in the work zone.

994-8 Qualified Products List.

994-8.1 General: All reflective and nonreflective sheeting materials and process inks shall be one of the products listed on the QPL. Products may only be used for applications recommended by the manufacturer. A notation of the sheeting materials approved for the inks may be placed on the QPL.

994-8.2 Other Requirements: Manufacturers seeking approval of sheeting material products shall submit an application, Material Safety Data Sheet (MSDS), and certification. Non-sheeting materials may be submitted under this Section with reference to specific equivalency of performance requirements of overall end product. Final acceptance will be based on tests and verification in accordance with this Specification, FM 5-571 and 6-1.

994-9 Samples.

Field samples will be obtained in accordance with the Department's Sampling, Testing and Reporting Guide Schedule.

INDEX

A

B

C

D

E

F

G

H

I

J

L

M

N

O

P

Q

R

S

T

U

V

W

Z