RFP Guidelines for Telecommunications Systems Infrastructure For Public Safety Complex Leon County, City of Tallahassee

Table of Contents

I. Outside Plant Service Entrance and Termination

INTRODUCTION
Construction documents provide the necessary guidelines to install service entrances to buildings and information for the termination of cables entering buildings.
Reference:
271300 Communications Backbone and Campus Cabling

Damaged cable is NOT acceptable. Damages incurred during installation are the responsibility of The Contractor. Damages incurred after installation and acceptance of the cable are the responsibility of the party involved. All damages are to be reported to Leon County MIS immediately.

All fiber optic cables shall be installed in 3-3" plenum rated innerduct with pull string. Approved manufacturer: MacCell or equivalent. NOTE: Construction drawings may not reflect an innerduct requirement; however, all fiber optic cabling shall be installed in innerduct. Submittals for innerduct must be approved by Leon County MIS prior to start of construction.

II. Telecommunications Rooms

INTRODUCTION
Construction documents provide the necessary guidelines to install service entrances to buildings and information for the termination of cables entering buildings.
Reference:
271100 Communications Equipment Room
270536 Cable Trays for Communications Systems

Overview

DEFINITIONS
Telecommunications rooms are special purpose rooms that house telecommunications equipment. These equipment rooms have stringent requirements due to the nature, size and complexity of the equipment housed in the rooms.

These rooms have two separate classifications. These are:

Main Distrubution Frame (MDF):

A MDF is defined as a telecommunications room that serves as the main communications equipment room in a building. This room will house some or all of the following building systems:

- telecommunications (PBX/KSU/ESSX) equipment
- broadband CATV equipment
- data network equipment

- lightning protection
- fiber optic cable terminations
- building automation system equipment
- building security and fire alarm equipment
- overhead paging systems
- Telecommunications room hardware installation will be coordinated with Leon County MIS.

Intermediate Distribution Frame (IDF):

A IDF is defined as a telecommunications room that serves as an intermediate connecting point for the building horizontal and vertical cabling and information systems. This room will typically serve an entire floor (less than 10,000 square feet) or a portion of a floor (greater than 10,000 square feet).

Communications Closets shall be star attached to the MDF unless special topologies are needed and approved by the Leon County MIS.

Minimum clearances for equipment and cross-connect fields in the telecommunications closet:

- Allow a minimum of 3.0 ft. of clear working space from equipment and cross connect fields.
- Equipment racks or cabinets should be provided within the telecommunications closet (room). Allocate a space of at least 32 in. deep and 7 ft., 6 in. high for each rack or cabinet. Provide space for an aisle of at least 32 in. wide
- Telecommunications room hardware installation will be coordinated with Leon County MIS

III. Inside Cable Plant Wiring and Raceways

Reference:
271500 Communications Horizontal Cabling

IV. Testing and Labeling

Reference:
271500 Communications Horizontal Cabling
271300 Communications Backbone & Campus Cabling
270553 Identification for Communications Systems

V. Grounding and Protection

NOTE: Grounding is specified in the various construction specification documents, as applicable.

VI. Codes, Standards and Regulations

NOTE: Codes, standards, and regulations are specified in various construction specification documents as applicable.

VII. Additional Requirements

Additional Requirements

- The Contractor will coordinate with Leon County MIS Construction Liaison on IT room hardware installation.
- The Contractor will provide submittals for approval for all equipment or hardware to be installed as described in the construction specification documents.
- The Contractor must have adequate staff working on site during installation phase of project. (Including project manager).
- The Contractor will provide a telephone number and project manager for this project.
- The Contractor will provide a telephone number and name for the second level contact in the event that acceptable response has not been made by project manager.

After the project is complete

- The Contractor shall provide all cable test results as outlined in Section V. The Contractor's RCDD shall sign off on all copper and fiber optic cable test results, indicating that he was in responsible charge of all cable testing procedures and that all cables were tested in compliance with the contract documents and met or exceeded the requirements stated therein.
- In addition, The Contractor shall provide as-built drawings (in AutoCAD .DWG format) indicating all outlets, cable routes, cable ID, conduit, Communications closets, cable trays, and pullboxes. The Contractor's RCDD shall affix his stamp to the as-built drawings, indicating that he has reviewed and approved the drawings as being complete, accurate, and representative of the system as actually installed.
- The RCDD is responsible for certifying and assuring that all installations by contractors are performed in compliance with the contract documents & specifications of this wiring standards document.

Division	Section Title

SPECIFICATIONS GROUP

Facility Construction Subgroup

END OF TABLE OF CONTENTS - TELECOMMUNICATIONS

SECTION 270100 - GENERAL PROVISIONS FOR TELECOMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and Division 01 Specification Sections, apply to this Section.

B. Applicable provisions of this section apply to all sections of Division 27, Telecommunications.

1.2 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Drawn to scale, on which space competing systems are shown and coordinated with each other, using input from installers of the items involved.

B. Qualification Data: For Installer and manufacturer.

C. Furnish a copy of the installer’s warranty.

D. Furnish a copy of the manufacturer's warranty for each piece of equipment.

E. Operating and Maintenance Instructions
   1. Secure three copies of operating and maintenance instructions, service manuals, and parts lists applicable to each item of equipment furnished. Deliver three bound sets for the Owner's use. Include nameplate data and design parameters in operation and maintenance manuals. Clearly distinguish between information which applies to the equipment and information which does not apply. Delivery of required documents is a condition of final acceptance.

1.3 QUALITY ASSURANCE

A. General:
   1. It is the intent of the plans and specifications to obtain a complete, operable and satisfactory installation.
   2. All materials shall be new, be properly labeled and/or identified and be in full compliance with the contract documents.
   3. All work shall comply with applicable Codes and Standards.
   4. Manufacturer's model names and numbers used in these specifications are subject to change per manufacturer's action. Contractor shall therefore verify them with manufacturer's representative before ordering any product or equipment

B. Furnish new and unused materials and equipment manufactured in the U.S.A. Where two or more units of the same type or class of equipment are required provide units of a single manufacturer.

C. All products used in this project installation shall be new and currently under manufacture and shall have been applied in similar installations for a minimum of two years. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner in writing. Spare parts shall be available for at least five years after completion of this contract.

1.4 Division 01 Section "Quality Requirements" CODE REQUIREMENTS

A. Perform work in accordance with the following codes and any applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.
   1. Occupational Safety and Health Regulations (OSHA).
   2. National Fire Codes
      a. NFPA 1 Uniform Fire Code, Florida 2007 Edition
      b. NFPA 70 National Electrical Code
      c. NFPA 101 Life Safety Code, Florida 2007 Edition
   3. Florida Building Codes 2007 Edition w/ 2008 & 2009 Supplements
      a. Building Code - Chapter 11 Florida Accessibility Code
      b. Building Code - Chapter 13 Energy Efficiency Code
   4. Florida Administrative Code
      a. Chapter 61C-5 Florida Elevator Safety Code
      b. Chapter 69A-3 Fire Prevention – General Provisions
      c. Chapter 69A-47 Uniform Fire Safety Standards for Elevators
      d. Chapter 69A-60 The Florida Fire Prevention Code
   5. ADA Accessibility Guidelines for Buildings (ADAAG)
   6. Motorola R-56 Standards and Guidelines for Communication Sites

B. Resolve, in writing, any code violation discovered in contract documents with the Engineer prior to bidding. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner.

C. The installer shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings required to comply with all applicable laws, ordinances, rules and regulations.

D. The installer shall include in his work the completion of Florida Energy Code compliance documentation for method A as required for building permit. The installer may engage the Engineer of Record to complete said compliance documentation for mutual agreeable compensation.

1.5 REFERENCE SPECIFICATIONS AND STANDARDS

A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments or supplements in effect on date bids are received. Specifications and standards are minimum requirements for all equipment, material and work. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.

B. Whenever a reference is made to a standard, installation and materials shall comply with the latest published edition of the standard at the time project is bid unless otherwise specified herein

1.6 PERMITS FEES AND INSPECTIONS

A. Obtain and pay for all permits, fees, tap fees, connection charges, demand charges, systems charges, impact fees and inspections.

B. Deliver all certificates of inspection issued by authorities having jurisdiction to the Engineer.

1.7 WARRANTY

A. Warranty work and equipment for one year from the date of final acceptance of the project. During the warranty period provide labor and materials to make good any faults or imperfections that may arise due to defects or omissions in materials or workmanship.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 CONTRACT DOCUMENTS

A. Examine all drawings and specifications carefully before submitting a bid. Architectural drawings take precedence over electrical drawings with reference to building construction. If discrepancies or conflicts occur between drawings, or between drawings and specifications, notify the Engineer in writing prior to bid date; however, the most stringent requirement shall govern.

B. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, Contractor shall make use of all data in all of the contract documents and shall verify this information at the building site.

C. The drawings indicate required size and points of termination of pipes, conduits and ducts and suggest proper routes to conform to structure avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the responsibility of the Contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or cost to the Owner.

D. Furnish, install and/or connect with appropriate services all items shown on any drawing without additional compensation.

E. Consider the terms "provide" and "install" as synonymous with "furnish and install".

F. Any and all questions about a subcontractor's scope of work responsibility shall be addressed to and answered by the Construction Manager.

G. Questions about Construction Documents: Any and all questions shall be submitted through the proper channels IN WRITING and, in turn, shall be answered by the Engineer in writing. All telephone conversations shall be considered unofficial and, as such, shall not be considered official or binding responses to Contractor's questions.

3.2 EXAMINATION

A. Each Contractor shall visit the projects site and fully familiarize himself with existing conditions and account for these conditions in the submitted bids

B. Examine conditions, with Installer present for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Included within the scope of Division 26 is work where equipment and/or materials are furnished or required by this Division and installed under another Division (designated by the Contractor). It is the responsibility of the Contractor to see that all such work is included in the contract bid amount and completed during construction.

3.3 INSTALLATION

A. Install materials and equipment in a professional manner. The Engineer may direct replacement of items which, in his opinion, do not present a professional appearance. Replace or reinstall items at the expense of the Contractor.

B. Examine all work installed by others where it applies to work of Division 26. Notify the Engineer if conditions exist which prevent satisfactory results. Start of work by the Contractor shall be construed as acceptance by him of all claims or questions as to suitability of the work of others to receive his work.

C. Conflicts: Where there is a conflict between the contract document and an applicable "CODE", the "CODE" shall govern except where the requirements of the contract documents are more stringent; where there is a conflict between the contract drawings and the contract specifications, the most stringent shall govern.

D. Damage to Other Work and Personnel
   1. Adequately protect work, equipment, fixtures, and materials. At work completion, all work must be clean and in good condition.
   2. Carry insurance as prescribed by law and as required in this specification for protection of employees, other persons, materials and equipment on the building site.
   3. Contractor shall pay for all damages caused by his personnel, including his subcontractors.

E. Obstructions
   1. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
   2. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided. Verify locations given.
   3. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
   4. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.

F. Where "rated" walls, floor, roofs and ceilings are penetrated or cut to install equipment, materials, devices, etc. the Contractor shall provide and install all materials required to re-establish the rating of the wall, floor, roof or ceiling to the satisfaction of the authority having jurisdiction.

G. Space Requirements: Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.

H. Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost to the Owner.

I. Comply with NECA 1.

J. Wiring Method: Install cables in raceways . Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceways and Boxes for Electrical Systems."

K. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

L. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.4 CLEANING

A. During construction keep the job site clean and remove all rubbish.

B. Upon completion of work leave the premises and work in a clean and acceptable condition. Remove all tools, scaffolding, materials and rubbish from the building and site. Clean all panels and equipment.

3.5 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of systems and equipment Installer or manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacture's authorized replacement parts and supplies.

END OF SECTION 270100

SECTION 270105 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and other Division 01 Specification Sections apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

1.3 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use CSI Form 13.1A .
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. Certificates and qualification data, where applicable or requested.
g. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified

product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.

h. Cost information, including a proposal of change, if any, in the Contract Sum.

i. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.

j. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Engineer will notify Contractor through Construction Manager of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.

b. Use product specified if Engineer does not issue a decision on use of a proposed substitution within time allocated.

1.5 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution is consistent with the Contract Documents and will produce indicated results.

b. Requested substitution provides sustainable design characteristics that specified product provided for achieving LEED prerequisites and credits.

c. Substitution request is fully documented and properly submitted.

d. Requested substitution will not adversely affect Contractor's construction schedule.

e. Requested substitution has received necessary approvals of authorities having jurisdiction.

f. Requested substitution is compatible with other portions of the Work.

g. Requested substitution has been coordinated with other portions of the Work.

h. Requested substitution provides specified warranty.

i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Engineer will consider requests for substitution if received within 60 days after the Notice of Award. Requests received after that time may be considered or rejected at discretion of Engineer.

1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
b. Requested substitution does not require extensive revisions to the Contract Documents.
c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
d. Requested substitution provides sustainable design characteristics that specified product provided for achieving LEED prerequisites and credits.
e. Substitution request is fully documented and properly submitted.
f. Requested substitution will not adversely affect Contractor's construction schedule.
g. Requested substitution has received necessary approvals of authorities having jurisdiction.
h. Requested substitution is compatible with other portions of the Work.
i. Requested substitution has been coordinated with other portions of the Work.
j. Requested substitution provides specified warranty.
k. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 - EXECUTION (Not Used)

END OF SECTION 206105

SECTION 270120 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and other Division 27 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Requirements:

1. Section 270170 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
2. Section 270180 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
3. Section 270190 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Engineer's Digital Data Files: Electronic digital data files of the Contract Drawings will not be provided by Engineer for Contractor's use in preparing submittals.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 15 days for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals by Engineer's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.

D. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.

    a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).

3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Engineer.
4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner**,** containing the following information:

    a. Project name.
    b. Date.
    c. Name and address of Engineer.
    d. Name of Construction Manager.
    e. Name of Contractor.
    f. Name of firm or entity that prepared submittal.
    g. Names of subcontractor, manufacturer, and supplier.
    h. Category and type of submittal.
    i. Submittal purpose and description.
    j. Specification Section number and title.
    k. Specification paragraph number or drawing designation and generic name for each of multiple items.
    l. Drawing number and detail references, as appropriate.
    m. Location(s) where product is to be installed, as appropriate.

n. Related physical samples submitted directly.
o. Indication of full or partial submittal.
p. Transmittal number, numbered consecutively.
q. Submittal and transmittal distribution record.
r. Other necessary identification.
s. Remarks.

5. Metadata: Include the following information as keywords in the electronic submittal file metadata:

a. Project name.
b. Number and title of appropriate Specification Section.
c. Manufacturer name.
d. Product name.

E. Options: Identify options requiring selection by Engineer.

F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.

H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Post electronic submittals as PDF electronic files directly to Engineer's FTP site specifically established for Project.

a. Engineer will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

2. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

a. Manufacturer's catalog cuts.
b. Manufacturer's product specifications.
c. Standard color charts.
d. Statement of compliance with specified referenced standards.
e. Testing by recognized testing agency.
f. Application of testing agency labels and seals.
g. Notation of coordination requirements.
h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

a. Wiring diagrams showing factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before or concurrent with Samples.
6. Submit Product Data in the following format:

a. PDF electronic file.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
3. Submit Shop Drawings in the following format:

a. PDF electronic file.

4. BIM File Incorporation: Develop and incorporate Shop Drawing files into Building Information Model established for Project.

a. Prepare Shop Drawings in the following format: Same digital data software program, version, and operating system as the original Drawings .

D. Maintenance Data: Comply with requirements specified in Section 270170 "Operation and Maintenance Data."

E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Engineers and owners, and other information specified.

F. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

G. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

2.2 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit four paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

C. BIM File Incorporation: Incorporate delegated-design drawing and data files into Building Information Model established for Project.

1. Prepare delegated-design drawings in the following format: Same digital data software program, version, and operating system as the original Drawings.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's

approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ENGINEER'S ACTION

A. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

B. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Submittals not required by the Contract Documents may be returned by the Engineer without action.

END OF SECTION 260120

SECTION 270130 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and other Division 27 Specification Sections apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Engineer, Owner, Commissioning Authority, or authorities having jurisdiction are not limited by provisions of this Section.
4. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer.

C. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.

D. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

E. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

F. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

G. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.5 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

G. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

1.6 QUALITY CONTROL

A. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections.

B. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

E. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to Owner, Engineer, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Engineer.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's, Commissioning Authority's, reference during normal working hours.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 270130

SECTION 270150 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and other Division 27 Specification Sections apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:

1. Section 270105 "Substitution Procedures" for requests for substitutions.

1.3 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, which is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS

A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
2. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Engineer will notify

Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Form of Approval: As specified in Section 270120 "Submittal Procedures."
b. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 260120 "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.
7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Engineer will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures:

1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
3. Products:

a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
b. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.

4. Manufacturers:

a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
b. Nonrestricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.

5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

C. Visual Selection Specification: Where Specifications include the phrase "as selected by Engineer from manufacturer's full range" or similar phrase, select a product that complies with requirements. Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer may return requests without action, except to record noncompliance with these requirements:

1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of engineers and owners, if requested.
5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION 270150

SECTION 270160 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and other Division 27 Specification Sections apply to this Section.

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Installation of the Work.
2. Cutting and patching.
3. Coordination of Owner-installed products.
4. Progress cleaning.
5. Starting and adjusting.
6. Protection of installed construction.
7. Correction of the Work.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 QUALITY ASSURANCE

A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection

2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:

a. Primary operational systems and equipment.
b. Fire separation assemblies.
c. Air or smoke barriers.
d. Fire-suppression systems.
e. Mechanical systems piping and ducts.
f. Control systems.
g. Communication systems.

h. Fire-detection and -alarm systems.
i. Conveying systems.
j. Electrical wiring systems.
k. Operating systems of special construction.

3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:

a. Water, moisture, or vapor barriers.
b. Membranes and flashings.
c. Exterior curtain-wall construction.
d. Sprayed fire-resistive material.
e. Equipment supports.
f. Piping, ductwork, vessels, and equipment.
g. Noise- and vibration-control elements and systems.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.

2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

1. Description of the Work.
2. List of detrimental conditions, including substrates.
3. List of unacceptable installation tolerances.
4. Recommended corrections.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Engineer.

3.3 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.

4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
2. Allow for building movement, including thermal expansion and contraction.
3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.4 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Temporary Support: Provide temporary support of work to be cut.

C. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.

E. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
5. Proceed with patching after construction operations requiring cutting are complete.

F. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.

    a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

    a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

G. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.5 OWNER-INSTALLED PRODUCTS

A. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.

3.6 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

    a. Use containers intended for holding waste materials of type to be stored.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

H. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

I. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.7 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer's Field Service: Comply with qualification requirements in Section 270130 "Quality Requirements."

3.8 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 270160

SECTION 270170 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and other Division 27 Specification Sections apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.
2. Emergency manuals.
3. Operation manuals for systems, subsystems, and equipment.
4. Product maintenance manuals.
5. Systems and equipment maintenance manuals.

B. Related Requirements:

1. Section 270120 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
2. Section 019113 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Engineer and Commissioning Authority will comment on whether content of operations and maintenance submittals are acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operations and maintenance manuals in the following format:

1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Engineer.

a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
b. Enable inserted reviewer comments on draft submittals.

C. Initial Manual Submittal: Submit draft copy of each manual at least 60 days before commencing demonstration and training. Engineer and Commissioning Authority will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Engineer and Commissioning Authority will return copy with comments.

1. Correct or revise each manual to comply with Engineer's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Engineer's and Commissioning Authority's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:

1. List of documents.
2. List of systems.
3. List of equipment.
4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents.

2.2 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Construction Manager.
7. Name and contact information for Engineer.
8. Name and contact information for Commissioning Authority.
9. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.
10. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

2.3 EMERGENCY MANUALS

A. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

2.4 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

2.5 PRODUCT MAINTENANCE MANUALS

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

2.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.

B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and wiring diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of operation and maintenance manuals.
2. Comply with requirements of newly prepared record Drawings in Section 270180 "Project Record Documents."

END OF SECTION 270170

SECTION 270180 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and other Division 27 Specification Sections apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Miscellaneous record submittals.

B. Related Requirements:

1. Section 270170 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:
1. Number of Copies: Submit copies of record Drawings as follows:

a. Initial Submittal:
1) Submit PDF electronic files of scanned record prints and one set of prints.
2) Engineer will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.

b. Final Submittal:
1) Submit PDF electronic files of scanned record prints and three set(s) of prints.
2) Print each drawing, whether or not changes and additional information were recorded.

B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Accurately record information in an acceptable drawing technique.
c. Record data as soon as possible after obtaining it.
d. Record and check the markup before enclosing concealed installations.
e. Cross-reference record prints to corresponding archive photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Depths of foundations below first floor.
d. Locations and depths of underground utilities.
e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Actual equipment locations.
h. Locations of concealed internal utilities.
i. Changes made by Change Order or Construction Change Directive.
j. Changes made following Engineer's written orders.
k. Details not on the original Contract Drawings.
l. Field records for variable and concealed conditions.
m. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Engineer. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:

1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
3. Refer instances of uncertainty to Engineer for resolution.

4. Engineer will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.

    a. See Section 013300 "Submittal Procedures" for requirements related to use of Engineer's digital data files.
    b. Engineer will provide data file layer information. Record markups in separate layers.

C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file.
3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
4. Identification: As follows:

    a. Project name.
    b. Date.
    c. Designation "PROJECT RECORD DRAWINGS."
    d. Name of Engineer.
    e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
5. Note related Change Orders, record Product Data, and record Drawings where applicable.

B. Format: Submit record Specifications as annotated PDF electronic file .

2.3 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, record Specifications, and record Drawings where applicable.

B. Format: Submit record Product Data as annotated PDF electronic file .

1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

2.4 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as PDF electronic file .

1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's reference during normal working hours.

END OF SECTION 270180

SECTION 270190 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and other Division 01 Specification Sections apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.
3. Demonstration and training video recordings.

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training two weeks prior to scheduled time, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

B. Attendance Record: For each training module, submit list of participants and length of instruction time.

1.4 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.

1. Identification: On each copy, provide an applied label with the following information:

a. Name of Project.
b. Name and address of videographer.
c. Name of Engineer.
d. Name of Construction Manager.
e. Name of Contractor.
f. Date of video recording.

2. At completion of training, submit complete training manual(s) for Owner's use in PDF electronic file format on flash drive.

1.5 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Engineer.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Performance and design criteria if Contractor is delegated design responsibility.
    c. Operating standards.
    d. Regulatory requirements.
    e. Equipment function.
    f. Operating characteristics.
    g. Limiting conditions.
    h. Performance curves.

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Operations manuals.
    c. Maintenance manuals.
    d. Project record documents.
    e. Identification systems.
    f. Warranties and bonds.
    g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

    a. Instructions on meaning of warnings, trouble indications, and error messages.
    b. Instructions on stopping.
    c. Shutdown instructions for each type of emergency.
    d. Operating instructions for conditions outside of normal operating limits.
    e. Sequences for electric or electronic systems.
    f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

    a. Startup procedures.
    b. Equipment or system break-in procedures.
    c. Routine and normal operating instructions.
    d. Regulation and control procedures.
    e. Control sequences.
    f. Safety procedures.
    g. Instructions on stopping.
    h. Normal shutdown instructions.
    i. Operating procedures for emergencies.
    j. Operating procedures for system, subsystem, or equipment failure.
    k. Seasonal and weekend operating instructions.
    l. Required sequences for electric or electronic systems.
    m. Special operating instructions and procedures.

5. Adjustments: Include the following:

    a. Alignments.
    b. Checking adjustments.
    c. Noise and vibration adjustments.
    d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

    a. Diagnostic instructions.
    b. Test and inspection procedures.

7. Maintenance: Include the following:

    a. Inspection procedures.
    b. Types of cleaning agents to be used and methods of cleaning.
    c. List of cleaning agents and methods of cleaning detrimental to product.
    d. Procedures for routine cleaning
    e. Procedures for preventive maintenance.
    f. Procedures for routine maintenance.
    g. Instruction on use of special tools.

8. Repairs: Include the following:

    a. Diagnosis instructions.
    b. Repair instructions.
    c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
    d. Instructions for identifying parts and components.
    e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Engineer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
2. Owner will furnish an instructor to describe Owner's operational philosophy.
3. Owner will furnish Contractor with names and positions of participants.

B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner, through Engineer, with at least seven days' advance notice.

C. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

D. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Video: Provide minimum 640 x 480 video resolution converted to .mp4 format file type , on electronic media.

1. Electronic Media: Read-only format compact disc acceptable to Owner, with commercial-grade graphic label.
2. File Hierarchy: Organize folder structure and file locations according to project manual table of contents. Provide complete screen-based menu.
3. File Names: Utilize file names based upon name of equipment generally described in video segment, as identified in Project specifications.
4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the Equipment Demonstration and Training DVD that describes the following for each Contractor involved on the Project, arranged according to Project table of contents:

    a. Name of Contractor/Installer.
    b. Business address.
    c. Business phone number.
    d. Point of contact.
    e. E-mail address.

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.

1. Film training session(s) in segments not to exceed 15 minutes.

a. Produce segments to present a single significant piece of equipment per segment.
b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.

D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.

1. Furnish additional portable lighting as required.

E. Narration: Describe scenes on video recording by audio narration by microphone while or dubbing audio narration off-site after video recording is recorded. Include description of items being viewed.

F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

G. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

END OF SECTION 270190

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ladder cable trays.
2. Wire-basket cable trays.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design cable tray supports and seismic bracing.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAYS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Chatsworth Products.
2. Cooper B-Line, Inc.
3. Hubbell Premise Wiring.
4. Ortronics/Legrande
5. Panduit.

B. Description:

1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
2. Rung Spacing: 12 inches o.c.
3. Radius-Fitting Rung Spacing: 9 inches at center of tray's width. Turns, TEE’s and Intersections shall be modular, interface with straight sections without modification and be self aligning. Provide proper grounding link as per NEC Art. 250.
4. Minimum Cable-Bearing Surface for Rungs: 1 1/2-inches width with radius edges.
5. No portion of the rungs shall protrude below the bottom plane of side rails.
6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
7. Minimum Usable Load Depth: 6 inches.
8. Straight Section Lengths: 10 feet except where shorter lengths are required to facilitate tray assembly.
9. Width: 12 inches unless otherwise indicated on Drawings.
10. Fitting Minimum Radius: 12 inches. 90 degree turns shall be provided at horizontal changes in direction.
11. Class Designation: Comply with NEMA VE 1, Class 12A.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.

13. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.
14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
15. Provide product with UL® listing.
16. Following ladder rack accessories shall be provided:

    a. Butt splice kit to connect runway sections end-to-end
    b. 90 degree turns at horizontal changes in direction
    c. T-Junction splice kit and cable runway corner bracket at runway intersections
    d. Channel rack-to- runway mounting plate at top of racks
    e. Protective end caps at exposed ends of side stringers
    f. Ttriangle wall supports
    g. Wall angle supports
    h. Runway radius drops at top of racks and cabinets

17. Finish: Black powder-coat enamel paint.

    a. Powder-Coat Enamel: Ladder cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
    b. Hardware: Chromium-zinc plated, ASTM F 1136.

2.4 OVERHEAD WIRE-BASKET CABLE TRAYS

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cable Management Solutions, Inc.
2. Cablofil/Legrande.
3. Cooper B-Line, Inc.
4. Cope - Tyco/Allied Tube & Conduit.
5. GS Metals Corp.
6. Niedax Group.
7. Snake Tray.

B. Description:

1. Trays shall be UL listed grid construction welded wire linear mesh. The top edge of the tray shall be bent 90 degrees perpendicular to the vertical sides providing a return, which allows for two ¼" linear wires to run the entire length of the tray forming a double rail. This double wire configuration shall allow for attachment of accessories, splice connections and threaded rod without additional brackets or components. Additionally, the double rail configuration shall allow for the accessory attachment of a section of standard strut to permit the tray to span up to ten (10) feet without intermediate supports.

    a. Turns, tees and intersections shall be modular, interface with straight sections without modification and be self aligning.
    b. Trays shall not require any additional mounting hardware when mounted via threaded rod.
    c. Mesh shall be standard 4 inch by 4 inch ¼" wire welded at each intersection.
    d. Tray sections, turns, tees and intersections shall be joined together with two (2) splice plates per junction. Splice plates shall incorporate three (3) pins that shall align each section.

2. Tray depth shall be 6.0 inches (unless otherwise shown on the drawings).

3. Tray width shall be 18.0 inches (unless otherwise shown on the drawings).
4. Straight tray section length shall be 120 inches.
5. Horizontal turning components shall be 18” wide, 6” deep, 90 degree turn.
6. Tee intersections shall be 18” wide, 6” deep, three way.
7. Crossing grids shall be 18” wide, 6” deep, four way intersection.
8. Accessories

    a. 18” wide cable drop-out
    b. Universal side mounted cable drop-out
    c. Splice Kit
    d. Wall Bracket
    e. Snap-in divider fence, 6” tall x 24” long
    f. Center support 18” wide x 6” deep,

9. Finish shall be electrodeposited clear zinc plated in accordance with ASTM B633 type III SC2.

2.5 UNDER-FLOOR WIRE-BASKET CABLE TRAYS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Snake Tray, Snake Canyon 301 Series or comparable product by one of the following:

1. Cablofil/Legrande.
2. Cooper B-Line, Inc.

B. Description:

1. Configuration: Wires are formed into a standard 2-by-4-inch wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
2. Materials: High-strength-steel longitudinal wires with no bends.
3. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.
4. Sizes:

    a. Straight sections shall be furnished in standard 24-inch lengths.
    b. Wire-Basket Depth: 6-inch usable loading depth by 24 inches wide.

5. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
6. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
7. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.

C. Finish: Electrogalvanized before fabrication.

2.6 MATERIALS

A. Steel:

1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1008/A 1008M, Grade 33, Type 2.
2. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.

3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.

2.7 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.8 WARNING SIGNS

A. Lettering: 1-inch-high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

B. Comply with requirements for fasteners in Division 26 Section "Identification for Electrical Systems."

2.9 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

F. Fasten cable tray supports to building structure.

G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems."

H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support bus assembly to prevent twisting from eccentric loading.

K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

L. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

M. Support wire-basket cable trays with trapeze hangers.

N. Support trapeze hangers for wire-basket trays with 3/8-inch-diameter rods.

O. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

P. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

Q. Make changes in direction and elevation using manufacturer's recommended fittings.

R. Make cable tray connections using manufacturer's recommended fittings.

S. Seal penetrations through fire and smoke barriers. Comply with requirements in Division 07 Section "Penetration Firestopping."

T. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

U. Install cable trays with enough workspace to permit access for installing cables.

V. Install barriers to separate cables of different systems.

W. Install warning signs in visible locations on or near cable trays after cable tray installation.

X. Install the cable tray system at locations indicated on the drawings, in accordance with manufacturer’s instructions. Coordinate installation with other trades. Field verification is required before installation.

Y. Comply with ANSI articles that apply to cable tray installation.

Z. Comply with NFPA 70B.

AA. All open cable trays shall be installed a minimum of six (6) inches away from any light fixture or other source of EMI (Electromagnetic Interference).

BB. Provide cable drop-outs at transitions in elevation such as at conduit.

CC. Provide divider fences to separate voice and data cables from other low voltage cables (such as security cables, fire alarm cables, intercom cables, radio cables, speaker wires, etc.). Coordinate with other trades for exact location of divider fences within the cable trays.

DD. Provide mounting brackets, turnout components, support rods and any special accessories as required to install the tray system.

EE. All cable trays shall be grounded per NFC Article 250.

FF. Provide external grounding straps at expansion joints, sleeves, crossovers and at other locations where pathway continuity may be interrupted.

3.2 CABLE TRAY GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Ground cable trays according to NFPA 70 and Motorola R-56 unless additional grounding is specified.

C. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

D. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

E. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

F. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Identification of elements in the Communications Systems. Work covered by this Section shall consist of furnishing labor, equipment, supplies and materials unless otherwise specified, and in performing the following operations necessary for the labeling of the telecommunications infrastructure as described on the Drawings and/or required by these specifications.

2. An ANSI/TIA/EIA 606-A Class 3 Administration compliant system shall be provided to establish a method to find the record associated with any specific identifier. The administration system shall be managed using a Microsoft Windows based cable management software program specifically designed for that purpose. Information shall be recorded using software licensed to the owner, provided and installed by the telecommunications contractor on the owner's computer. Include a single user licensed package with unlimited documentation capabilities.

3. A unique identifier shall be associated with each element of the infrastructure to be identified and shall serve as the key to finding the recorded information within the administration system.

1.3 DEFINITIONS

A. Horizontal Link: The cabling between and including the telecommunications outlet/connector and the horizontal cross-connect termination hardware.

B. Identifier: A label or sign associated with each element of the infrastructure to be identified to serve as the key to finding the recorded information within the administration system.

C. Telecommunications Space (TS): Telecommunications spaces are areas used for housing the installation and termination of telecommunications equipment and cable, e.g., common equipment rooms, equipment rooms, common telecommunications rooms, telecommunications rooms, work areas, and maintenance holes/handholes.

1.4 CODES AND STANDARDS

A. Florida Building Code (FBC).

B. U.S. Public Law 336. 101st Congress, ADA: Americans with Disabilities Act of 1992.

C. Local AHJ (Authority Having Jurisdiction) interpretations of codes, amendments, and ordinances.

D. ANSI/TIA/EIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure, 2002.

E. ANSI/TIA/EIA-942, Telecommunications Infrastructure Standards for Data Centers (Latest revision and all published amendments).

F. Telecommunications Distribution Methods Manual, 11th Ed., Building Industry Consulting Services International (BICSI), (And all published amendments).

G. ISO/IEC 14763-1, Information Technology – Implementation and Operation of Customer Premises Cabling – Part 1: Administration, 2004.

H. Underwriter's Laboratory, Inc. (UL®) 723, Test for Surface Burning Characteristics of Building Materials.

I. Underwriter's Laboratory, Inc. (UL®)
   1. UL®-94-V0, Tests for Flammability of Plastic Materials.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include construction details, material descriptions, dimensions and finishes of individual labeling and identification products.

1.6 INFORMATIONAL SUBMITTALS

A. Product Data:

   1. The Contractor shall submit product data for approval prior to the start of work and shall not start work until complete product data for each component, describing physical characteristics and method of installation has been submitted and approved. Product data shall be submitted for, but is not limited to labeling and identification products for:

      a. Telecommunications spaces
      b. Horizontal link, including equipment cabinets, equipment racks, cabling, termination fields and patch panels.
      c. Floor grids.
      d. Conduits.
      e. Telecommunications main grounding busbar(s).
      f. Telecommunications grounding busbar(s).
      g. Intrabuilding backbone cable.
      h. Intrabuilding backbone pair or optical fiber.
      i. Firestop locations.
      j. Interbuilding backbone cable.
      k. Interbuilding backbone pair or optical fiber.
      l. Building(s).

PART 2 - PRODUCTS

2.1 LABELING

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Worldwide, Inc.
2. Dymo.
3. HellermannTyton North America
4. Panduit Corp.

B. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials used by label printers or engravers per the labeling convention shown on the drawings.

C. Labels shall be self-laminating, machine-printed with alphanumeric cable designations. Hand-lettered labels shall not be acceptable.

D. Labels used to identify Telecommunications Spaces shall be coordinated with the general building signage system so that the identifier is either incorporated into the respective room sign or is a separate sign that matches the room sign in size, color and material.

E. Labels for cabling shall be heat shrink tubes or wraparound flexible nylon or vinyl. Printing area and font color shall contrast with cable jacket color but still comply with requirements in TIA/EIA 606-A.

F. Labels for patch panels and faceplates shall be white polyester.

G. Labels for equipment racks and cabinets shall be black engraved Micarta with 1/2" high white letters.

H. Labels for floor grid identification shall be 8" high black vinyl letters on gloss white MDF placards.

I. Labels for interbuilding cables shall be steel or aluminum tags.

PART 3 - EXECUTION

3.1 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class: 3.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Label colors for equipment identification shall comply with TIA/EIA-606-A for Class 3 level of administration.

C. Cable and Wire Identification:

1. Label each cable within 12 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed cables and cables in cable trays and ladder racks: Label each cable at intervals not exceeding 15 feet. All exposed fiber cables shall have labels indicating "CAUTION" and the number of strands.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

6. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

D. Equipment Cabinet, Equipment Rack and Server Rack Identification:

1. Engraved Micarta labels for equipment cabinets, equipment racks and server racks shall be permanently attached using stainless steel screws or rivets. Locate labels on the front top angle on racks and near the top of the front door of cabinets.

E. Floor Grid Identification:

1. Support placards using appropriately sized picture frame hangers. Provide two hangers near the top of each placard and one near the bottom to evenly space them from the wall.

F. Record all identification information using the cable management software program.

G. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules, in software and format selected by Owner.

H. Cabling Administration Drawings: Show building floor plans with cable administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

END OF SECTION 270553

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Telecommunications equipment racks.
3. Grounding.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. F/UTP: Foil applied over unshielded twisted pair (also known as screened twisted pair – ScTP).

E. IDC: Insulation displacement connector.

F. LAN: Local area network.

G. RCDD: Registered Communications Distribution Designer.

H. UTP: Unshielded twisted pair.

1.4 CODES AND STANDARDS

A. Florida Building Code (FBC).

B. National Electrical Code (NEC/NFPA 70)

1. National Electric Code (NEC), 2005.
2. NEC Article 250: Grounding.
3. NEC Article 386: Surface Metal Raceways.
4. NEC Article 388: Surface Non-Metallic Raceways.
5. NEC Article 708: Critical Operations Power Systems.
6. NEC Article 770: Optical Fiber Cables and Raceway.
7. NEC Article 800: Communications Circuits.

C. National Electrical Safety Code (NESC IEEE C 2).

D. U.S. Public Law 336. 101st Congress, ADA: Americans with Disabilities Act of 1992.

E. Local AHJ (Authority Having Jurisdiction) interpretations of codes, amendments, and ordinances.

F. ANSI/EIA-310-E - Cabinets, Racks, Panels and Associated Equipment, 2005.

G. ANSI/TIA/EIA-440B Fiber Optic Terminology, 2004.

H. ANSI/TIA/EIA-492AAAC, Detail Specification for 850nm Laser-Optimized 50um Core Diameter/125 um Cladding Diameter Class 1A Graded Index Multimode Optical Fibers, 2003.

I. ANSI/TIA/EIA-492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Single-mode Optical fibers, 2002.

J. ANSI/TIA/EIA-526-7, Optical Power Loss Measurements of Installed Single-mode Fiber Plant: OFSTP-7, 2002.

K. ANSI/TIA/EIA-526-14-A, Optical Power Loss Measurements of Installed Multimode Fiber Plant: OFSTP-14A, 2003.

L. ANSI/TIA/EIA-568-C.0, Generic Telecommunications Cabling For Customer Premises, 2009.

M. ANSI/TIA/EIA-568-C.1, Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements, 2009.

N. ANSI/TIA/EIA-568-C.2, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components, 20098.

O. ANSI/TIA/EIA-568-C.3, Optical Fiber Cabling Components Standard, 2009.

P. ANSI/TIA/EIA-569-B, Commercial Building Standards for Telecommunications Pathways and Spaces Standard (Latest revision and all published amendments).

Q. ANSI/EIA/TIA-570-B, Residential and Light Commercial Telecommunications Wiring Standard (Latest revision and all published amendments).

R. ANSI/TIA/EIA-604, Fiber Optic Connector Intermateability Standard.

S. ANSI/TIA/EIA-604-7A, Measurements of Optical Power Loss of Installed Single-mode Fiber Cable Plant, 2002.

T. ANSI/TIA/EIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure, 2002.

U. ANSI/TIA/EIA-758, Customer-Owned Outside Plant Telecommunications Cabling Standard, 2004.

V. ANSI/TIA/EIA-942, Telecommunications Infrastructure Standards for Data Centers (Latest revision and all published amendments).

W. ANSI/TIA/EIA-TSB-125, Guidelines for Maintaining Optical Fiber Polarity Through Reverse-Pair Positioning, 2001.

X. ANSI/TIA/EIA-TSB-140, Additional Guidelines for Field Testing Length, Loss, and Polarity of Optical Fiber Cabling Systems, 2004.

Y. ANSI/J-STD-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

Z. ANSI/NECA/BICSI-568-2001, Standard for Installing Commercial Building Telecommunications Cabling.

AA. ANSI/ICEA S-83-596, Fiber Optic Premises Distribution Cable, 2001.

BB. ANSI/ICEA S-87-640, Fiber Optic Outside Plant Distribution Cable, 1999.

CC. IEEE 802.3af, Data Terminal Equipment (DTE) Power Over Media Dependent Interface (MDI), 2003 (Superseded by IEEE 802.3-2005).

DD. IEEE 802.3, Information Technology – Telecommunications and Information Exchange between Systems – Local and Metropolitan Area Networks – Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications, 2005.

EE. IEEE 802.3at (current draft), Data Terminal Equipment (DTE) Enhanced Power Over Media Dependent Interface (MDI).

FF. IEEE 802.3ae, Specification for 10 Gbit/s Ethernet Operation over Optical Fiber.

GG. TSB-162 - Telecommunications Cabling Guidelines for Wireless Access Points (Latest revision and all published amendments).

HH. Telecommunications Distribution Methods Manual, 11th Ed., Building Industry Consulting Services International (BICSI), (And all published amendments).

II. Information Transport Systems Installation Manual, 4th Ed., Building Industry Consulting Services International (BICSI), 2004.

JJ. IEC/TR3 61000-5-2-Ed. 1.0 and amendments, Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling.

KK. ISO/IEC 11801, Ed. 2:2002, Information Technology – Generic Cabling for Customer Premises, 2002.

LL. ISO/IEC 18010 - Information Technology – Pathways and Spaces for Customer Premises Cabling, 2005.

MM. ISO/IEC 14763-1, Information Technology – Implementation and Operation of Customer Premises Cabling – Part 1: Administration, 2004.

NN. BS EN 50173-1, Information Technology – Generic Cabling Systems – Part 1: General Requirements, 2002.

OO. BS EN 50174-1, Information Technology – Cabling Installation – Part 1: Specification and Quality Assurance, 2001.

PP. UL® 723, Test for Surface Burning Characteristics of Building Materials.

QQ. Federal Communications Commission (FCC) Title 47, Code of Federal Regulations, Part 68: Connection of Terminal Equipment to the Telephone Network, 1998.

RR. Underwriter's Laboratory, Inc. (UL®)

1. UL®-5A, Standard for Non-Metallic Raceways and Fittings.
2. UL®-5, Standard for Surface Metal Raceways and Fittings.
3. UL®-5C, Standard for Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits.
4. UL®-50, Standard for Enclosures for Electrical Equipment.
5. UL®-94-V0, Tests for Flammability of Plastic Materials.
6. UL®-498, Attachment Plugs and Receptacles.
7. UL®-1479, Fire Tests of Through-penetration Firestops (in Accordance with ASTM E814).
8. UL®-1863, Standard for Safety of Communications Circuit Accessories.

SS. National Electrical Manufacturer's Association (NEMA)

1. ANSI/NEMA WD-6-2002, Wiring Devices – Dimensional Requirements
2. NEMA 250-2003, Enclosures for Electrical Equipment

TT. Motorola R-56 Standards and Guidelines for Communication Sites

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.6 INFORMATIONAL SUBMITTALS

A. Product Data:

1. The Contractor shall submit product data for approval prior to the start of work and shall not start work until complete product data for each component, describing physical characteristics and method of installation has been submitted and approved. Product data shall be submitted for, but is not limited to.

a. Equipment racks.
b. Firestop products and proposed UL® listed installation details.

B. Qualification Data: For BICSI Certified Installers and RCDD.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. The Structured Cabling System Contractor (SCSC) shall be an experienced firm regularly engaged in the layout and installation of structured cabling systems of similar size and complexity as required. The Structured Cabling System Contractor, under the same company name, shall have successfully completed the layout, installation, testing and warranty of not less than five Structured Cabling Systems similar in scope to this project for a minimum period of three years prior to the bid date, and shall have been regularly engaged in the business of Structured Cabling Systems contracting continuously since.
2. The SCSC shall have an ~~existing permanent~~ office ~~located within a 40 miles radius of Leon County, Florida~~ from which installation and warranty service operations will be performed.
3. The SCSC and their Sub-Contractors must be Manufacturer-authorized Certified System Vendors certified by the Manufacturer to offer a 25-year Permanent Link Warranty, adhere to the engineering, installation, and testing procedures, and use Manufacturer's components and distribution channels in provisioning this Project.
4. The SCSC and their Sub-Contractors shall have successfully completed all Manufacturer design and installation training. All members of the installation team must be certified by the manufacturer as having completed the necessary training to complete their part of the installation. All personnel shall be adequately trained in the use of necessary tools and equipment to install the system.
5. The SCSC and their Sub-Contractors must be certified to install UL listed Fire-Stop systems.
6. The system installer shall have an RCDD on staff to assist with project installation.
7. The system installers shall certified by BICSI.
8. The Contractor shall own and maintain tools, installation equipment, and test equipment necessary for successful installation and testing of fiber optic and copper Structured Cabling Systems.
9. The Owner reserves the right to require the Contractor to remove from the project any such employee the Owner deems to be incompetent, careless or insubordinate.

PART 2 - PRODUCTS

2.1 TWO POST FREE STANDING RELAY RACKS (UNIVERSAL RACK)

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Belden

2. Chatsworth Products
3. Cooper B-Line
4. Great Lakes Case and Cabinet Co.
5. Homaco
6. Newton
7. Panduit

B. Racks shall be manufactured from aluminum extrusions.

C. Each rack shall have two L-shaped top angles, two L-shaped base angles and two C-shaped equipment-mounting channels. The rack shall assemble with bolt hardware. Equipment-mounting channels shall be threaded for easy assembly. The base angles shall be pre-punched for attachment to the floor.

D. Equipment mounting channels shall be 3” deep and punched on the front and rear flange with the EIA-310-E Universal hole pattern to provide 45 rack-mount spaces for equipment. Each mounting space shall be marked and numbered on the mounting channel.

E. When assembled with top and bottom angles, equipment-mounting channels shall be spaced to allow attachment of 19” EIA rack-mount equipment. Attachment points shall be threaded with 12-24 roll-formed threads. The rack shall include assembly and equipment-mounting hardware. Each rack shall include 50 each combination pan head, pilot point mounting screws.

F. The assembled rack shall measure 7’ (84”) high and 20.3” wide. The sides (webs) of the equipment-mounting channels shall be punched to allow attachment of vertical cable managers along the sides of the rack or for rack-to-rack baying.

1. The rack shall be rated for 1,500 lb. of equipment.
2. The rack shall be UL® Listed.
3. Finish shall be black epoxy-polyester hybrid powder coat.

2.2 FOUR POST FREE STANDING RELAY RACKS (UNIVERSAL RACK)

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Belden
2. Chatsworth Products
3. Cooper B-Line
4. Great Lakes Case and Cabinet Co.
5. Homaco
6. Newton
7. Panduit

B. Racks shall be manufactured from aluminum extrusions.

C. Each frame shall have two L-shaped top angles, two L-shaped base angles, a top and bottom pan, and four C-shaped equipment-mounting channels (a front and rear pair). The rack shall assemble with nut and bolt hardware. The base angles and bottom pan shall be pre-punched for attachment to the floor. The top pan shall be pre-punched for attaching ladder rack with J-bolts.

D. Equipment mounting channels shall be 3” deep and punched on the front and rear flange with the EIA-310-E Universal hole pattern to provide 45 rack-mount spaces for equipment. Each mounting space shall be marked and numbered on the mounting channel.

E. When assembled with top and bottom pans and angles, equipment-mounting channels shall be spaced to allow attachment of 19” EIA rack-mount equipment. Attachment points shall be threaded with 12-24 roll-formed threads. The frame shall include assembly and equipment-mounting hardware. Frames shall include 100 each combination pan head, pilot point, mounting screws.

F. The assembled frame shall measure 7’ (84”) high, 20.3” wide and 29” deep. The sides (webs) of the equipment-mounting channels shall be punched to allow attachment of vertical cable managers along the sides of the frame or for frame-to-frame or frame-to-rack baying (frames must be able to bay with a 2-post relay rack).

1. The rack shall be rated for 2,000 lb. of equipment.
2. The rack shall be UL® Listed.
3. Finish shall be black epoxy-polyester hybrid powder coat.

2.3 CABLE MANAGEMENT

A. Manufacturers:

1. Panduit

B. Owner provided floor mount equipment cabinets shall be augmented with a cable management system, comprised of double-sided horizontal managers.

1. 2U horizontal managers with front and rear ducts shall be installed where shown. Managers shall be PVC finger duct with snap-on hinged covers. The overall duct size shall be 3.5” H X 19” W X 8.9” D.
2. 1U horizontal managers with front and rear ducts shall be installed where shown. Managers shall be PVC finger duct with snap-on hinged covers. The overall duct size shall be 1.75” H X 19” W X 8.9” D.

C. Floor mount equipment racks shall be augmented with a cable management system, comprised of double-sided horizontal and vertical managers.

1. 2U horizontal managers with front and rear ducts shall be installed where shown. Managers shall be PVC finger duct with snap-on hinged covers. The overall duct size shall be 3.5” H X 19” W X 8.9” D.
2. 1U horizontal managers with front and rear ducts shall be installed where shown. Managers shall be PVC finger duct with snap-on hinged covers. The overall duct size shall be 1.75” H X 19” W X 8.9” D.
3. Vertical managers with front, and front/rear ducts shall be installed where shown. Managers shall be PVC finger duct with snap-on hinged covers and wire retainers. The overall duct size is shown on the drawings. Vertical panels shall be available in a side version for mounting on the side of a rack or a center version for mounting between two racks. Cable fill for vertical managers shall not exceed 40% fill ratios.

2.4 POWER STRIPS

A. Power Strips: Power strips will be provided and installed by the owner.

2.5 GROUNDING

A. Comply with NFPA 70.

B. Comply with J-STD-607-A.

C. Comply with Motorola R-56.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation points provided by communications service provider.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.3 SLEEVE SEAL INSTALLATION FOR COMMUNICATION CABLE PENETRATIONS

A. Install sleeve seals at penetrations of floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. All metal armored cables or cables having metallic conductors entering a building shall conform to the bonding and grounding requirements in NEC Article 760.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

END OF SECTION 271100

SECTION 271105 - COMMUNICATIONS EQUIPMENT CABINETS (OWNER PROVIDED)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Telecommunications equipment cabinets.
3. Hot aisle containment system.
4. Grounding.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. LAN: Local area network.

D. RCDD: Registered Communications Distribution Designer.

1.4 CODES AND STANDARDS

A. Florida Building Code (FBC).

B. National Electrical Code (NEC/NFPA 70)

1. National Electric Code (NEC), 2005.
2. NEC Article 250: Grounding.
3. NEC Article 386: Surface Metal Raceways.
4. NEC Article 388: Surface Non-Metallic Raceways.
5. NEC Article 708: Critical Operations Power Systems.
6. NEC Article 770: Optical Fiber Cables and Raceway.
7. NEC Article 800: Communications Circuits.

C. National Electrical Safety Code (NESC IEEE C 2).

D. U.S. Public Law 336. 101st Congress, ADA: Americans with Disabilities Act of 1992.

E. Local AHJ (Authority Having Jurisdiction) interpretations of codes, amendments, and ordinances.

F. ANSI/EIA-310-E - Cabinets, Racks, Panels and Associated Equipment, 2005.

G. ANSI/TIA/EIA-569-B, Commercial Building Standards for Telecommunications Pathways and Spaces Standard (Latest revision and all published amendments).

H. ANSI/TIA/EIA-942, Telecommunications Infrastructure Standards for Data Centers (Latest revision and all published amendments).

I. ANSI/J-STD-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

J. Telecommunications Distribution Methods Manual, 11th Ed., Building Industry Consulting Services International (BICSI), (And all published amendments).

K. Information Transport Systems Installation Manual, 4th Ed., Building Industry Consulting Services International (BICSI), 2004.

L. UL® 723, Test for Surface Burning Characteristics of Building Materials.

M. Underwriter's Laboratory, Inc. (UL®)
1. UL®-50, Standard for Enclosures for Electrical Equipment.
2. UL®-94-V0, Tests for Flammability of Plastic Materials.
3. UL®-498, Attachment Plugs and Receptacles.

N. National Electrical Manufacturer's Association (NEMA)

1. ANSI/NEMA WD-6-2002, Wiring Devices – Dimensional Requirements
2. NEMA 250-2003, Enclosures for Electrical Equipment

O. Motorola R-56 Standards and Guidelines for Communication Sites

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.6 INFORMATIONAL SUBMITTALS

A. Product Data:

1. The Contractor shall submit product data for approval prior to the start of work and shall not start work until complete product data for each component, describing physical characteristics and

method of installation has been submitted and approved. Product data shall be submitted for, but is not limited to.

a. Equipment cabinets.

B. Qualification Data: For BICSI Certified Installers and RCDD.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. The Structured Cabling System Contractor (SCSC) shall be an experienced firm regularly engaged in the layout and installation of structured cabling systems of similar size and complexity as required. The Structured Cabling System Contractor, under the same company name, shall have successfully completed the layout, installation, testing and warranty of not less than five Structured Cabling Systems similar in scope to this project for a minimum period of three years prior to the bid date, and shall have been regularly engaged in the business of Structured Cabling Systems contracting continuously since.
2. The SCSC shall have an ~~existing permanent~~ office ~~located within a 40 miles radius of Leon County, Florida~~ from which installation and warranty service operations will be performed.
3. The SCSC and their Sub-Contractors must be Manufacturer-authorized Certified System Vendors certified by the Manufacturer to offer a 25-year Permanent Link Warranty, adhere to the engineering, installation, and testing procedures, and use Manufacturer's components and distribution channels in provisioning this Project.
4. The SCSC and their Sub-Contractors shall have successfully completed all Manufacturer design and installation training. All members of the installation team must be certified by the manufacturer as having completed the necessary training to complete their part of the installation. All personnel shall be adequately trained in the use of necessary tools and equipment to install the system.
5. The SCSC and their Sub-Contractors must be certified to install UL listed Fire-Stop systems.
6. The system installer shall have an RCDD on staff to assist with project installation.
7. The system installers shall certified by BICSI.
8. The Contractor shall own and maintain tools, installation equipment, and test equipment necessary for successful installation and testing of fiber optic and copper Structured Cabling Systems.
9. The Owner reserves the right to require the Contractor to remove from the project any such employee the Owner deems to be incompetent, careless or insubordinate.

PART 2 - PRODUCTS

2.1 MODULAR FREESTANDING CABINETS

A. Basis-of-Design Product: Subject to compliance with requirements, provide NetShelter SX equipment cabinets, RC series chilled water in-row cooling units and hot-aisle containment system including modular Lexan twinwall clear polycarbonate corrugated ceiling tiles in tubular steel frames and door units manufactured by the following:

1. APC by Schneider Electric.

B. General Requirements

1. The equipment cabinet shall be designed to provide a secure, managed environment for server and networking equipment.

2. The equipment cabinet shall conform to EIA-310-E Standard for Cabinets, Racks, Panels and Associated Equipment and accommodate industry standard 19" rack mount equipment.
3. The equipment cabinet shall be designed with four (4) vertical posts to allow rack mount equipment installation utilizing four (4) vertical mounting rails.
4. The equipment cabinet shall have a vertical equipment mounting space of 48 rack mount units (RMU). (1RMU=1.75").
5. Refer to Division 23 for specifications for RC chilled water in-row cooling units.
6. Provide a cable trough and an electrical power cord trough over each equipment cabinet and in-row cooling unit.

C. Physical Specifications

1. Enclosure dimensions, rack mounting compatibility and weight load ratings:

Internal Height	EIA-310	External Height	External Width	External Depth	Static Rating	Dynamic Rating
48RMU	19"	88.90"	29.53"	47.24"	3000lbs	2250lbs
48RMU	19"	88.90"	29.53"	42.13"	3000lbs	2250lbs
42RMU	19"	78.40"	29.53"	42.13"	3000lbs	2250lbs

2. The unit shall support a static load (weight supported by the casters and leveling feet) of at least 3,000 lb total installed equipment weight.
3. The unit shall support a dynamic load (rolling on the casters) of at least 2,250 lb total installed equipment weight.
4. The unit shall ship with a perforated front door, four (4) half-height side panels, toolless roof, four (4) vertical frame posts, four (4) adjustable vertical mounting rails, four (4) vertical PDU mount cable organizers, four (4) leveling feet and four (4) casters, baying and grounding hardware pre-installed by the manufacturer.

D. Equipment Access & Installation

1. The unit shall provide 48RMU of equipment vertical mounting space.
2. The vertical mounting rails shall be easily adjustable to allow different mounting depths.

    a. Each vertical mounting rail shall be marked on both sides with lines showing the top and bottom of each RMU and the number RMU space next to the middle hole. Each RMU consists of three square holes and is 1.75 inches high.

3. The unit shall include M6 caged nuts, bolts and cup washers, and caged nut tool for the mounting of equipment inside the unit.
4. The front door shall be designed with lift-off hinges allowing for quick and easy detachment without the use of tools.

    a. The front door shall open a minimum of 120 degrees to allow easy access to the interior.
    b. The front door of the unit shall be reversible so that it can be mounted on either side.

5. The unit shall include half-height side panels that are removed without tools using easy finger latches for fast access to cabling and equipment.

    a. The side panels on the unit shall double as privacy panels when the units are bayed together.
    b. Side panels are flush with the frame so the overall width of the unit does not change with the side panels installed.
    c. Baying brackets must provide two sets of mounting holes for standard enclosure spacing of 24".

E. Material Requirements

1. All weight bearing components shall be constructed from steel with a thickness no less than 20 gauge.
2. All sheet metal parts shall be painted using manufacturer's standard black polyester powder coat paint process.
3. Plastic materials shall comply with Underwriters Laboratory Specification 94 with HB rating (UL94 V-1) or better.
4. All interior components of racks shall have electroplated zinc coating to minimize zinc whiskers near active equipment.

F. Grounding Requirements

1. All enclosure components such as doors, side panels, roofs, etc. shall be bonded directly to the frame.
2. Grounding points shall be provided on frame to externally bond each unit to building ground.

G. Environmental and Safety Requirements

1. The unit shall have a minimum of IP 20 rating for protection against touch, ingress of foreign bodies, and ingress of water.
2. Manufacturer shall certify products are RoHS compliant.
3. The enclosure shall both protect the user from mechanical hazards and generally meet the requirements for a mechanical enclosure (stability, mechanical strength, aperture sizes, etc.) as defined in IEC 60950 Third Edition.

H. Ventilation

1. The unit shall have ventilated front doors to provide adequate airflow required by the major server manufacturers.
2. The unit shall have a minimum total ventilation area of 1395 in^2 for the front door.
3. The unit shall provide the means to mount optional cooling accessories for high-density.
4. The manufacturer shall provide toolless blanking panel kits to prevent the recirculation of hot exhaust air.
5. The manufacturer shall ensure all gaps are blocked to prevent recirculation of hot air.

I. Cable Access

1. Top cable management openings provided in the enclosure roof shall be two 2.60" x 35.60" openings located in the roof and one 28.20 x 40.28" opening with the roof removed. The openings in the roof panel shall have filament brushes to minimize air flow.

    a. Cable opening edges must be protected with plastic grommets or radiused edges.

2. One 28.23" x 37.87" bottom cable management opening shall be provided in the enclosure base.

    a. Cable opening edges must be protected with plastic grommets or radiused edges.

3. Side cable management opening provided in the enclosure base; four (4) vertical PDU mount cable organizers.

    a. Cable opening edges must be protected with plastic grommets or radiused edges.

J. Security

1. The unit shall include a front door lock and side panel locks that are keyed the same; two keys included.

    a. Replacement key lock cylinders from the handle manufacturer should be available to provide a minimum of 220 unique key combinations on front doors.

2. The manufacturer shall provide optional products and accessories that allow the enclosure environment to be monitored for temperature, humidity, and electronic pass key door access.
3. The unit shall have mounting provisions for optional door alarm switch to monitor access to the enclosure doors.

K. Stabilization

1. The unit shall ship with provisions for stabilization in the field with pallet mounting brackets.
2. The manufacturer shall have stabilizer plate kits, consisting of a plate, and mounting hardware that can be attached to the enclosure frame, and that can be bolted to the floor.
3. The manufacturer shall have optional bolt down brackets, consisting of four (4) brackets and mounting hardware that attach to the enclosure frame on the front and rear (on the interior or exterior), and which must be anchored to the sub-floor for compliance with the local Uniform Building Code (UBC).
4. The manufacturer should supply structural calculations by a professionally registered engineering firm showing compliance with the local UBC for floor anchoring.
5. The unit shall have four (4) adjustable leveling feet to help provide a stable base in the event of an uneven floor surface and to prevent rolling.

L. Warranty

1. The manufacturer shall warrant the unit to be free from defects in materials and workmanship for a minimum period of five years from the date of purchase. The manufacturer's obligation under this warranty shall be to repair or replace the unit, at its own sole option. This warranty shall not apply to equipment that has been damaged by accident, negligence, or misapplication or has been altered or modified in any way.
2. The manufacturer shall warrant all accessories and options to be free from defects in materials and workmanship for a minimum period of two years from the date of purchase. The manufacturer's obligation under this warranty shall be to repair or replace the equipment, at its own sole option. This warranty shall not apply to equipment that has been damaged by accident, negligence, or misapplication or has been altered or modified in any way.

M. Accessories

1. RM LCD Monitor/Keyboard Drawer: The manufacturer shall offer a 1U high, rack-mounted LCD monitor/keyboard drawer to maximize space in a data center environment.
2. Cooling: The manufacturer shall offer roof-mounted fan trays, door mounted fan trays, monitoring devices, and stand alone cooling units for maintaining a cool environment.
3. Rack Power Distribution Units: The manufacturer shall offer a variety of single-phase and three-phase rack mount power distribution units with current monitoring outlet switching, and remote management capabilities.
4. Cable Management: The manufacturer shall offer a variety of cable management accessories to neatly organize the routing of data and power cables within the enclosure.
5. Shelving: The manufacturer shall offer as optional accessories various fixed and sliding shelves with the ability to support up to 250 lbs of non-rack mount equipment.
6. Uninterruptible Power Supplies: The manufacturer shall offer various rack mounted uninterruptible power supplies (UPS), with user-replaceable and hot-swappable batteries, and with extended runtime options available.

2.2 POWER STRIPS

A. Power Strips: Provide power strips as directed by the owner.

2.3 GROUNDING

A. Comply with NFPA 70.

B. Comply with J-STD-607-A.

C. Comply with Motorola R-56.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers.

D. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

END OF SECTION 271105

SECTION 271300 - COMMUNICATIONS BACKBONE AND CAMPUS CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and Specification Division 01, applicable provisions of Division 27, and other provisions and requirements of the contract apply to this Section.

1.2 SUMMARY

A. The backbone cabling system shall provide interconnections between Communications Equipment Rooms, Entrance Facilities, and Telecommunications Rooms in the telecommunications cabling system structure. The cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations and fiber optic jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

C. Section Includes:

1. Category 3 multi-pair cable.
2. 50/125 µm OM3 multimode optical fiber cabling.
3. 8.3/125 µm OM2 single-mode optical fiber cabling.
4. RG-11/U Coaxial cable.
5. Cable connecting hardware, fiber termination cabinets, and cross-connects.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. F/UTP: Foil applied over unshielded twisted pair (also known as screened twisted pair – ScTP).

E. IDC: Insulation displacement connector.

F. LAN: Local area network.

G. RCDD: Registered Communications Distribution Designer.

H. UTP: Unshielded twisted pair.

1.4 CODES AND STANDARDS

A. Florida Building Code (FBC).

B. National Electrical Code (NEC/NFPA 70)

1. National Electric Code (NEC), 2005.
2. NEC Article 250: Grounding.
3. NEC Article 386: Surface Metal Raceways.
4. NEC Article 388: Surface Non-Metallic Raceways.
5. NEC Article 708: Critical Operations Power Systems.
6. NEC Article 770: Optical Fiber Cables and Raceway.
7. NEC Article 800: Communications Circuits.

C. National Electrical Safety Code (NESC IEEE C 2).

D. U.S. Public Law 336. 101st Congress, ADA: Americans with Disabilities Act of 1992.

E. Local AHJ (Authority Having Jurisdiction) interpretations of codes, amendments, and ordinances.

F. ANSI/EIA-310-E - Cabinets, Racks, Panels and Associated Equipment, 2005.

G. ANSI/TIA/EIA-440B Fiber Optic Terminology, 2004).

H. ANSI/TIA/EIA-492AAAC, Detail Specification for 850nm Laser-Optimized 50um Core Diameter/125 um Cladding Diameter Class 1A Graded Index Multimode Optical Fibers, 2003.

I. ANSI/TIA/EIA-492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Single-mode Optical fibers, 2002.

J. ANSI/TIA/EIA-526-7, Optical Power Loss Measurements of Installed Single-mode Fiber Plant: OFSTP-7, 2002.

K. ANSI/TIA/EIA-526-14-A, Optical Power Loss Measurements of Installed Multimode Fiber Plant: OFSTP-14A, 2003.

L. ANSI/TIA-568-C.0, Generic Telecommunications Cabling For Customer Premises, 2009.

M. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements, 2009.

N. ANSI/TIA-568-C.2, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components, 20098.

O. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, 2009.

P. ANSI/TIA/EIA-569-B, Commercial Building Standards for Telecommunications Pathways and Spaces Standard (Latest revision and all published amendments).

Q. ANSI/EIA/TIA-570-B, Residential and Light Commercial Telecommunications Wiring Standard (Latest revision and all published amendments).

R. ANSI/TIA/EIA-604, Fiber Optic Connector Intermateability Standard.

S. ANSI/TIA/EIA-604-7A, Measurements of Optical Power Loss of Installed Single-mode Fiber Cable Plant, 2002.

T. ANSI/TIA/EIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure, 2002.

U. ANSI/TIA/EIA-758, Customer-Owned Outside Plant Telecommunications Cabling Standard, 2004.

V. ANSI/TIA/EIA-942, Telecommunications Infrastructure Standards for Data Centers (Latest revision and all published amendments).

W. ANSI/TIA/EIA-TSB-125, Guidelines for Maintaining Optical Fiber Polarity Through Reverse-Pair Positioning, 2001.

X. ANSI/TIA/EIA-TSB-140, Additional Guidelines for Field Testing Length, Loss, and Polarity of Optical Fiber Cabling Systems, 2004.

Y. ANSI/J-STD-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

Z. ANSI/NECA/BICSI-568-2001, Standard for Installing Commercial Building Telecommunications Cabling.

AA. ANSI/ICEA S-83-596, Fiber Optic Premises Distribution Cable, 2001.

BB. ANSI/ICEA S-87-640, Fiber Optic Outside Plant Distribution Cable, 1999.

CC. IEEE 802.3af, Data Terminal Equipment (DTE) Power Over Media Dependent Interface (MDI), 2003 (Superseded by IEEE 802.3-2005).

DD. IEEE 802.3, Information Technology – Telecommunications and Information Exchange between Systems – Local and Metropolitan Area Networks – Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications, 2005.

EE. IEEE 802.3at (current draft), Data Terminal Equipment (DTE) Enhanced Power Over Media Dependent Interface (MDI).

FF. IEEE 802.3ae, Specification for 10 Gbit/s Ethernet Operation over Optical Fiber.

GG. TSB-162 - Telecommunications Cabling Guidelines for Wireless Access Points (Latest revision and all published amendments).

HH. Telecommunications Distribution Methods Manual, 12th Ed., Building Industry Consulting Services International (BICSI), (And all published amendments).

II. Information Transport Systems Installation Manual, 6th Ed., Building Industry Consulting Services International (BICSI), 2004.

JJ. IEC/TR3 61000-5-2-Ed. 1.0 and amendments, Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling.

KK. ISO/IEC 11801, Ed. 2:2002, Information Technology – Generic Cabling for Customer Premises, 2002.

LL. ISO/IEC 18010 - Information Technology – Pathways and Spaces for Customer Premises Cabling, 2005.

MM. ISO/IEC 14763-1, Information Technology – Implementation and Operation of Customer Premises Cabling – Part 1: Administration, 2004.

NN. BS EN 50173-1, Information Technology – Generic Cabling Systems – Part 1: General Requirements, 2002.

OO. BS EN 50174-1, Information Technology – Cabling Installation – Part 1: Specification and Quality Assurance, 2001.

PP. UL® 723, Test for Surface Burning Characteristics of Building Materials.

QQ. Federal Communications Commission (FCC) Title 47, Code of Federal Regulations, Part 68: Connection of Terminal Equipment to the Telephone Network, 1998.

RR. Underwriter's Laboratory, Inc. (UL®)

1. UL®-5A, Standard for Non-Metallic Raceways and Fittings.
2. UL®-5, Standard for Surface Metal Raceways and Fittings.
3. UL®-5C, Standard for Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits.
4. UL®-50, Standard for Enclosures for Electrical Equipment.
5. UL®-94-V0, Tests for Flammability of Plastic Materials.
6. UL®-498, Attachment Plugs and Receptacles.
7. UL®-1479, Fire Tests of Through-penetration Firestops (in Accordance with ASTM E814).
8. UL®-1863, Standard for Safety of Communications Circuit Accessories.

SS. National Electrical Manufacturer's Association (NEMA)

1. ANSI/NEMA WD-6-2002, Wiring Devices – Dimensional Requirements
2. NEMA 250-2003, Enclosures for Electrical Equipment

TT. Motorola R-56 Standards and Guidelines for Communication Sites

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in ANSI/TIA-568-C.0, ANSI/TIA-568-C.1, ANSI/TIA-568-C.2 and ANSI/TIA-568-C.3 when tested according to test procedures of these standards.

1.6 INFORMATIONAL SUBMITTALS

A. Product Data:

1. The Contractor shall submit product data for approval prior to the start of work and shall not start work until complete product data for each component, describing physical characteristics and method of installation has been submitted and approved. Product data shall be submitted for, but is not limited to.

a. Copper, coax and fiber optic cable.
b. Copper patch panels.
c. Fiber termination boxes.
d. Firestop products and proposed UL® listed installation details.

B. Qualification Data:

1. The Structured Cabling System Contractor (SCSC) shall present, with his signed contract, the name and certification number of a minimum of two BICSI certified Registered Communications Distribution Designers (RCDD) who are permanent employees of the Contractor. The SCSC shall maintain these RCDDs, or other RCDDs approved by Leon County MIS, in his permanent

employment throughout this project. These RCDDs shall have overall responsibility for certifying that the installed structured cabling system conforms to these contract documents and to the referenced EIA/TIA, IEEE, BICSI, and UL standards. Specific requirements for the RCDDs are as follows:

a. The RCDD shall be, in the judgment of Leon County MIS, thoroughly experienced in the design, layout, and installation of structured cabling systems of similar size and complexity as required for this installation. The RCDD shall submit evidence of these qualifications to Leon County MIS upon request.
b. The RCDD shall affix his stamp to the SCSC's pre-installation submittal drawings, indicating that he has reviewed and approved the drawings for conformance to the contract documents and to the referenced codes and standards. As part of the Structured Cabling System installation, the SCSC shall provide detailed documentation to facilitate system administration, maintenance, and future moves, adds and changes. Drawings shall be provided which incorporate all information in the Design Drawings, and which fully document any and all approved changes in materials and methods made by the SCSC. Submittal drawings are not required if no changes to the A/E design drawings are made by the SCSC.
c. The RCDD shall periodically visit the site and inspect the work in progress. RCDD site visits shall be made not less than once per week when the job is in active progress. The RCDD shall prepare a field report for each site visit for submission to the Engineer, Leon County MIS, and Leon County Facilities.

2. The SCSC shall provide the following documentation, to be presented with the signed contract, as evidence that the requirements for Structured SCSC qualifications listed above are satisfied.

a. A list of not less than five (5) references for jobs of similar size and complexity including project name, location, contact person and phone number.
b. RCDD name, BICSI certification number, and qualifications.
c. Installers' name, BICSI certification number, and qualifications.
d. Manufacturer' certificates as having completed their necessary training.
e. Certificate to install UL listed Fire-Stop systems.
f. Location of office from which installation and warranty work will be performed.

1.7 CLOSEOUT SUBMITTALS

A. Software and Operational Documentation:

1. The Structured Cabling System Contractor (SCSC) shall provide as-built drawings indicating all outlets, cable routes, cable ID, conduit, Communications closets, cable trays, and pullboxes. The contractor's RCDD shall affix his stamp to the as-built drawings, indicating that he has reviewed and approved the drawings as being complete, accurate, and representative of the system as actually installed. The RCDD is responsible for certifying and assuring that all installations by contractors are performed in compliance with the contract documents.
2. Mark up floor plans showing outlet locations, type, and cable marking of cables. Turn these drawings over to the owner two (2) weeks prior to move in to allow the owner's personnel to connect and test owner-provided equipment in a timely fashion.
3. Three (3) sets of as-built drawing shall be delivered to the owner within four (4) weeks of acceptance of project by the owner. A set of as-built drawings shall be provided to the owner in digital form (CD) and utilizing CAD software that is acceptable to the owner. The digital media shall be delivered to the owner within six (6) weeks of acceptance of project by owner.
4. The (SCSC) shall provide all cable test results as outlined in Part 3 of this specification. The SCSC's RCDD shall sign off on all copper and fiber optic cable test results, indicating that he was in responsible charge of all cable testing procedures and that all cables were tested in compliance with the contract documents and met or exceeded the requirements stated therein.

5. The test results/measurements shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time.
6. The database for the completed job shall be stored and delivered on CD-ROM or DVD including the software tools required to view, inspect, and print any selection of test reports.
7. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. The Structured Cabling System Contractor (SCSC) shall be an experienced firm regularly engaged in the layout and installation of structured cabling systems of similar size and complexity as required. The Structured Cabling System Contractor, under the same company name, shall have successfully completed the layout, installation, testing and warranty of not less than five Structured Cabling Systems similar in scope to this project for a minimum period of three years prior to the bid date, and shall have been regularly engaged in the business of Structured Cabling Systems contracting continuously since.
2. The SCSC shall have an ~~existing permanent~~ office ~~located within a 40 miles radius of Leon County, Florida~~ from which installation and warranty service operations will be performed.
3. The SCSC and their Sub-Contractors must be Manufacturer-authorized Certified System Vendors certified by the Manufacturer to offer a 25-year Permanent Link Warranty, adhere to the engineering, installation, and testing procedures, and use Manufacturer’s components and distribution channels in provisioning this Project.
4. The SCSC and their Sub-Contractors shall have successfully completed all Manufacturer design and installation training. All members of the installation team must be certified by the manufacturer as having completed the necessary training to complete their part of the installation. All personnel shall be adequately trained in the use of necessary tools and equipment to install the system.
5. The SCSC and their Sub-Contractors must be certified to install UL listed Fire-Stop systems.
6. The system installer shall have an RCDD on staff to assist with project installation.
7. The system installers shall certified by BICSI.
8. The Contractor shall own and maintain tools, installation equipment, and test equipment necessary for successful installation and testing of fiber optic and copper Structured Cabling Systems.
9. The Owner reserves the right to require the Contractor to remove from the project any such employee the Owner deems to be incompetent, careless or insubordinate.

B. Surface-Burning Characteristics:

1. As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

    a. Flame-Spread Index: 25 or less.
    b. Smoke-Developed Index: 50 or less.

C. Cable and Termination Hardware:

1. Cables and termination hardware shall be manufactured and assembled in the United States of America. Products manufactured or assembled offshore are not acceptable.

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces:

1. Comply with TIA/EIA-569-A.

F. Grounding:

1. Comply with ANSI-J-STD-607-A.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry.

B. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight.
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects. Retain test data and include the record in maintenance data.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's and Service Provider’s LAN/WAN equipment.

B. Completely coordinate with work of other trades.

PART 2 - PRODUCTS

2.1 MULTI-PAIR CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Berk-Tek; a Nexans company.
2. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: 100-ohm, 24 AWG UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket, installed indoors in conduit or in vertical risers. Refer to drawings for pair count.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with ANSI/TIA-568-C.0 for generic specifications
3. Comply with ANSI/TIA-568-C.1 for performance specifications.
4. Comply with ANSI/TIA-568-C.2, Category 3.
5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

    a. Communications, Riser Rated: Shielded ARMM, Type CMR or MPR, complying with UL 1666.

6. Cable shall be marked every two feet with:

a. Pair count
b. Product identification
c. AWG
d. Listings (NEC)
e. UL® listing markings shall be marked on the cable jacket according to the certifying agency's requirements.
f. Sequential footage markers.
g. Verification date
h. Manufacturing traceability code

C. Description: 100-ohm, 24 AWG UTP, PE-89 gel filled, formed into 25-pair binder groups with corrugated, copolymer coated, a-mil aluminum shielding having flooded interfaces, with a black, low-density polyethylene jacket, installed outdoors in conduit below grade. Refer to drawings for pair count. (This cable type shall not exceed 50' inside the building without being installed in conduit and in no case shall this cable be installed exposed in plenum spaces.)

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with ANSI/TIA-568-C.0 for generic specifications
3. Comply with ANSI/TIA-568-C.1 for performance specifications.
4. Comply with ANSI/TIA-568-C.2, Category 3.
5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

    a. Communications, Riser Rated: Shielded ARMM, Type CMR or MPR, complying with UL 1666.

6. Cable shall be marked every two feet with:

    a. Pair count
    b. Product identification
    c. AWG
    d. Listings (NEC)
    e. UL® listing markings shall be marked on the cable jacket according to the certifying agency's requirements.
    f. Sequential footage markers.
    g. Verification date
    h. Manufacturing traceability code

2.2 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. Ortronics
4. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIA-568-C.2, I transmission performance specifications for 4-pair 100 Ohm Category 3, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

D. Connecting Blocks: 110-style IDC for Category 3. Provide blocks for the number of cables terminated on the block, plus 25 percent spare.

1. Number of Terminals per Field: One for each conductor in assigned cables.
2. Construction shall be a polycarbonate base, wall-mount style, with individual 4-pair connecting blocks.
3. 110 wiring blocks shall be 100 or 300-pair capacities, with detachable standoff legs.
4. Cross-connect kits shall include label strips, and the appropriate quantity of connecting blocks for termination to full capacity.
5. Wiring blocks shall be constructed of UL® 94-V0 rated high-impact flame-retardant polycarbonate blend thermoplastic.
6. Wiring blocks shall accept 26-22 AWG solid or stranded conductors. Wiring blocks shall have through-openings to permit rear cable entry and direct routing to each point of termination.
7. Connecting blocks shall withstand a minimum of 200 re-terminations without degradation to electrical or mechanical performance.
8. Cross-connect kits shall be UL® listed.

E. Category 3 Cross-Connection Wire

1. Category 3 cross-connect wire consisting of 24-AWG, solid annealed copper conductors, with 0.008 inch semi-rigid PVC insulation, for the punch down block. The wire shall meet or exceed the following electrical specifications:

a. DC Resistance: 52W/1,000 ft (17.1W/100m), maximum
b. Mutual Capacitance: 0.015 uF/1,000 ft (4.9 nF/100m) maximum

F. Building Entrance Terminals (BET)

1. Building Entrance Terminals shall be UL® 497 listed 110 style, factory fully populated with 5-pin 240V solid state transient voltage surge suppressors. The surge suppression device shall not attenuate or reduce the signal under normal conditions.

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Circa Telecom.
b. Edco.
c. Porta Systems.

2.3 OPTICAL FIBER CABLE

A. Basis of Design Product: Subject to compliance with requirements, provide products as indicated on the drawings and as herein specified as manufactured by Corning Cable Systems or comparable products by one of the following:

1. Berk-Tek; a Nexans company.
2. Optical Cable Corporation.
3. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Fiber optic products shall be manufactured in the United States using optical quality glass. Products manufactured with plastic cores will not be accepted. There shall be no substitutions allowed.

C. Description: Interbuilding Multimode Fiber, Freedm® One LANscape® 600, Tight-Buffered, 12 fibers/tube, OFNR and FT-4 listed, indoor/outdoor riser rated, UL ® listed, all-dielectric, constructed

with 50/125 • m OM3 laser optimized optical fiber, installed in conduit below grade. Refer to drawings for fiber optic strand count.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with ANSI/TIA-568-C.0 for generic specifications
3. Comply with ANSI/TIA-568-C.1 for performance specifications.
4. Comply with ANSI/TIA-568-C.3 for performance specifications.
5. Comply with TIA/EIA-492AAAC-B for detailed specifications.
6. Comply with TIA/EIA-598-B for cable cordage jacket, fiber, unit, and group color.

    a. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 24 inches.

7. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

    a. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.

8. Constructed using gel-free waterblocking technology with a UL® listed, UV resistant, flame retardant flexible outer jacket
9. Class 1A fiber in compliance with ANSI/TIA/EIA-492AAAC.
10. The cable shall meet all requirements stated in this specification. The cable shall be an accepted product of the United States Department of Agriculture Rural Utilities Service (RUS) 7 CFR 1755.900 (PE-90).
11. The cable shall meet or exceed ANSI/TIA-568-C.3 Commercial Building Telecommunications Cabling Standard; Backbone Cable specifications optical performance.
12. The cable shall meet or exceed ANSI/ICEA S-87-640-2006 Optical Fiber Outside Plant Communications Cable.
13. Detailed information on the fiber types available for this cable design can be found in the following documents:

    a. 50/125 • m Multimode Fiber: Generic Specification F2, “Generic Specification for Multimode Optical Fiber in Loose Tube and Ribbon Cables.”

14. Color-coded tubes and fibers
15. 250 µm loose tube fibers - All Dielectric
16. Outer jacket color: Aqua
17. Cable shall be marked every two feet with:

    a. OFNR cable code
    b. Listings (NEC)
    c. UL® listing markings shall be marked on the cable jacket according to the certifying agency’s requirements.
    d. Sequential footage markers.
    e. Verification date
    f. Manufacturing traceability code

18. Cable Construction

    a. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be either 2.5 mm or 3.0 mm.
    b. Each buffer tube shall contain up to 12 fibers.
    c. The fibers shall not adhere to the inside of the buffer tube.
    d. Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-C.3, "Optical Fiber Cable Color Coding."

e. The fibers shall be colored with ultraviolet (UV) curable inks.

f. Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-C.3, "Optical Fiber Cable Color Coding."

    1) Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm.

g. For cables containing more than 12 buffer tubes, standard colors shall be used for tubes 1 through 12 and stripes shall be used to denote tubes 13 through 24. The color sequence applies to tubes containing fibers only, and shall begin with the first tube. If fillers are required, they shall be placed in the inner layer of the cable. The tube color sequence shall start from the inside layer and progress outward.

h. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and shall not be subject to fading or smearing onto each other. Colors shall not cause fibers to stick together.

i. The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrinkback requirements of 7 CFR 1755.900.

j. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes. In dual layer cables, any fillers shall be placed in the inner layer. Fillers shall be nominally 2.5 mm or 3.0 mm in outer diameter.

k. The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod to provide tensile strength and prevent buckling. The central member shall be overcoated with a thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.

l. Each buffer tube shall contain a water-swellable yarn or water blocking element for water-blocking protection. The water-swellable yarn or water blocking element shall be non-nutritive to fungus, electrically non-conductive, and homogeneous. It shall also be free from dirt or foreign matter. This yarn or element will preclude the need for other water-blocking material; the buffer-tube shall be gel-free.

m. The optical fibers shall not require cleaning before placement into a splice tray or fan-out kit.

n. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z", stranding process. Water swellable yarn(s) shall be applied longitudinally along the central member during stranding. Water blocking elements shall be applied uniformly throughout the buffer tube.

o. Two polyester yarn binders shall be applied contrahelically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage.

p. For single layer cables, a water swellable tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

q. For dual layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two layer core. A water swellable tape shall be applied longitudinally over both the inner and outer layer. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

r. Cables shall contain one ripcord under the sheath for easy sheath removal.

s. Tensile strength shall be provided by the central member, and additional dielectric yarns as required.

t. The dielectric yarns shall be helically stranded evenly around the cable core.

u. Cables shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.3 mm. For reduced diameter (RD) cables, the minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members (as required) and water swellable tape. The polyethylene shall

contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

v. The MDPE jacket material shall be as defined by ASTM D1248, Type II, Class C, Category 4 and Grades J4, E7 and E8.

w. The jacket or sheath shall be free of holes, splits, and blisters.

x. The cable jacket shall contain no metal elements and shall be of a consistent thickness.

y. Cable jackets shall be marked with the manufacturer's name, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety CodeÒ (NESCÒ), fiber count, and fiber type. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm.

z. If the initial marking fails to meet the specified requirements (i.e., improper text statement, color, legibility, or print interval), the cable may be remarked using a contrasting alternate color. The numbering sequence will differ from the previous numbering sequence, and a tag will be attached to both the outside end of the cable and to the reel to indicate the sequence of remarking. The preferred remarking color will be yellow, with the secondary choice being blue.

aa. The maximum pulling tension shall be 2700 N (607 lbf) during installation (short term) and 890 N (200 lbf) long term installed.

bb. The shipping, storage, and operating temperature range of the cable shall be -40°C to +70°C. The installation temperature range of the cable shall be –30°C to +70°C.

19. Cable Performance

a. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the change in attenuation at extreme operational temperatures (-40°C and +70°C) shall not exceed 0.3 dB/km at 1300 nm for multimode fiber.

b. When tested in accordance with FOTP-82, "Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable," a one meter length of unaged cable shall withstand a one meter static head or equivalent continuous pressure of water for one hour without leakage through the open cable end.

c. When tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable," the cable shall exhibit no flow (drip or leak) of filling and/or flooding material at 70°C.

d. When tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables," the cable shall withstand a minimum compressive load of 220 N/cm (125 lbf/in) applied uniformly over the length of the sample. The 220 N/cm (125 lbf/in) load shall be applied at a rate of 2.5 mm (0.1 in) per minute. The load shall be maintained for a period of 1 minute. The load shall then be decreased to 110 N/cm (63 lbf/in). Alternatively, it is acceptable to remove the 220 N/cm (125 lbf/in) load entirely and apply the 110 N/cm (63 lbf/in) load within five minutes at a rate of 2.5 mm (0.1 in) per minute. The 110 N/cm (63 lbf/in) load shall be maintained for a period of 10 minutes. Attenuation measurements shall be performed before release of the 110 N/cm (63 lbf/in) load. The change in attenuation shall not exceed 0.30 dB at 1300 nm for multimode fiber.

e. When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The change in attenuation shall not exceed 0.30 dB at 1300 nm for multimode fiber.

f. When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," except that the number of cycles shall be two at three locations along a one meter cable length and the impact energy shall be at least 4.4 Nm (in accordance with ICEA S-87-640)", the change in attenuation shall not exceed 0.30 dB at 1300 nm for multimode fiber.

g. When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test," using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a rated tensile load of 2670N (601 lbf) and residual load of 30% of the rated installation load. The axial fiber strain shall be • 60% of the fiber proof level after completion of 60 minute conditioning and while the cable is under the rated installation load. The axial fiber strain shall be • 20% of the fiber proof level after completion of 10 minute conditioning and while the cable is under the residual load. The change in attenuation at residual load and after load removal shall not exceed 0.30 dB at 1300 nm for multimode fiber.

h. When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test," a length of cable no greater than 2 meters shall withstand 10 cycles of mechanical twisting. The change in attenuation shall not exceed 0.30 dB at 1300 nm for multimode fiber.

i. When tested in accordance with FOTP-181, "Lightning Damage Susceptibility Test for Optic Cables with Metallic Components," the cable shall withstand a simulated lightning strike with a peak value of the current pulse equal to 105 kA without loss of fiber continuity. For cables with 2.5mm OD buffer tubes, the peak value shall be 55 kA. A damped oscillatory test current shall be used with a maximum time-to-peak value of 15 ms (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz. The time to half value of the waveform envelope shall be from 40 to 70 µs.

j. When tested in accordance with FOTP-37, "Low or High Temperature Bend Test for Fiber Optic Cable," the cable shall withstand four full turns around a mandrel of • 20 times the cable diameter after conditioning for four hours at test temperatures of -30°C and +60°C. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears, or other openings. The change in attenuation shall not exceed 0.50 dB at 1300 nm for multimode fiber.

k. Miscellaneous

1) At the request of the customer, the cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification.

D. Description: Multimode Fiber, Freedm® Fan-Out LANscape® 600, Tight Buffered, 2 fibers, OFNR and FT-4 listed, indoor/outdoor riser rated, UL ® listed, all-dielectric, constructed with 50/125 • m OM3 laser optimized optical fiber, installed in conduit below grade. For exterior security cameras. Refer to the site plan for locations.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with ANSI/TIA-568-C.0 for generic specifications
3. Comply with ANSI/TIA-568-C.1 for performance specifications.
4. Comply with ANSI/TIA-568-C.3 for performance specifications.
5. Comply with TIA/EIA-492AAAC-B for detailed specifications.
6. Comply with TIA/EIA-598-B for cable cordage jacket, fiber, unit, and group color.

a. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 24 inches.

7. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

a. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.

8. Constructed using gel-free waterblocking technology with a UL® listed, UV resistant, flame retardant flexible outer jacket
9. Class 1A fiber in compliance with ANSI/TIA/EIA-492AAAC.

10. The cable shall meet all requirements stated in this specification. The cable shall be an accepted product of the United States Department of Agriculture Rural Utilities Service (RUS) 7 CFR 1755.900 (PE-90).
11. The cable shall meet or exceed ANSI/TIA-568-C.3 Commercial Building Telecommunications Cabling Standard; Backbone Cable specifications optical performance.
12. The cable shall meet or exceed ANSI/ICEA S-87-640-2006 Optical Fiber Outside Plant Communications Cable.
13. Detailed information on the fiber types available for this cable design can be found in the following documents:

    a. 50/125 •m Multimode Fiber: Generic Specification F2, "Generic Specification for Multimode Optical Fiber in Loose Tube and Ribbon Cables."

14. Color-coded tubes and fibers
15. 250 µm loose tube fibers - All Dielectric
16. Outer jacket color: Aqua
17. Cable shall be marked every two feet with:

    a. OFNR cable code
    b. Listings (NEC)
    c. UL® listing markings shall be marked on the cable jacket according to the certifying agency's requirements.
    d. Sequential footage markers.
    e. Verification date
    f. Manufacturing traceability code

18. Cable Construction

    a. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be either 2.5 mm or 3.0 mm.
    b. The buffer tube shall contain 2 fibers.
    c. The fibers shall not adhere to the inside of the buffer tube.
    d. Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-C.3, "Optical Fiber Cable Color Coding."
    e. The fibers shall be colored with ultraviolet (UV) curable inks.
    f. Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-C.3, "Optical Fiber Cable Color Coding."

        1) Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm.

    g. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and shall not be subject to fading or smearing onto each other. Colors shall not cause fibers to stick together.
    h. The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrinkback requirements of 7 CFR 1755.900.
    i. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes. In dual layer cables, any fillers shall be placed in the inner layer. Fillers shall be nominally 2.5 mm or 3.0 mm in outer diameter.
    j. The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod to provide tensile strength and prevent buckling. The central member shall be overcoated with a thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.
    k. Each buffer tube shall contain a water-swellable yarn or water blocking element for water-blocking protection. The water-swellable yarn or water blocking element shall be non-

nutritive to fungus, electrically non-conductive, and homogeneous. It shall also be free from dirt or foreign matter. This yarn or element will preclude the need for other water-blocking material; the buffer-tube shall be gel-free.

l. The optical fibers shall not require cleaning before placement into a splice tray or fan-out kit.

m. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z", stranding process. Water swellable yarn(s) shall be applied longitudinally along the central member during stranding. Water blocking elements shall be applied uniformly throughout the buffer tube.

n. Two polyester yarn binders shall be applied contrahelically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage.

o. For single layer cables, a water swellable tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

p. For dual layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two layer core. A water swellable tape shall be applied longitudinally over both the inner and outer layer. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

q. Cables shall contain one ripcord under the sheath for easy sheath removal.

r. Tensile strength shall be provided by the central member, and additional dielectric yarns as required.

s. The dielectric yarns shall be helically stranded evenly around the cable core.

t. Cables shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.3 mm. For reduced diameter (RD) cables, the minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members (as required) and water swellable tape. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

u. The MDPE jacket material shall be as defined by ASTM D1248, Type II, Class C, Category 4 and Grades J4, E7 and E8.

v. The jacket or sheath shall be free of holes, splits, and blisters.

w. The cable jacket shall contain no metal elements and shall be of a consistent thickness.

x. Cable jackets shall be marked with the manufacturer's name, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety CodeÒ (NESCÒ), fiber count, and fiber type. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm.

y. If the initial marking fails to meet the specified requirements (i.e., improper text statement, color, legibility, or print interval), the cable may be remarked using a contrasting alternate color. The numbering sequence will differ from the previous numbering sequence, and a tag will be attached to both the outside end of the cable and to the reel to indicate the sequence of remarking. The preferred remarking color will be yellow, with the secondary choice being blue.

z. The maximum pulling tension shall be 2700 N (607 lbf) during installation (short term) and 890 N (200 lbf) long term installed.

aa. The shipping, storage, and operating temperature range of the cable shall be -40°C to +70°C. The installation temperature range of the cable shall be –30°C to +70°C.

19. Cable Performance

a. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the change in attenuation at extreme operational temperatures (-40°C and +70°C) shall not exceed 0.3 dB/km at 1300 nm for multimode fiber.

b. When tested in accordance with FOTP-82, "Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable," a one meter length of unaged cable shall withstand a one meter static head or equivalent continuous pressure of water for one hour without leakage through the open cable end.

c. When tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable," the cable shall exhibit no flow (drip or leak) of filling and/or flooding material at 70°C.

d. When tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables," the cable shall withstand a minimum compressive load of 220 N/cm (125 lbf/in) applied uniformly over the length of the sample. The 220 N/cm (125 lbf/in) load shall be applied at a rate of 2.5 mm (0.1 in) per minute. The load shall be maintained for a period of 1 minute. The load shall then be decreased to 110 N/cm (63 lbf/in). Alternatively, it is acceptable to remove the 220 N/cm (125 lbf/in) load entirely and apply the 110 N/cm (63 lbf/in) load within five minutes at a rate of 2.5 mm (0.1 in) per minute. The 110 N/cm (63 lbf/in) load shall be maintained for a period of 10 minutes. Attenuation measurements shall be performed before release of the 110 N/cm (63 lbf/in) load. The change in attenuation shall not exceed 0.30 dB at 1300 nm for multimode fiber.

e. When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The change in attenuation shall not exceed 0.30 dB at 1300 nm for multimode fiber.

f. When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," except that the number of cycles shall be two at three locations along a one meter cable length and the impact energy shall be at least 4.4 Nm (in accordance with ICEA S-87-640)", the change in attenuation shall not exceed 0.30 dB at 1300 nm for multimode fiber.

g. When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test," using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a rated tensile load of 2670N (601 lbf) and residual load of 30% of the rated installation load. The axial fiber strain shall be • 60% of the fiber proof level after completion of 60 minute conditioning and while the cable is under the rated installation load. The axial fiber strain shall be • 20% of the fiber proof level after completion of 10 minute conditioning and while the cable is under the residual load. The change in attenuation at residual load and after load removal shall not exceed 0.30 dB at 1300 nm for multimode fiber.

h. When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test," a length of cable no greater than 2 meters shall withstand 10 cycles of mechanical twisting. The change in attenuation shall not exceed 0.30 dB at 1300 nm for multimode fiber.

i. When tested in accordance with FOTP-181, "Lightning Damage Susceptibility Test for Optic Cables with Metallic Components," the cable shall withstand a simulated lightning strike with a peak value of the current pulse equal to 105 kA without loss of fiber continuity. For cables with 2.5mm OD buffer tubes, the peak value shall be 55 kA. A damped oscillatory test current shall be used with a maximum time-to-peak value of 15 ms (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz. The time to half value of the waveform envelope shall be from 40 to 70 µs.

j. When tested in accordance with FOTP-37, "Low or High Temperature Bend Test for Fiber Optic Cable," the cable shall withstand four full turns around a mandrel of • 20 times the cable diameter after conditioning for four hours at test temperatures of -30°C and +60°C. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears, or other openings. The change in attenuation shall not exceed 0.50 dB at 1300 nm for multimode fiber.

k. Miscellaneous

1) At the request of the customer, the cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification.

E. Description: Itrabuilding Multimode Fiber, MIC LANscape® 300, Tight Buffered Gel-Free Cable (2-24 fibers) with 12 fibers/tube, OFNP and FT-6 listed, plenum rated, UL® listed, constructed with 50/125 • m OM3 laser optimized optical fiber and MIC Unitized LANscape® 300, Tight Buffered Gel-Free Cable (36-144 fibers) with 6 and 12 fibers/tube, OFNP and FT-6 listed, plenum rated, UL® listed, constructed with 50/125 • m OM3 laser optimized optical fiber, installed above grade in conduit, plenums and in vertical risers. Refer to drawings for fiber optic strand count.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with ANSI/TIA-568-C.0 for generic specifications
3. Comply with ANSI/TIA-568-C.1 for performance specifications.
4. Comply with ANSI/TIA-568-C.3 for performance specifications.
5. Comply with TIA/EIA-492AAAC-B for detailed specifications.
6. Comply with TIA/EIA-598-B for cable cordage jacket, fiber, unit, and group color.

    a. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 24 inches.

7. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following type:

    a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

8. Class 1A fiber in compliance with ANSI/TIA/EIA-492AAA-C.
9. Constructed with a UL® listed flexible outer jacket.
10. The cable shall meet or exceed ANSI/TIA-568-C.3 Commercial Building Telecommunications Cabling Standard; Backbone Cable specifications optical performance.
11. The cable shall meet the requirements of the National Electrical Code® (NEC)® Section 770.
12. Plenum Applications - Applicable Flame Test: NFPA 262. Cables shall be listed OFNP (OFCP).
13. Finished cables shall conform to the applicable performance of the Insulated Cable Engineers Association, Inc. (ICEA) Standard for Fiber Optic Premises Distribution Cable (ICEA S-83-596).
14. Detailed information on the cabled performance of the fiber types available for this cable design can be found in the following documents:

    a. 50/125 • m Multimode Fiber: Generic Specification F4, “Generic Specification for Multimode Optical Fiber in Tight Buffer Cables”.

15. Color-coded tubes and fibers
16. 900 µm tight buffer fibers - All Dielectric
17. Jacket color: Aqua
18. Cable shall be marked every two feet with:

    a. OFNP cable code
    b. Listings (NEC)
    c. UL® listing markings shall be marked on the cable jacket according to the certifying agency’s requirements.
    d. Sequential footage markers.
    e. Verification date.
    f. Manufacturing traceability code.

19. Cable Construction

a. The coated fiber shall have a low friction slip layer placed between the acrylate coating of the optical fiber and the thermoplastic buffer. The diameter of the thermoplastic buffer coating shall be 900 ± 50 • m.
b. The fiber coating and buffer shall be removable with commercially available stripping tools in a single pass for connectorization or splicing.
c. Cables with 6 and 12 fibers/tube

1) Layered strength yarns shall serve as the tensile strength member of the cable.
2) A ripcord may be applied between the strength yarns and the outer jacket to facilitate jacket removal.
3) The outer jacket shall be extruded over the strength yarns for physical and environmental protection. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness. The jacket shall be smooth, as is consistent with the best commercial practice.
4) The fibers shall be stranded around a dielectric strength yarn. The fibers shall be arranged in two layers.
5) The dielectric strength yarn shall be overcoated with a thermoplastic, when required, to achieve dimensional sizing to accommodate and support the 900 • m buffered fibers.
6) The strength members shall be of a high modulus strength yarn. The strength yarns shall be helically stranded around the buffered fibers. Non-toxic, nonirritant talc shall be applied to the yarns to allow them to be easily separated from the fibers and the subunit jacket.

d. Outer Cable Jacket:

1) The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as is consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.
2) The nominal thickness of the cable outer jacket shall be sufficient to provide adequate cable protection while meeting the mechanical, flammability, and environmental test requirements of this document over the life of the cable.
3) The cable jacket color shall be aqua for cables containing 50/125 • m Laser Optimized Multimode fiber.

a) The cable shall be all dielectric.

e. Identification

1) The individual fibers shall be color coded for identification. The optical fiber color coding shall be in accordance with EIA/TIA-598, "Optical Fiber Cable Color Coding." The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color-coded buffered fibers shall not adhere to one another.
2) When buffered fibers are grouped into individual subunits, each subunit jacket shall be numbered for identification, with the exception of filler subunits where used. The number shall be repeated at regular intervals. The subunit jacket color shall aqua for subunits containing 50/125 • m Laser Optimized Multimode fiber and white for filler subunits.
3) The outer jacket for all dielectric cable shall be marked with the manufacturer's name or ETL file number, date of manufacture, fiber count, fiber type, flame rating,

listing symbol, and sequential length markings every two feet. The marking shall be in contrasting color to the cable jacket.

f. Cable Specifications

1) Up to 144 Fiber Tight Buffer Gel-Free Cable ,12 fibers/tube, OFNP and FT-6 listed, plenum rated, UL® listed, constructed with 50/125 • m OM3 laser optimized Multimode optical fiber.

2) Temperature Range.

a) The storage temperature range for the cable on the original shipping reel shall be -40° C to +70° C. The installation temperature range for plenum cables shall be 0° C to +60° C. The operational temperature range for riser cables shall be 0° C to +70° C. Testing shall be in accordance with FOTP-3.

3) Crush Resistance

a) When tested in accordance with FOTP-41, “Compressive Loading Resistance of Fiber Optic Cables,” the cable shall withstand a minimum compressive load of 100 N/cm (57 lbf/in) applied uniformly over the length of the compression plate. While under compressive load, the fiber shall not experience an attenuation change greater than 0.60 dB at 1300 nm (multimode).

4) Cyclic Flexing

a) When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles at a rate of 30 ± 1 cycles per minute. The fiber shall not experience an attenuation change greater than 0.60 dB at 1300 nm (multimode). The jacket shall not crack, split, or tear.

5) High and Low Temperature Bend

a) When tested in accordance with FOTP-37, "Fiber Optic Cable Bend Test, Low and High Temperature," the cable shall withstand four full turns around a mandrel at low temperatures of -10° C for riser cables and 0° C for plenum cables. The cable shall also withstand four full turns at a high temperature of +60° C for both riser and plenum cables. The mandrel diameter shall be the greater of 20 times the cable OD or 150 mm. The fibers shall not experience an attenuation change greater than 0.60 dB at 1300 nm (multimode).

6) Impact Resistance

a) When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," the cable shall withstand a minimum of 2 impact cycles at 3 locations spaced a minimum distance of 150 mm. The impact energy shall be 2.94 N•m. The fibers shall not experience an attenuation change greater than 0.60 dB at 1300 nm (multimode). The jacket shall not crack, split or tear.

7) Temperature Cycling

a) When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fiber, Optical Cable, and Other

Passive Fiber Optic Components," the change in attenuation after the second cycle at the extreme operational temperatures shall not exceed 0.60 dB/km at 1300 nm (multimode). The change in attenuation is measured with respect to the baseline values measured at room temperature before temperature cycling.

8) Twist-Bend

a) When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test," a length of cable no greater than 2 meters shall withstand 10 cycles of mechanical twisting and bending. The fibers shall not experience an attenuation change greater than 0.60 dB at 1300 nm (multimode).

9) Tensile and Fiber Strain

a) When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test," and FOTP-38, “Measurement of Fiber Strain in Cables Under Tensile Load,” a length of cable shall be tested to the rated tensile load. For plenum cables < 12f the rated tensile load is 440 N (99 lbf) and for plenum cables • 12f the rated tensile load is 660 N (148 lbf). While under the rated tensile load, the fiber shall not experience a measured fiber strain greater than 60% of the fiber proof test level. After being held at the residual load (30% of the rated tensile load) the fiber shall not experience a measured fiber strain greater than 20% of the fiber proof test level nor an attenuation change greater than 0.60 dB at 1300 nm (multimode). After the tensile load is removed, the fibers shall not experience an attenuation change greater than 0.60 dB at 1300 nm (multimode).

g. Packing and Shipping

1) The cable shall be packaged in cartons and/or wound on spools. Each package shall contain only one continuous length of cable. The packaging shall be constructed so as to prevent damage to the cable during shipping and handling.

2) When the length of an order requires a wooden reel the cable shall be covered with a three-layer laminated protective material. The outer end of the cable shall be securely fastened to the reel head so as to prevent the cable from becoming loose in transit. The inner end of the cable shall project into a slot in the side of the reel or into a housing on the inner slot of the drum, in such a manner and with sufficient length to make it available for testing.

a) Test tails shall be at least two meters long. The inner end shall be fastened so as to prevent the cable from becoming loose during shipping and installation.

b) Reel Marking and Labeling. Every cable shall come with the following information:

I. Reel Label:

i. Part number
ii. Reel number
iii. Length (ft/m)
iv. Marking (ft/m) top and bottom
v. Date of manufacture
vi. Listing information

II. Bar Code Label:

i. Package ID
ii. Reel number
iii. Quantity
iv. Customer ID
v. Package count
vi. Factory order number
vii. Release part number
viii. Length (ft)
ix. “Ship to:” address
x. “Attention to:”

III. Stenciling:

i. Manufacturer’s name and address
ii. Direction of rotation
iii. Reel size
iv. “DO NOT LAY REEL ON SIDE”

h. Quality Assurance Provisions

1) All optical fibers in cables lengths of 300 m or greater shall be 100 % attenuation tested. The attenuation shall be measured at 850 nm and 1300 nm for multimode fibers. The manufacturer shall store these values for a minimum of 5 years. These values shall be available upon request.
2) The cable manufacturer shall be ISO 9001 registered.

i. Miscellaneous

1) At the request of the customer, the cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification.

F. Description: Interbuilding Single-mode Fiber, Freedm® One, Tight-Buffered, 12 fibers/tube, OFNR and FT-4 listed, indoor/outdoor riser rated, UL ® listed, all-dielectric, constructed with 8.3/125 • m OS2 optical fiber, installed in conduit below grade. Refer to drawings for fiber optic strand count.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with ANSI/TIA-568-C.3 for performance specifications.
3. Comply with TIA/EIA-492CAA-B for detailed specifications.
4. Comply with TIA/EIA-598-B for cable cordage jacket, fiber, unit, and group color.

a. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 24 inches.

5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

a. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.

6. Constructed using gel-free waterblocking technology with a UL® listed, UV resistant, flame retardant flexible outer jacket.
7. The cable shall meet all requirements stated in this specification. The cable shall be an accepted product of the United States Department of Agriculture Rural Utilities Service (RUS) 7 CFR 1755.900 (PE-90).

8. The cable shall meet or exceed ANSI/TIA-568-C.3 Commercial Building Telecommunications Cabling Standard; Backbone Cable specifications optical performance.
9. The cable shall meet or exceed ANSI/ICEA S-87-640-2006 Optical Fiber Outside Plant Communications Cable.
10. Detailed information on the fiber types available for this cable design can be found in the following documents:

    a. Dispersion Un-shifted and Non-zero Dispersion Shifted Single-mode Fiber: Generic Specification F1, “Generic Specification for Single-mode Optical Fiber in Loose Tube and Ribbon Cables.”

11. Color-coded tubes and fibers
12. 250 µm loose tube fibers - All Dielectric
13. Outer jacket color: Yellow
14. Cable shall be marked every two feet with:

    a. OFNR cable code
    b. Listings (NEC)
    c. UL® listing markings shall be marked on the cable jacket according to the certifying agency’s requirements.
    d. Sequential footage markers.
    e. Verification date
    f. Manufacturing traceability code

15. Cable Construction

    a. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be either 2.5 mm or 3.0 mm.
    b. Each buffer tube shall contain up to 12 fibers.
    c. The fibers shall not adhere to the inside of the buffer tube.
    d. Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-C.3, "Optical Fiber Cable Color Coding."
    e. The fibers shall be colored with ultraviolet (UV) curable inks.
    f. Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-C.3, "Optical Fiber Cable Color Coding."

        1) Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm.

    g. For cables containing more than 12 buffer tubes, standard colors shall be used for tubes 1 through 12 and stripes shall be used to denote tubes 13 through 24. The color sequence applies to tubes containing fibers only, and shall begin with the first tube. If fillers are required, they shall be placed in the inner layer of the cable. The tube color sequence shall start from the inside layer and progress outward.
    h. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and shall not be subject to fading or smearing onto each other. Colors shall not cause fibers to stick together.
    i. The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrinkback requirements of 7 CFR 1755.900.
    j. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes. In dual layer cables, any fillers shall be placed in the inner layer. Fillers shall be nominally 2.5 mm or 3.0 mm in outer diameter.
    k. The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod to provide tensile strength and prevent buckling. The central member shall be overcoated with

a thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.

l. Each buffer tube shall contain a water-swellable yarn or water blocking element for water-blocking protection. The water-swellable yarn or water blocking element shall be non-nutritive to fungus, electrically non-conductive, and homogeneous. It shall also be free from dirt or foreign matter. This yarn or element will preclude the need for other water-blocking material; the buffer-tube shall be gel-free.

m. The optical fibers shall not require cleaning before placement into a splice tray or fan-out kit.

n. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z", stranding process. Water swellable yarn(s) shall be applied longitudinally along the central member during stranding. Water blocking elements shall be applied uniformly throughout the buffer tube.

o. Two polyester yarn binders shall be applied contrahelically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage.

p. For single layer cables, a water swellable tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

q. For dual layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two layer core. A water swellable tape shall be applied longitudinally over both the inner and outer layer. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

r. Cables shall contain one ripcord under the sheath for easy sheath removal.

s. Tensile strength shall be provided by the central member, and additional dielectric yarns as required.

t. The dielectric yarns shall be helically stranded evenly around the cable core.

u. Cables shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.3 mm. For reduced diameter (RD) cables, the minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members (as required) and water swellable tape. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

v. The MDPE jacket material shall be as defined by ASTM D1248, Type II, Class C, Category 4 and Grades J4, E7 and E8.

w. The jacket or sheath shall be free of holes, splits, and blisters.

x. The cable jacket shall contain no metal elements and shall be of a consistent thickness.

y. Cable jackets shall be marked with the manufacturer’s name, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety CodeÒ (NESCÒ), fiber count, and fiber type. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm.

z. If the initial marking fails to meet the specified requirements (i.e., improper text statement, color, legibility, or print interval), the cable may be remarked using a contrasting alternate color. The numbering sequence will differ from the previous numbering sequence, and a tag will be attached to both the outside end of the cable and to the reel to indicate the sequence of remarking. The preferred remarking color will be yellow, with the secondary choice being blue.

aa. The maximum pulling tension shall be 2700 N (607 lbf) during installation (short term) and 890 N (200 lbf) long term installed.

bb. The shipping, storage, and operating temperature range of the cable shall be -40°C to +70°C. The installation temperature range of the cable shall be –30°C to +70°C.

16. Cable Performance

a. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the change in attenuation at extreme operational temperatures (-40°C and +70°C) shall not exceed 0.15 dB/km at 1550 nm for single-mode fiber.

b. When tested in accordance with FOTP-82, "Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable," a one meter length of unaged cable shall withstand a one meter static head or equivalent continuous pressure of water for one hour without leakage through the open cable end.

c. When tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable," the cable shall exhibit no flow (drip or leak) of filling and/or flooding material at 70°C.

d. When tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables," the cable shall withstand a minimum compressive load of 220 N/cm (125 lbf/in) applied uniformly over the length of the sample. The 220 N/cm (125 lbf/in) load shall be applied at a rate of 2.5 mm (0.1 in) per minute. The load shall be maintained for a period of 1 minute. The load shall then be decreased to 110 N/cm (63 lbf/in). Alternatively, it is acceptable to remove the 220 N/cm (125 lbf/in) load entirely and apply the 110 N/cm (63 lbf/in) load within five minutes at a rate of 2.5 mm (0.1 in) per minute. The 110 N/cm (63 lbf/in) load shall be maintained for a period of 10 minutes. Attenuation measurements shall be performed before release of the 110 N/cm (63 lbf/in) load. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber.

e. When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber.

f. When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," except that the number of cycles shall be two at three locations along a one meter cable length and the impact energy shall be at least 4.4 Nm (in accordance with ICEA S-87-640)", the change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber.

g. When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test," using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a rated tensile load of 2670N (601 lbf) and residual load of 30% of the rated installation load. The axial fiber strain shall be • 60% of the fiber proof level after completion of 60 minute conditioning and while the cable is under the rated installation load. The axial fiber strain shall be • 20% of the fiber proof level after completion of 10 minute conditioning and while the cable is under the residual load. The change in attenuation at residual load and after load removal shall not exceed 0.15 dB at 1550 nm for single mode fiber.

h. When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test," a length of cable no greater than 2 meters shall withstand 10 cycles of mechanical twisting. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber.

i. When tested in accordance with FOTP-181, "Lightning Damage Susceptibility Test for Optic Cables with Metallic Components," the cable shall withstand a simulated lightning strike with a peak value of the current pulse equal to 105 kA without loss of fiber continuity. For cables with 2.5mm OD buffer tubes, the peak value shall be 55 kA. A damped oscillatory test current shall be used with a maximum time-to-peak value of 15 ms (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz. The time to half value of the waveform envelope shall be from 40 to 70 µs.

j. When tested in accordance with FOTP-37, "Low or High Temperature Bend Test for Fiber Optic Cable," the cable shall withstand four full turns around a mandrel of • 20 times the cable diameter after conditioning for four hours at test temperatures of -30°C and +60°C. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears, or

other openings. The change in attenuation shall not exceed 0.30 dB at 1550 nm for single mode fiber.

k. Miscellaneous

1) At the request of the customer, the cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification.

G. Description: Intrabuilding Single-mode fiber MIC tight buffer gel-free cable (2-24 fibers) with 12 fibers/tube and MIC Unitized tight buffer gel-free cable (36-144 fibers) with 6 and 12 fibers/tube, OFNP and FT-6 listed, plenum rated, UL® listed, constructed with 8.3/125 • m optical fiber, installed above grade in conduit, plenums and in vertical risers. Refer to drawings for fiber optic strand count.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with ANSI/TIA-568-C.0 for generic specifications
3. Comply with ANSI/TIA-568-C.1 for performance specifications.
4. Comply with ANSI/TIA-568-C.3 for performance specifications.
5. Comply with TIA/EIA-492CAA-B for detailed specifications.
6. Comply with TIA/EIA-598-B for cable cordage jacket, fiber, unit, and group color.
   a. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 24 inches.

7. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following type:

   a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

8. Class 1A fiber in compliance with ANSI/TIA/EIA-492CAA-B.
9. Constructed with a UL® listed flexible outer jacket.
10. The cable shall meet or exceed ANSI/TIA-568-C.3 Commercial Building Telecommunications Cabling Standard; Backbone Cable specifications optical performance.
11. Detailed information on the cabled performance of the fiber types available for this cable design can be found in the following documents:

    a. Dispersion Un-shifted Single-mode Fiber: Generic Specification F3, “Generic Specification for Single-mode Optical Fiber in Tight Buffer Cables.”

12. Color-coded tubes and fibers
13. 900 µm tight buffer fibers - All Dielectric
14. Jacket color: Yellow
15. Number of strands: Refer to drawings.
16. Cable shall be marked every two feet with:

    a. OFNP cable code
    b. Listings (NEC)
    c. UL® listing markings shall be marked on the cable jacket according to the certifying agency’s requirements.
    d. Sequential footage markers.
    e. Verification date
    f. Manufacturing traceability code

17. Cable Construction

a. The coated fiber shall have a low friction slip layer placed between the acrylate coating of the optical fiber and the thermoplastic buffer. The diameter of the thermoplastic buffer coating shall be 900 ± 50 • m.
b. The fiber coating and buffer shall be removable with commercially available stripping tools in a single pass for connectorization or splicing.
c. Cables with up to 12 fibers/tube

1) Layered strength yarns shall serve as the tensile strength member of the cable.
2) A ripcord may be applied between the strength yarns and the outer jacket to facilitate jacket removal.
3) The outer jacket shall be extruded over the strength yarns for physical and environmental protection. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness. The jacket shall be smooth, as is consistent with the best commercial practice.
4) The fibers shall be stranded around a dielectric strength yarn. The fibers shall be arranged in two layers.
5) The dielectric strength yarn shall be overcoated with a thermoplastic, when required, to achieve dimensional sizing to accommodate and support the 900 • m buffered fibers.
6) The strength members shall be of a high modulus strength yarn. The strength yarns shall be helically stranded around the buffered fibers. Non-toxic, nonirritant talc shall be applied to the yarns to allow them to be easily separated from the fibers and the subunit jacket.

d. Outer Cable Jacket:

1) The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as is consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.
2) The nominal thickness of the cable outer jacket shall be sufficient to provide adequate cable protection while meeting the mechanical, flammability, and environmental test requirements of this document over the life of the cable.
3) The cable jacket color shall be yellow for cables containing Single-mode fiber.

a) The cable shall be all dielectric.

e. Identification

1) The individual fibers shall be color coded for identification. The optical fiber color coding shall be in accordance with EIA/TIA-598, "Optical Fiber Cable Color Coding." The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color-coded buffered fibers shall not adhere to one another.
2) When buffered fibers are grouped into individual subunits, each subunit jacket shall be numbered for identification, with the exception of filler subunits where used. The number shall be repeated at regular intervals. The subunit jacket color shall be yellow for subunits containing Single-mode fibers, and white for filler subunits.
3) The outer jacket for all dielectric cable shall be marked with the manufacturer's name or ETL file number, date of manufacture, fiber count, fiber type, flame rating, listing symbol, and sequential length markings every two feet. The marking shall be in contrasting color to the cable jacket.

f. Cable Specifications

1) Up to 144 Fiber Tight Buffer Gel-Free Cable 12 fibers/tube, OFNP and FT-6 listed, plenum rated, UL® listed, constructed with 1310/1383/1550 • m OM2 Single-mode optical fiber.

2) Temperature Range.

a) Plenum Applications. The storage temperature range for the cable on the original shipping reel shall be -40 °C to +70 °C. The installation temperature range for plenum cables shall be 0 °C to +60 °C. The operational temperature range for riser cables shall be 0 °C to +70 °C. Testing shall be in accordance with FOTP-3.

3) Crush Resistance

a) When tested in accordance with FOTP-41, “Compressive Loading Resistance of Fiber Optic Cables,” the cable shall withstand a minimum compressive load of 100 N/cm (57 lbf/in) applied uniformly over the length of the compression plate. While under compressive load, the fiber shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode).

4) Cyclic Flexing

a) When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles at a rate of 30 ± 1 cycles per minute. The fiber shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode). The jacket shall not crack, split, or tear.

5) High and Low Temperature Bend

a) When tested in accordance with FOTP-37, "Fiber Optic Cable Bend Test, Low and High Temperature," the cable shall withstand four full turns around a mandrel at low temperatures of -10 °C for riser cables and 0 °C for plenum cables. The cable shall also withstand four full turns at a high temperature of +60 °C for both riser and plenum cables. The mandrel diameter shall be the greater of 20 times the cable OD or 150 mm. The fibers shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode).

6) Impact Resistance

a) When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," the cable shall withstand a minimum of 2 impact cycles at 3 locations spaced a minimum distance of 150 mm. The impact energy shall be 2.94 N•m. The fibers shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode). The jacket shall not crack, split or tear.

7) Temperature Cycling

a) When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fiber, Optical Cable, and Other Passive Fiber Optic Components," the change in attenuation after the second

cycle at the extreme operational temperatures shall not exceed 0.40 dB/km at 1550 nm (single-mode). The change in attenuation is measured with respect to the baseline values measured at room temperature before temperature cycling.

8) Twist-Bend

a) When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test," a length of cable no greater than 2 meters shall withstand 10 cycles of mechanical twisting and bending. The fibers shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode).

9) Tensile and Fiber Strain

a) When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test," and FOTP-38, “Measurement of Fiber Strain in Cables Under Tensile Load,” a length of cable shall be tested to the rated tensile load. For plenum cables < 12f the rated tensile load is 440 N (99 lbf) and for plenum cables • 12f the rated tensile load is 660 N (148 lbf). While under the rated tensile load, the fiber shall not experience a measured fiber strain greater than 60% of the fiber proof test level. After being held at the residual load (30% of the rated tensile load) the fiber shall not experience a measured fiber strain greater than 20% of the fiber proof test level nor an attenuation change greater than 0.40 dB at 1550 nm (single-mode). After the tensile load is removed, the fibers shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode).

g. Packing and Shipping

1) The cable shall be packaged in cartons and/or wound on spools. Each package shall contain only one continuous length of cable. The packaging shall be constructed so as to prevent damage to the cable during shipping and handling.

2) When the length of an order requires a wooden reel the cable shall be covered with a three-layer laminated protective material. The outer end of the cable shall be securely fastened to the reel head so as to prevent the cable from becoming loose in transit. The inner end of the cable shall project into a slot in the side of the reel or into a housing on the inner slot of the drum, in such a manner and with sufficient length to make it available for testing.

a) Test tails shall be at least two meters long. The inner end shall be fastened so as to prevent the cable from becoming loose during shipping and installation.

b) Reel Marking and Labeling. Every cable shall come with the following information:

I. Reel Label:

i. Part number
ii. Reel number
iii. Length (ft/m)
iv. Marking (ft/m) top and bottom
v. Date of manufacture
vi. Listing information

II. Bar Code Label:

i. Package ID
ii. Reel number
iii. Quantity
iv. Customer ID
v. Package count
vi. Factory order number
vii. Release part number
viii. Length (ft)
ix. “Ship to:” address
x. “Attention to:”

III. Stenciling:

i. Manufacturer’s name and address
ii. Direction of rotation
iii. Reel size
iv. “DO NOT LAY REEL ON SIDE”

h. Quality Assurance Provisions

1) All optical fibers in cables lengths of 300 m or greater shall be 100 % attenuation tested. The attenuation shall be measured at 1310 nm and 1550 nm for single-mode fibers. The manufacturer shall store these values for a minimum of 5 years. These values shall be available upon request.
2) The cable manufacturer shall be ISO 9001 registered.

i. Miscellaneous

1) At the request of the customer, the cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification.

2.4 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Berk-Tek; a Nexans company.
2. Corning Cable Systems.
3. Ortronics
4. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Fiber Termination Cabinets: Modular panels housing multiple-numbered, duplex cable connectors. Refer to plans for cabinet size and required termination modules.

C. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with ANSI/TIA-568-C.3.
2. Unicam, Type LC connectors. Insertion loss not more than 0.75 dB per mated pair.
3. Pre-terminated MTP duplex modules.
4. All fiber optic cables shall be pre-terminated using MTP connectors.

2.5 COAXIAL CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Tappan Wire and Cable Inc.
2. General Cable.

B. Description: RG-11/U (734 and 735 type), Telcordia Technologies GR-139-CORE, 75 Ohm 14 AWG solid copper-covered steel conductor with FEP-Foam Fluorinated Ethylene Propylene insulation, bonded foil plus 60% aluminum braid shield, PVDF - Fluorocopolymer plenum rated jacket, installed above grade in plenums or in vertical risers.

1. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
2. Cable shall be marked every two feet with:

a. CMP cable code
b. Listings (NEC)
c. UL®, ETL, or CSA agency certification or verification markings shall be marked on the cable jacket according to the certifying agency's requirements.
d. Sequential footage markers.
e. Verification date
f. Manufacturing traceability code

C. Description: RG-11/U (734 and 735 type), Telcordia Technologies GR-139-CORE, 75 Ohm 14 AWG solid bare copper-covered steel conductor with gas-injected foam Polyethylene insulation, bonded foil plus 60% aluminum braid shield, PVC jacket, installed above grade in conduit or in vertical risers.

1. CATV Riser Rated: Type CATVR, complying with UL® 1666.
2. Cable shall be marked every two feet with:

a. CMR cable code
b. Listings (NEC)
c. UL®, ETL, or CSA agency certification or verification markings shall be marked on the cable jacket according to the certifying agency's requirements.
d. Sequential footage markers.
e. Verification date
f. Manufacturing traceability code.

D. Description: RG-11/U (734 and 735 type), Telcordia Technologies GR-139-CORE, 75 Ohm 14 AWG solid bare copper-covered steel conductor with gas-injected foam Polyethylene insulation, bonded foil plus 60% aluminum braid shield, water blocking gel, sunlight-resistant Polyethylene jacket, installed below grade in conduit.

1. CATV Riser Rated: Type CATVR, complying with UL® 1666.
2. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 80 deg C.
3. Cable shall be marked every two feet with:

a. CMR cable code
b. Listings (NEC)
c. UL®, ETL, or CSA agency certification or verification markings shall be marked on the cable jacket according to the certifying agency's requirements.
d. Sequential footage markers.
e. Verification date
f. Manufacturing traceability code

2.6 COAXIAL CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. Blonder Tongue Laboratories, Inc.
4. Toner Cable Equipment, Inc.
5. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Coaxial cable and accessories shall have 75 ohm nominal impedance with an insertion loss of 0.02 dB maximum and return loss of 35 dB maximum from 1 to 22.5 MHz.

C. Coaxial-Cable Connectors: Type BNC, 75 ohms.

D. Coax Transient Voltage Surge Suppressors

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Edco.
b. Ditek Corp.

2. Coax transient voltage surge suppressors shall meet the following:

a.	Attenuation:	0.1db @ 500Mhz
b.	Response Time:	100ns @ 10kv/us
c.	Spark-over Voltage:	750 volts @ 10kv/us typ
d.	Surge Handling (1 time):	5 kA (8x20us)
e.	Matching:	2 75 Ohm

2.7 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to ANSI/TIA-568-C.1.

C. Factory test UTP cables according to ANSI/TIA-568-C.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and ANSI/TIA-568-C.3.

E. Factory test single mode optical fiber cables according to TIA/EIA-526-7 and ANSI/TIA-568-C.3.

F. Cable will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation points provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways, cable trays and ladder racks except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install only plenum rated cables in environmental air spaces, including plenum ceilings.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with ANSI/TIA-568-C.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In each communications equipment room, install a 10-foot- long service loop of each type of cable.
11. At each workstation outlet feed point, install a 6-foot - long service loop not less than 12 inches in diameter of each type of cable.
12. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

13. Voice interbuilding backbone cables shall be terminated on building entrance terminals (BETs) at both ends.
14. Coax interbuilding backbone cables shall be terminated on transient voltage surge suppressors at both ends.
15. Voice and data cables sharing same cable trays with other low voltage cables (such as security cables, fire alarm cables, intercom cables, speaker wires, etc.) shall be separated from those cables by divider fences.

C. UTP and F/UTP Cable Installation:

1. Comply with ANSI/TIA-568-C.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.
3. Cables shall be terminated on rack or wall mounted connecting hardware. Refer to drawings.

D. Optical Fiber Cable Installation:

1. Cables shall be terminated on rack or wall mounted connecting hardware. Refer to drawings.

E. Coaxial Cable Installation:

1. Cables shall be terminated with connecting hardware on wall mounted electronic equipment. Refer to drawings.

F. General Cable Routing:

1. Where backbone cables in telecommunications spaces are installed horizontally they shall be supported on ladder racks. All cables shall be separated and bundled into like groups. When large quantities of cables leave ladder rack, cables shall be supported by drop-outs or cable support hardware manufactured specifically for the purpose of supporting cables.
2. Where backbone cables are installed vertically on backboards cables shall be supported by D-rings installed at a maximum of 2 feet. All cables shall be separated and bundled into like groups.
3. Where backbone cables are installed horizontally they shall be supported in conduit or on cable trays, J-hooks or ladder racks. Refer to drawings for the extent of the particular method of support. All cables shall be separated and bundled into like groups. When large quantities of cables leave cable trays or ladder rack, cables shall be supported by drop-outs or cable support hardware manufactured specifically for the purpose of supporting cables.
4. J-hooks shall be installed at a maximum of 5 feet and cabling shall maintain minimal deflection and strain (less than 12” deflection). Cables shall not be supported from ceiling grid wires. All cables shall be separated and bundled into like groups.
5. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

G. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling in cable trays in raised floor areas after the flooring system supports have been installed.

H. Outdoor Cable Installation:
1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.

I. Group connecting hardware for cables into separate logical fields.

J. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 SLEEVE SEAL INSTALLATION FOR COMMUNICATION CABLE PENETRATIONS

A. Install sleeve seals at penetrations of floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with NFPA 70.

C. Comply with J-STD-607-A.

D. Comply with Motorola R-56.

E. All metal armored cables or cables having metallic conductors entering a building shall conform to the bonding and grounding requirements in NEC Article 760.

F. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

G. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.7 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with ANSI/TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Multimode attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in ANSI/TIA-568-C.1.

    c. All field technicians must be a trained in the functional areas of termination, splicing and network testing, which includes testing with an OLTS and an OTDR and have obtained a Certificate as proof thereof to execute the tests. Certifications shall be obtained from:

        1) Manufacturer of the test equipment used for the field certification.

    d. Testing shall be carried out in accordance with this document. This includes testing the attenuation and polarity of the installed cable plant with an optical loss test set (OLTS) and the installed condition of the cabling system and its components with an optical time domain reflectometer (OTDR). The condition of the fiber endfaces shall also be verified.

    e. The light source shall meet the launch requirements of ANSI/EIA/TIA 455 50B, Method A. This launch condition shall be achieved by use of an external mandrel wrap and a 1-

jumper reference (as described in ANSI/TIA-568-C.1) with a Category 1 light source. Referencing refers to the common practice of adjusting the optical meter reading of the source power so as to show 0.0 dB.

f. The test jumper shall have the same connector type as the system under test and this connector shall be inserted into the meter port during the 1-jumper test.

g. After the 1-jumper reference is performed the second test jumper shall inserted into the meter and connected to the first. The extra loss seen will be the test jumper connector loss. During this "check" step, a high loss could represent poor or dirty jumpers that may adversely affect the test results. The original first jumper should not be disconnected from the source during this process. Referencing is NOT done again at this 2-jumper check. The jumper loss is considered part of the system to be measured; as long as the loss is not out of specification, it will not produce high system loss. Only after the 1-jumper reference is made, and the test connectors are shown to have acceptable loss, the system under test can be accurately tested. It is not acceptable to simply use "known good" jumpers. Test jumpers may wear out over time, may get dirty, or may get damaged during storage or transit.

h. Testing shall be performed on each cabling link (connector to connector).

i. Testing shall be performed on each cabling permanent link (equipment to equipment) that is identified by the owner.

    1) Testing shall not include any active devices or passive devices within the link other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

j. All tests shall be documented including optical length measurements, OLTS dual wavelength attenuation measurements for multimode and single-mode links and OTDR traces and event tables for multimode and single-mode links.

k. A certification report shall be provided listing the calculated and measured loss at 850 µm and 1300 µm for multimode fibers and 1310 µm 1550 µm for single-mode fibers. The certification report shall also include the installed lengths for all fibers within the cables that have been provided. All fibers shall be tested in one direction with an OTDR and printouts of the traces for each fiber shall be provided as part of the certification documents. Approval of the test results will be made by the Owner's Representative before the project is accepted by the Owner as satisfactory and complete.

l. Quality Assurance

    1) All testing procedures and field-test instruments shall comply with applicable requirements of:

        a) ANSI Z136.2, ANS For Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources
        b) ANSI/EIA/TIA 455 50B, Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements
        c) ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR.
        d) ANSI/TIA/EIA 455 60A, Measurement of Fiber or Cable Length Using an OTDR.
        e) ANSI/TIA/EIA 455 61A, Measurement of Fiber or Cable Attenuation Using an OTDR.

f) ANSI/TIA/EIA 526 7, Optical Power Loss Measurements of Installed Single-mode Fiber Cable Plant.
g) ANSI/TIA/EIA 526 14 A, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
h) ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, Part 1, General Requirements.
i) ANSI/TIA-568 C.3, Optical Fiber Cabling Components Standard.
j) TIA/EIA TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems.
k) ANSI/TIA/EIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure, including requirements specified by the owner, unless the owner specifies their own labeling requirements.

2) The Owner or the Owner's representative shall be invited to witness and/or review field-testing.

a) The Owner or the Owner's representative shall be notified of the start date of the testing phase five (5) business days before testing commences.
b) The Owner or the Owner's representative will select a random sample of 5% of the installed links. The Owner or the Owner's representative shall test these randomly selected links and the results are to be stored in accordance with Part 3 of this document. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the representative shall repeat 100% testing at no cost to the Owner.

m. Acceptance of Test Results

1) Unless otherwise specified by the Owner or the Owners representative, each cabling link shall be in compliance with the following test limits:

a) Optical loss testing

I. The link attenuation shall be calculated by the following formulas as specified in ANSI/TIA-568-C.1.

i. Link Attenuation (dB) = Cable Attn (dB) + Connector Attn (dB) + Splice Attn (dB)
ii. Cable Attn (dB) = Attenuation Coefficient (dB/km) * Length (Km)
iii. Connector Attn (dB) = number of connector pairs * connector loss (dB)
iv. Maximum allowable connector loss = 0.75 dB
v. Splice Attn (dB) = number of splices * splice loss (dB)
vi. Maximum allowable splice loss = 0.3 dB
vii. The values for the Attenuation Coefficient (dB/km) are listed in the table below:

Type of Optical Fiber	Wavelength (nm)	Attenuation coefficient (dB/km)	Wavelength (nm)	Attenuation coefficient (dB/km)
Multimode 50/125 µm	850	3.5	1300	1.5
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5

b) OTDR Testing

I. Reflective events (connections) shall not exceed 0.75 dB.
II. Non-reflective events (splices) shall not exceed 0.3 dB.

c) Magnified Endface Inspection

I. Fiber connections shall be visually inspected for endface quality.
II. Scratched, pitted or dirty connectors shall be diagnosed and corrected.

2) All installed cabling links shall be field-tested and pass the test requirements and analysis as described in Part 3. Any link that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link meets performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Part 3.

3) Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

Note: High Bandwidth applications such as 1000BASE-SX, 10GBASE-S, and FC1200 impose stringent channel loss limits. Where practical, certification should consider loss length limits that meet maximum channel (transmitter to receiver) loss.

Performance specification for MM fiber at 850 nm

Fiber Type		Bandwidth	1000BASE-SX		10GBASE-SR		FibreChannel 1200-MX-SN-I	
	µm	(MHz• Km)	Length (m)	Loss (dB)	Length (m)	Loss (dB)	Length (m)	Loss (dB)
OM1	62.5	220	275	2.38	26	2.6	33	2.4
OM2	50	500	550	3.56	82	2.3	82	2.2
OM3	50	2000	1000	3.56	300	2.6	300	2.6

n. Optical Fiber Cable Testers

1) The field-test instrument shall be within the calibration period recommended by the manufacturer.
2) Optical loss test set (OLTS)

a) Multimode optical fiber light source

I. Provide dual LED light sources with central wavelengths of 850 nm ±30 nm) and 1300 nm (±20 nm)
II. Output power of –20 dBm minimum.
III. The light source shall meet the launch requirements of ANSI/EIA/TIA 455 50B, Method A. This launch condition shall be achieved by use of an external mandrel wrap and a 1-jumper reference (as described in ANSI/TIA-568-C.1) with a Category 1 light source.
IV. The test jumper shall have the same connector type as the system under test and this connector shall be inserted into the meter port during the 1-jumper test.

V. The optical meter (receive) test unit may require an optical port that can accept various connector types.
VI. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

i. Corning Cable Systems.
ii. Fluke Networks.
iii. GN Nettest.

b) Single-mode Optical Fiber Light Source

I. Provide dual laser light sources with central wavelengths of 1310 nm (±20 nm) and 1550 nm (±20 nm).
II. Output power of –10 dBm minimum.
III. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

i. Corning Cable Systems.
ii. Fluke Networks.
iii. GN Nettest.

c) Power Meter

I. Provide 850 nm, 1300/1310 nm, and 1550 nm wavelength test capability.
II. Power measurement uncertainty of ± 0.25 dB.
III. Store reference power measurement.
IV. Save at least 100 results in internal memory.
V. PC interface (serial or USB).
VI. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

i. Corning Cable Systems.
ii. Fluke Networks.
iii. GN Nettest.

d) Length measurement

I. Use an OLTS that is capable of measuring the optical length of the fiber using time-of-flight techniques.

3) Optical Time Domain Reflectometer (OTDR)

a) Shall have a bright, color transmissive SCD display with backlight.
b) Serial and USB ports to transfer data to a PC.
c) Multimode OTDR

I. Wavelengths of 850 nm (± 20 nm) and 1300 nm (± 20 nm).
II. Event deadzones of 3.7 m maximum at 850 nm and 1300 nm.
III. Attenuation deadzones of 10 m maximum at 850 nm and 13 m maximum at 1300 nm.
IV. Distance range not less than 2000 m.
V. Dynamic range at least 10 dB at 850 nm and 1300 nm

d) Single-mode OTDR

I. Wavelengths of 1310 nm (± 20 nm) and 1550 nm (± 20 nm).
II. Event deadzones of 3.5 m maximum at 1310 nm and 1550 nm.
III. Attenuation deadzones of 10 m maximum at 1310 nm and 12 m maximum at 1550 nm.
IV. Distance range not less than 10000 m.
V. Dynamic range at least 10 dB at 1310 nm and 1550 nm

e) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

I. Corning Cable Systems.
II. Fluke Networks.
III. GN Nettest.

5. Category 3 Copper Cabling Testing

a. Test each pair and shield (where applicable) of each cable for opens, shorts, grounds and pair reversal. Correct grounded, and reversed pairs. Examine open and shorted pairs to determine if problem is caused by improper termination. If termination is proper, tag bad pair at both ends and note on termination sheets.
b. Testing shall conform to ANSI/TIA-568-C.1 standard. Testing shall be accomplished using Level III or higher field testers.

6. Coaxial Cable Testing
a. Test each cable for center conductor continuity, shield continuity, impedance (75-ohms) and attenuation based on the planned application for the cable per ANSI 942 Addendum 1.
b. Make sure that all unused ports on splitters and taps are terminated. Test each cable for continuity and attenuation. Check each cable for correct termination. Verify proper grounding at service entrance and at all surge suppression devices. Test each wall tap to verify correct signal strength. Document results of testing and submit to Engineer for review and approval. The test log shall include outlet identifier, the test date, the initials of the technician who tested the cable and the test results.
c. The Contractor shall perform a Cumulative Leakage Index test (CLI) on the completed system utilizing industry standard test equipment. Leakage shall be no more than allowed by FCC rules and regulations. Document results of testing and submit to Engineer for review and approval. The test results shall include documentation on the instrumentation used, the test date, the name of the technician who performed the test, and the test results, compared to the applicable FCC rules and regulations. Proof of performance of the ITV System shall be conducted in the presence of the Engineer and the Owner's Representative. All applicable test equipment shall be supplied by the Contractor for all tests. Any equipment or material not meeting specifications shall be remedied or replaced with other equipment to the satisfaction of the Engineer. These tests shall be conducted after the Contractor has adjusted the system to his satisfaction. The Engineer reserves the right to conduct any test in addition to those prescribed in this specification.
d. Contractor shall verify that each outlet has a minimum of 5dBmV and a maximum of 10dBmV on all channels. Provide amplification as necessary to meet this criterion.
e. Testing shall be performed after all components have been labeled and prior to system cut-over.
f. Reports on any field testing during installation shall be forwarded to the Owner's Representative. Test results shall meet or exceed Manufacturer's documentation data. Contractor shall affirm that the testers have the latest firmware and software. All testers shall be calibrated within the time period recommended by the manufacturer.

B. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

C. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 271300

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and Specification Division 01, applicable provisions of Division 27, and other provisions and requirements of the contract apply to this Section.

1.2 SUMMARY

A. The horizontal cabling system shall provide interconnections between Communications Equipment Rooms, Entrance Facilities, or Telecommunications Rooms and Workstation outlets in the telecommunications cabling system structure. The cabling system consists of horizontal cables and mechanical terminations.

B. Horizontal cabling cross-connects may be located in Communications Equipment Rooms, Entrance Facilities, or Telecommunications Rooms. Bridged taps and splitters shall not be used as part of the horizontal cabling.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowable length of 16 feet for patch cords at the workstation or in the horizontal cross-connect.

D. Section Includes:

1. Category 6 F/UTP cabling.
2. Category 6 UTP cabling.
3. Cable connecting hardware, patch panels, and cross-connects.
4. Telecommunications outlet/connectors.
5. Cable management system.

E. Related Requirements:

1. Division 27 Section "Communications Backbone Cabling" for voice, data and TV cabling associated with system panels and devices.
2. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice, data and TV cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. F/UTP: Foil applied over unshielded twisted pair (also known as screened twisted pair – ScTP).

F. IDC: Insulation displacement connector.

G. LAN: Local area network.

H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

I. RCDD: Registered Communications Distribution Designer.

J. UTP: Unshielded twisted pair.

1.4 CODES AND STANDARDS

A. Florida Building Code (FBC).

B. National Electrical Code (NEC/NFPA 70)

1. National Electric Code (NEC), 2005.
2. NEC Article 250: Grounding.
3. NEC Article 386: Surface Metal Raceways.
4. NEC Article 388: Surface Non-Metallic Raceways.
5. NEC Article 708: Critical Operations Power Systems.
6. NEC Article 770: Optical Fiber Cables and Raceway.
7. NEC Article 800: Communications Circuits.

C. National Electrical Safety Code (NESC IEEE C 2).

D. U.S. Public Law 336. 101st Congress, ADA: Americans with Disabilities Act of 1992.

E. Local AHJ (Authority Having Jurisdiction) interpretations of codes, amendments, and ordinances.

F. ANSI/EIA-310-E - Cabinets, Racks, Panels and Associated Equipment, 2005.

G. ANSI/TIA/EIA-440B Fiber Optic Terminology, 2004).

H. ANSI/TIA/EIA-492AAAC, Detail Specification for 850nm Laser-Optimized 50um Core Diameter/125 um Cladding Diameter Class 1A Graded Index Multimode Optical Fibers, 2003.

I. ANSI/TIA/EIA-492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Single-mode Optical fibers, 2002.

J. ANSI/TIA/EIA-526-7, Optical Power Loss Measurements of Installed Single-mode Fiber Plant: OFSTP-7, 2002.

K. ANSI/TIA/EIA-526-14-A, Optical Power Loss Measurements of Installed Multimode Fiber Plant: OFSTP-14A, 2003.

L. ANSI/TIA-568-C.0, Generic Telecommunications Cabling For Customer Premises, 2009.

M. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements, 2009.

N. ANSI/TIA-568-C.2, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components, 20098.

O. ANSI/TIA-C.3, Optical Fiber Cabling Components Standard, 2009.

P. ANSI/TIA/EIA-569-B, Commercial Building Standards for Telecommunications Pathways and Spaces Standard (Latest revision and all published amendments).

Q. ANSI/EIA/TIA-570-B, Residential and Light Commercial Telecommunications Wiring Standard (Latest revision and all published amendments).

R. ANSI/TIA/EIA-604, Fiber Optic Connector Intermateability Standard.

S. ANSI/TIA/EIA-604-7A, Measurements of Optical Power Loss of Installed Single-mode Fiber Cable Plant, 2002.

T. ANSI/TIA/EIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure, 2002.

U. ANSI/TIA/EIA-758, Customer-Owned Outside Plant Telecommunications Cabling Standard, 2004.

V. ANSI/TIA/EIA-942, Telecommunications Infrastructure Standards for Data Centers (Latest revision and all published amendments).

W. ANSI/TIA/EIA-TSB-125, Guidelines for Maintaining Optical Fiber Polarity Through Reverse-Pair Positioning, 2001.

X. ANSI/TIA/EIA-TSB-140, Additional Guidelines for Field Testing Length, Loss, and Polarity of Optical Fiber Cabling Systems, 2004.

Y. ANSI/J-STD-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

Z. ANSI T1.404, Network And Customer Installation Interfaces - DS3 Metallic Interface Specification.

AA. ANSI/NECA/BICSI-568-2001, Standard for Installing Commercial Building Telecommunications Cabling.

BB. ANSI/ICEA S-83-596, Fiber Optic Premises Distribution Cable, 2001.

CC. ANSI/ICEA S-87-640, Fiber Optic Outside Plant Distribution Cable, 1999.

DD. IEEE 802.3af, Data Terminal Equipment (DTE) Power Over Media Dependent Interface (MDI), 2003 (Superseded by IEEE 802.3-2005).

EE. IEEE 802.3, Information Technology – Telecommunications and Information Exchange between Systems – Local and Metropolitan Area Networks – Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications, 2005.

FF. IEEE 802.3at (current draft), Data Terminal Equipment (DTE) Enhanced Power Over Media Dependent Interface (MDI).

GG. IEEE 802.3ae, Specification for 10 Gbit/s Ethernet Operation over Optical Fiber.

HH. TSB-162 - Telecommunications Cabling Guidelines for Wireless Access Points (Latest revision and all

published amendments).

II. Telecommunications Distribution Methods Manual, 12th Ed., Building Industry Consulting Services International (BICSI), (And all published amendments).

JJ. Information Transport Systems Installation Manual, 6th Ed., Building Industry Consulting Services International (BICSI), 2004.

KK. IEC/TR3 61000-5-2-Ed. 1.0 and amendments, Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling.

LL. ISO/IEC 11801, Ed. 2:2002, Information Technology – Generic Cabling for Customer Premises, 2002.

MM. ISO/IEC 18010 - Information Technology – Pathways and Spaces for Customer Premises Cabling, 2005.

NN. ISO/IEC 14763-1, Information Technology – Implementation and Operation of Customer Premises Cabling – Part 1: Administration, 2004.

OO. BS EN 50173-1, Information Technology – Generic Cabling Systems – Part 1: General Requirements, 2002.

PP. BS EN 50174-1, Information Technology – Cabling Installation – Part 1: Specification and Quality Assurance, 2001.

QQ. UL® 723, Test for Surface Burning Characteristics of Building Materials.

RR. Federal Communications Commission (FCC) Title 47, Code of Federal Regulations, Part 68: Connection of Terminal Equipment to the Telephone Network, 1998.

SS. Underwriter's Laboratory, Inc. (UL®)

1. UL®-5A, Standard for Non-Metallic Raceways and Fittings.
2. UL®-5, Standard for Surface Metal Raceways and Fittings.
3. UL®-5C, Standard for Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits.
4. UL®-50, Standard for Enclosures for Electrical Equipment.
5. UL®-94-V0, Tests for Flammability of Plastic Materials.
6. UL®-498, Attachment Plugs and Receptacles.
7. UL®-1479, Fire Tests of Through-penetration Firestops (in Accordance with ASTM E814).
8. UL®-1863, Standard for Safety of Communications Circuit Accessories.

TT. National Electrical Manufacturer's Association (NEMA)

1. ANSI/NEMA WD-6-2002, Wiring Devices – Dimensional Requirements

UU. NEMA 250-2003, Enclosures for Electrical Equipment

VV. Motorola R-56 Standards and Guidelines for Communication Sites

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in ANSI/TIA-568-C.0, ANSI/TIA-568-C.1, ANSI/TIA-568-C.2 and ANSI/TIA-568-C.3 when tested according to test procedures of these standards.

1.6 INFORMATIONAL SUBMITTALS

A. Product Data:

1. The Contractor shall submit product data for approval prior to the start of work and shall not start work until complete product data for each component, describing physical characteristics and method of installation has been submitted and approved. Product data shall be submitted for, but is not limited to:

a. Copper and coax cable.
b. Copper patch panels.
c. Cable supports.
d. Firestop products and proposed UL® listed installation details.
e. Vertical and horizontal backboard mounted cable management.

B. Samples: For workstation outlets, jacks, jack assemblies, and faceplates for color selection and evaluation of technical features.

C. Qualification Data:

1. The Structured Cabling System Contractor (SCSC) shall present, with his signed contract, the name and certification number of a minimum of two BICSI certified Registered Communications Distribution Designers (RCDD) who are permanent employees of the Contractor. The SCSC shall maintain these RCDDs, or other RCDDs approved by Leon County MIS, in his permanent employment throughout this project. These RCDDs shall have overall responsibility for certifying that the installed structured cabling system conforms to these contract documents and to the referenced EIA/TIA, IEEE, BICSI, and UL standards. Specific requirements for the RCDDs are as follows:

a. The RCDD shall be, in the judgment of Leon County MIS, thoroughly experienced in the design, layout, and installation of structured cabling systems of similar size and complexity as required for this installation. The RCDD shall submit evidence of these qualifications to Leon County MIS upon request.
b. The RCDD shall affix his stamp to the SCSC's pre-installation submittal drawings, indicating that he has reviewed and approved the drawings for conformance to the contract documents and to the referenced codes and standards. As part of the Structured Cabling System installation, the SCSC shall provide detailed documentation to facilitate system administration, maintenance, and future moves, adds and changes. Drawings shall be provided which incorporate all information in the Design Drawings, and which fully document any and all approved changes in materials and methods made by the SCSC. Submittal drawings are not required if no changes to the A/E design drawings are made by the SCSC.
c. The RCDD shall periodically visit the site and inspect the work in progress. RCDD site visits shall be made not less than once per week when the job is in active progress. The RCDD shall prepare a field report for each site visit for submission to the Engineer, Leon County MIS, and Leon County Facilities.

2. The SCSC shall provide the following documentation, to be presented with the signed contract, as evidence that the requirements for Structured SCSC qualifications listed above are satisfied.

a. A list of not less than five (5) references for jobs of similar size and complexity including project name, location, contact person and phone number.
b. RCDD name, BICSI certification number, and qualifications.
c. Installers' name, BICSI certification number, and qualifications.
d. Manufacturer' certificates as having completed their necessary training.

e. Certificate to install UL listed Fire-Stop systems.
f. Location of office from which installation and warranty work will be performed.

1.7 CLOSEOUT SUBMITTALS

A. Software and Operational Documentation:

1. The Structured Cabling System Contractor (SCSC) shall provide as-built drawings indicating all outlets, cable routes, cable ID, conduit, Communications closets, cable trays, and pullboxes. The contractor's RCDD shall affix his stamp to the as-built drawings, indicating that he has reviewed and approved the drawings as being complete, accurate, and representative of the system as actually installed. The RCDD is responsible for certifying and assuring that all installations by contractors are performed in compliance with the contract documents.
2. Mark up floor plans showing outlet locations, type, and cable marking of cables. Turn these drawings over to the owner two (2) weeks prior to move in to allow the owner's personnel to connect and test owner-provided equipment in a timely fashion.
3. Three (3) sets of as-built drawing shall be delivered to the owner within four (4) weeks of acceptance of project by the owner. A set of as-built drawings shall be provided to the owner in digital form (CD) and utilizing CAD software that is acceptable to the owner. The digital media shall be delivered to the owner within six (6) weeks of acceptance of project by owner.
4. The (SCSC) shall provide all cable test results as outlined in Part 3 of this specification. The SCSC's RCDD shall sign off on all copper and fiber optic cable test results, indicating that he was in responsible charge of all cable testing procedures and that all cables were tested in compliance with the contract documents and met or exceeded the requirements stated therein.
5. The test results/measurements shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time.
6. The database for the completed job shall be stored and delivered on CD-ROM or DVD including the software tools required to view, inspect, and print any selection of test reports.
7. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. The Structured Cabling System Contractor (SCSC) shall be an experienced firm regularly engaged in the layout and installation of structured cabling systems of similar size and complexity as required. The Structured Cabling System Contractor, under the same company name, shall have successfully completed the layout, installation, testing and warranty of not less than five Structured Cabling Systems similar in scope to this project for a minimum period of three years prior to the bid date, and shall have been regularly engaged in the business of Structured Cabling Systems contracting continuously since.
2. The SCSC shall have an existing permanent office located within a 40 miles radius of Leon County, Florida from which installation and warranty service operations will be performed.
3. The SCSC and their Sub-Contractors must be Manufacturer-authorized Certified System Vendors certified by the Manufacturer to offer a 25-year Permanent Link Warranty, adhere to the engineering, installation, and testing procedures, and use Manufacturer’s components and distribution channels in provisioning this Project.
4. The SCSC and their Sub-Contractors shall have successfully completed all Manufacturer design and installation training. All members of the installation team must be certified by the

manufacturer as having completed the necessary training to complete their part of the installation. All personnel shall be adequately trained in the use of necessary tools and equipment to install the system.

5. The SCSC and their Sub-Contractors must be certified to install UL listed Fire-Stop systems.
6. The system installer shall have an RCDD on staff to assist with project installation.
7. The system installers shall certified by BICSI.
8. The Contractor shall own and maintain tools, installation equipment, and test equipment necessary for successful installation and testing of fiber optic and copper Structured Cabling Systems.
9. The Owner reserves the right to require the Contractor to remove from the project any such employee the Owner deems to be incompetent, careless or insubordinate.

B. Surface-Burning Characteristics:

1. As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 50 or less.

C. Cable and Termination Hardware:

1. Cables and termination hardware shall be manufactured and assembled in the United States of America. Products manufactured or assembled offshore are not acceptable.

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces:

1. Comply with TIA/EIA-569-A.

F. Grounding:

1. Comply with ANSI-J-STD-607-A.

1.9 DELIVERY, STORAGE, AND HANDLING

1. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's and Service Provider’s LAN/WAN equipment.

B. Completely coordinate with work of other trades.

PART 2 - PRODUCTS

2.1 F/UTP AND UTP CATEGORY 6 CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description:
1. Category 6 horizontal cable shall be 100-ohm 4-pair, balanced shielded twisted pair (F/UTP) and balanced unshielded twisted pair (UTP), available in 1000 ft. reels, installed indoors in conduit or in vertical risers or in plenum spaces. Cable jacket color shall be green.
2. Category 6 balanced shielded twisted pair (F/UTP) and balanced unshielded twisted pair (UTP) cable, from the manufacturer, shall meet or exceed all electrical requirements, including alien crosstalk performance requirements of ANSI/TIA-568-C.2-10. Shielding on F/UTP cable shall be continuous.
3. Category 6 distribution cable, when installed and terminated, shall meet or exceed the link performance requirements of ANSI/TIA-568-C.2-10.
4. Comply with ICEA S-90-661 for mechanical properties.
5. Comply with ANSI/TIA-568-C.1 for performance specifications.
6. Comply with ANSI/TIA-568-C.2, Category 6.
7. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, Plenum Rated: Type CMP, complying with UL 1666.

8. Cable shall be marked every two feet with:

a. Product identification
b. AWG
c. Listings (NEC)
d. UL® listing markings shall be marked on the cable jacket according to the certifying agency's requirements.
e. Sequential footage markers.
f. Verification date.
Manufacturing traceability code

2.2 F/UTP AND UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Belden CDT Inc.; Electronics Division.
2. Leviton Manufacturing Company.
3. Ortronics.
4. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIA-568-C.2, transmission performance specifications for 4-pair 100 Ohm Category 6 IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Patch Panels: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Panel: One for each four-pair F/UTP and UTP horizontal cable indicated, plus spares and blank positions adequate to suit specified expansion criteria. Panels shall be fully populated with jacks.

D. Jacks and Jack Assemblies: Modular, shielded (F/UTP), color-coded (UTP), eight-position modular receptacle units with integral IDC-type terminals.

2.3 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with ANSI/TIA-568-C.1.

B. Workstation Outlets: Multiport-connector assemblies mounted in single or double gang faceplate.

1. Faceplates: Satin-finished, Type 302 stainless steel.
2. For use with snap-in jacks accommodating any combination of F/UTP and UTP work area cords.

a. Flush mounting jacks. Non-shielded jack colors to be selected from manufacturer’s standard colors.

3. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.4 J-HOOKS

A. Wide base cable support system. Size of cable support shall be based on the number of cables and to be supported plus 10% for growth. Do not exceed the manufacturer’s recommended cable capacity, including the cables for future growth.

1. Approved manufactures: Erico, CAT 21 or CAT 32 type.

2.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter. Comply with NFPA 70.

B. Comply with J-STD-607-A.

C. Comply with Motorola R-56.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

2.6 SOURCE QUALITY CONTROL

A. Factory test F/UTP and optical fiber cables on reels according to ANSI/TIA-568-C.1.

B. Factory test F/UTP cables according to ANSI/TIA-568-C.2.

C. Factory test multimode optical fiber cables according to TIA-526-14-A and ANSI/TIA-568-C.3.

D. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements in Division 27 Section "Information Technology Cabling System Cable Trays."
3. Comply with requirements in Division 27 Section "Cable Trays for Communications Systems."

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with ANSI/TIA-568-C.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP and F/UTP Cable Installation:

1. Comply with ANSI/TIA-568-C.2.
2. Do not untwist UTP and F/UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.
3. Cables shall be terminated on rack mounted connecting hardware. Refer to drawings.

D. General Cable Routing:

1. Where horizontal cables in telecommunications spaces are installed horizontally they shall be supported on ladder racks. All cables shall be separated and bundled into like groups. When large quantities of cables leave ladder rack, cables shall be supported by drop-outs or cable support hardware manufactured specifically for the purpose of supporting cables. Bundle cables together in groups of no more than 50 cables and route parallel and perpendicular to building lines. Bundle cables at 48” on center with plenum rated industrial Velcro or ty-wraps.
2. Where horizontal cables are installed vertically on backboards cables shall be supported by ladder racks where indicated on drawings and D-rings installed at a maximum of 2 feet. All cables shall be separated and bundled into like groups.
3. Where horizontal cables are installed horizontally they shall be supported in conduit, in cable trays, J-hooks or ladder racks. Refer to drawings for the extent of the particular method of support. All cables shall be separated and bundled into like groups. When large quantities of cables leave cable trays or ladder rack, cables shall be supported by drop-outs or cable support hardware manufactured specifically for the purpose of supporting cables. Cable pathways shall run parallel or perpendicular to walls and modular furniture
4. J-hooks shall be installed at a maximum of 4 feet and cabling shall maintain minimal deflection and strain (less than 12” deflection). Install multiple rows of J-hooks when more than 50 cables are installed. Do not support from hanger wire used to support ceilings, nor from piping or conduit. Where installed in ceilings utilize independent support rod or wire to mount appropriate cable fasteners loaded with multiple cables up to the total weight for which the fastener is approved. Do not screw-attach J-hooks to raised floor stations as this will void the raised floor system warranty.
5. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
6. Suspend cable not in a wireway or pathway a minimum of 12 inches above ceilings by cable supports not more than 48 inches apart.
7. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

3.4 The fastener design shall not interfere with the inserting or removing of the ceiling tile.

A. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

B. Group connecting hardware for cables into separate logical fields.

C. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. All metal armored cables or cables having metallic conductors entering a building shall conform to the bonding and grounding requirements in NEC Article 760.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

F. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Category 6 Cable Testing

a. All field technicians must be trained in the functional areas of termination and network testing, which includes testing with level III field testers. Certifications shall be obtained from the manufacturer of the test equipment used for the field certification

b. Permanent Link testing shall be completed on all horizontal (station) cables. The Contractor shall be responsible to supply a Permanent Link Warranty. The Contractor shall supply all manufacturer patch cords per the contract.

c. Category 6 cabling systems shall be tested as an installed horizontal link configuration following manufactures recommendations to meet 25-year warranty requirements. Jacks and faceplates shall be assembled complete and properly mounted into outlet boxes. Panels shall be terminated complete and fully dressed with proper cable management.

d. All cabling shall be certified to meet or exceed the specifications as set forth in ANSI/TIA-568-C for category 6 requirements for link testing. All testing shall be for category 6 using a tester capable of testing to 10Base-T and 1000Base-T.

e. Every cabling link in the installation shall be tested for:

1) Wire Map
2) Length
3) Insertion Loss
4) NEXT Loss
5) PS NEXT Loss
6) ACR-F Loss
7) PS ACR-F Loss
8) Return Loss
9) Propagation Delay
10) Delay Skew
11) Continuity of Shield

in accordance with the field test specifications defined in ANSI/TIA-568-C.2-1, hereto referred to as the “Category 6 Standard.”

f. The installed twisted-pair horizontal links shall be tested from the TR in the telecommunications room to the telecommunication wall outlet in the work area for compliance with the “Permanent Link” performance specification as defined in the Category 6 Standard.

g. One hundred percent of the installed cabling links must pass the requirements of the Category 6 Standard and as further detailed herein. Any failing link shall be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the

corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation as specified below.

h. The test equipment (tester) shall comply with the accuracy requirements for level III field testers as defined in the Category 6 Standard. The tester, including the appropriate interface adapter shall meet the specified accuracy requirements. The accuracy requirements for the Permanent Link configuration test configuration (baseline accuracy plus adapter contribution) are specified in Table B.3 of Annex B of the Category 6 Standard.

i. The test plug shall fall within the values specified in Annex E Modular test plug NEXT loss requirements of the Category 6 Standard.

j. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.

k. The tester interface adapters shall be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.

l. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests (detailed in Section I.2.2 of ANSI/TIA-568-C.2). Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.

m. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer shall provide documentation as an aid to interpret results marked with asterisks. To which extent (*) results shall determine approval or disapproval of the element under test shall be defined in the relevant detail specification, or agreed on as a part of a contractual specification.

n. Performance Test Parameters

The test parameters are defined in the Category 6 Standard. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test, all measurements (at each frequency in the range from 1 MHz through 250 MHz) must meet or exceed the limit value determined in the above-mentioned standard.

o. Wire Map

Shall report Pass if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.

p. Length

The field tester shall be capable of measuring length of all pairs of a basic link or channel based on the propagation delay measurement and the average value for Nominal Velocity of Propagation (NVP). The physical length of the link shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10% to allow for the variation and uncertainty of NVP. Each cable shall be tested for length bi-directionally. If the distance readings are different the cable shall be tested for faulty terminations and corrected.

q. Insertion Loss (Attenuation)

Insertion Loss shall be tested from 1 MHz through 250 MHz in maximum step size of 1 MHz. Insertion loss shall be measured at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter. Minimum test results documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs, and the test limit value at this frequency.

r. Pair-to-pair near-end crosstalk (NEXT) Loss

NEXT Loss shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter shall be measured from 1 through 250 MHz. The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the Category 6 Standard as shown in Table 1.1. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin and the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT shall be measured from each end of the link-under-test. These wire pair combinations shall be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

Table 1.1 Maximum frequency step size as defined in the Category 6 Standard

Frequency Range (MHz)	Maximum Step size (MHz)
1 – 31.25	0.15
31.26 – 100	0.25
100 – 250	0.50

s. Power Sum (PS) NEXT Loss

Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link under-test (a total of eight results). This test parameter shall be evaluated from 1 through 250 MHz and the step size may not exceed the maximum step size defined in the Category 6 Standard as shown in Table 1.1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS NEXT. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

t. Attenuation Crosstalk Ratio Far-end (ACR-F Loss, pair-to-pair)

Attenuation Crosstalk Ratio Far-end shall be measured for each wire-pair combination from both ends of the link under-test. ACR-F Loss shall be evaluated and reported in the test results. ACR-F shall be measured from 1 through 250 MHz and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the standard as in Table 1.1. Minimum test results documentation (summary results). Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR-F. These wire pairs shall be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

u. Power Sum Attenuation Crosstalk Ratio Far-end (PS ACR-F Loss)

This test yields eight wire-pair combinations. Each wire-pair shall be evaluated from 1 through 250 MHz in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1.1. Minimum test results documentation (summary results). Identify the wire pair that exhibits the worst pair combinations shall be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

v. Return Loss

Return Loss (RL) shall be measured from both ends of the link-under-test for each wire pair. This parameter shall also be measured from 1 through 250 MHz in frequency increments that do not exceed the maximum step size defined in the Category 6 Standard as shown in Table 1.1. Minimum test results documentation (summary results). Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs shall be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit

value at this frequency.

w. Propagation Delay

This measurement shall be performed for each of the four wire pairs. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.

x. Delay Skew

(As defined in the Category 6 Standard; Section 7.5) Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.

2. Test Result Documentation

a. The test results/measurements shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test and that these results cannot be modified at a later time.

b. The database for the completed job shall be stored and delivered on CD-ROM or DVD including the software tools required to view, inspect, and print any selection of test reports.

c. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information:

1) The identification of the link in accordance with the naming convention defined in the overall system documentation
2) The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number
3) The date and time the test results were saved in the memory of the tester.

d. General Information to be provided in the electronic data base with the test results information for each link:

1) The identification of the customer site as specified by the end-user
2) The identification of the link in accordance with the naming convention defined in the overall system documentation
3) The overall Pass/Fail evaluation of the link-under-test
4) The name of the test limit selected to execute the stored test results
5) The cable type and the value of NVP used for length calculations
6) The date and time the test results were saved in the memory of the tester
7) The brand name, model and serial number of the tester
8) The identification of the tester interface
9) The revision of the tester software and the revision of the test limits database in the tester
10) The test results information must contain information on each of the required test parameters that are listed under Performance Test Parameters and as further detailed under paragraph e below.

e. For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters. The

detailed test results data to be provided in the electronic database for must contain the following information:

1) Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m and the test limit value
2) Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value
3) Delay Skew: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns) and the test limit value
4) Insertion Loss (Attenuation): Minimum test results documentation for the worst pair
5) Return Loss: Minimum test results documentation for the worst pair as measured from each end of the link
6) NEXT, ACR-F: Minimum test results documentation for the worst pair combination as measured from each end of the link
7) PS NEXT and PS ACR-F: Minimum test results documentation for the worst pair as measured from each end of the link

f. Each cable tested shall be recorded in a log with the cable number, date, and the initials of the technician who tested the cable. A printout of the test results for each cable shall be placed in the log. Any cables failing the above tests shall be replaced. A copy of the logs, a termination sequence chart, and all test results shall be provided to the Information Resource Manager prior to acceptance by the University as satisfactory and complete.

g. Completed test reports shall be submitted to the Information Resource Manager for review. Failed results will not be accepted.

h. The Owner or the Owner's representative shall be invited to witness and/or review field-testing.

1) The Owner or the Owner's representative shall be notified of the start date of the testing phase five (5) business days before testing commences.
2) The Owner or the Owner's representative will select a random sample of 5% of the installed links. The Owner or the Owner's representative shall test these randomly selected links and the results are to be stored in accordance with Part 3 of this document. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the representative shall repeat 100% testing at no cost to the Owner.

B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 271500

SECTION 278123 - COMPUTER-ROOM AIR-CONDITIONERS (OWNER PROVIDED)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. In-row computer-room air conditioners.

1.3 DEFINITION

A. BAS: Building automation system.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of filters for each unit.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.9 COORDINATION

A. Coordinate installation of computer-room air conditioners with computer-room access flooring Installer.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 IN-ROW COOLING UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Advanced Power Corporation, a division of Schneider Electric.

B. Description: Packaged, factory assembled, prewired, and prepiped cooling unit, consisting of cabinet, fans, filters, and controls. Completely accessible from the front and rear, allowing units to be placed within a row of racks.

C. Cabinet Construction

1. Frame: Fully welded 16 gauge formed steel.
2. Exterior Side Panels: 18 gauge metal with
3. Exterior Front and Rear Panels: 18 gauge perforated steel with 69.5% open free area, and equipped with a keyed lock.
4. Insulation: 5 lb/ft^3 (80 kg/m^3) density foam insulation. Insulation shall comply with UL94-5VA ASTM E84 flame spread and smoke developed rating of 25/50.
5. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
6. Finish on Exterior Surfaces: Powder coated, color as selected from manufacturer's standard colors.

7. Support: Units shall include casters and leveling feet.

D. Supply-Air Fan(s):

1. Mixed flow, axial fans.
2. Drive: Direct drive, variable speed.
3. Fan Protection: Each fan assembly shall consist of a plastic injection molded bezel with integral fan discharge finger guard. Inlet of the fan should include a cage type finger guard.
4. Operation and Service: The unit should be capable of operation in the event of a fan failure. Fans shall be replaceable while the unit is in operation.
5. Fans shall be located to draw air over the coil to ensure even distribution and maximum coil performance.

E. Power Supplies:

1. Input Power Feeds: Dual A-B power inputs should be a locking NEMA or IEC plug connection suitable for the input power selected.
2. Power Supplies: The unit shall include two power supplies, each capable of running the unit at 60% capacity in the event of a single power supply failure. Unit power consumption is not to exceed 1100 watts during normal operation.
3. Operation and Service: Power supply shall be user replaceable.

F. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating three-way control valve.

1. Cooling Medium: Water.
2. Control Valve: Class 125 body.

    a. Maximum Pressure Drop: 3 psig (21 kPa) at design flow rate.
    b. Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

3. Mount coil assembly over primary and secondary non-ferrous drain pans complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.

G. Extended-Surface, Disposable, Panel Filter: Pleated, lofted, nonwoven, reinforced cotton fabric; supported and bonded to welded-wire grid; enclosed in cardboard frame.

1. Thickness: 2 inches (50 mm).
2. Initial Resistance: 0.25-inch wg (62 Pa) at 350 fpm (1.8 m/s).
3. Recommended Final Resistance: 1.0-inch wg (249 Pa).
4. Merv (ASHRAE 52.2): 8.

H. Microprocessor-Control System

1. Monitoring and Configuration: The master display shall allow monitoring and configuration of the air conditioning unit through a menu-based control. Functions include status reporting, set-up, and temperature set points. Four LEDs report the operational status of the connected air conditioning unit.
2. Controls: The microprocessor controller shall come equipped with control keys to allow the user to navigate between menus, select items, and input alpha numeric information.
3. Alarms: The microprocessor controller shall activate a visible and audible alarm in the occurrence of the following events:

a. Internal Communications Fault
b. Link Isolation Relay Fault
c. Cooling Failure
d. Rack Inlet High Temperature
e. Air Filter Clogged
f. Lower Return Air Sensor Fault
g. Upper Return Air Sensor Fault
h. Lower Supply Air Sensor Fault
i. Upper Supply Air Sensor Fault
j. Rack Inlet Temperature Sensor
k. Coil Fluid Valve Actuator Fault
l. Fan Fault
m. Water Detection Fault
n. Condensate Pump Fault
o. Fluid Flow Meter Failure
p. Entering Fluid High Temperature
q. Entering Fluid Temperature Sensor
r. Leaving Fluid Temperature Sensor
s. Condensate Pan Full Alarm
t. Power Feed Failure
u. Fan Power Supply Fault
v. Air Filter Run Hours Exceeded
w. RACS Air Pressure High
x. Supply Air High Temperature
y. Return Air High Temperature
z. Group Communications Lost
aa. Filter Sensor Fault
bb. RACS Pressure Sensor Fault

4. Logging: The microprocessor controller shall log and display all available events. Each alarm log shall contain time/date stamp as well as operating conditions at the time of occurrence. Controller shall display the run time hours for major components.

I. Network Management Card

1. The unit shall include a network management card to provide management through a computer network through TCP/IP. Management through the network should include the ability to change set points as well as view and clear alarms.

J. Remote Temperature Sensor: Factory wired to the unit for placement in the field to provide control input based on rack inlet temperature.

K. Flow Meter: Factory piped inside the unit and connected to microprocessor controls to provide water flow rate through the unit. The microprocessor controller shall also use this information to provide total unit capacity out of the unit while in operation.

L. Piping Kit:

1. For each in-row cooler provide 6 foot (1.8 m) flexible, braided stainless steel pipe for supply and return connection including threaded adapters required for connection to unit.

2.2 FAN MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances. Install according to ARI Guideline B.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Provide shutoff valves in inlet and outlet piping to cooling coils.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. After startup service and performance test, change filters.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION 278123