

Division 27 Specifications
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SECTION 27 00 00
COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Virginia Polytechnic Institute and State University (VT) Network Infrastructure & Services (NI&S) Division 27 specifications are to be used for all new construction and major renovation projects.
 - a. Major renovation projects are defined as complete buildings, floors, or work group areas which require new telecommunication rooms (TRs) and cabling to the new room(s).
 - b. Renovations that will require cabling to existing NI&S rooms may have materials or installation techniques that do not conform to these standards. These types of small renovations are considered outside the scope of this document and requests for these types of cabling projects must be submitted to NI&S Customer Support Services (CSS) at (540) 231-6460 or at CNSDESIGN@vt.edu .
- B. Network Infrastructure & Services, part of Virginia Tech's Information Technology organization, is responsible for installing, operating, managing and maintaining the university's telephone, data and CATV systems. The telecommunications cabling system described in this standard will be utilized by NI&S to provision these services to the university. NI&S is responsible for the ongoing management and maintenance of university telecommunications cabling systems including adding, removing and or relocating cabling as required to support the needs of the university as persons and departments relocate and/or their requirements change over time. NI&S is certified by Siemon and OCC as required to perform this ongoing cable plant work without voiding the manufacturer's warranties provided by these companies.
- C. The products and execution from these standards are the accepted practices from NI&S and any products or execution outside these specifications will require written approval from NI&S.
- D. NI&S has the right to change and update these Division 27 specifications at any time without notice. Contractors and consultants shall make sure they are working with the latest addenda to these specifications.
- E. This document is not intended to eliminate the need for a detailed review of a new project between the designers, the end users, and NI&S engineers. The best and most cost efficient method for designing a building's telecommunications infrastructure is to have the A&E team, the UDC project manager and a CNS representative meet with the future occupants of the building and discuss in detail the telecommunications needs for the buildings. These meetings help avoid unnecessary infrastructure being installed and necessary infrastructure being omitted – both of which drive up project costs. These meeting should occur after the Schematic Design prints are released but before the 50% working drawings are released.

- F. All service activation requests, or modification of existing services, must be submitted by the requesting department to NI&S Customer Support Services (CSS) at (540) 231-6460 or at CNSDESIGN@vt.edu.
- G. The contractor shall review related project documents and report any and all concerns prior to installation.
- H. In the event of a conflict or discrepancy between these specifications and other project related documents the contractor shall submit a written request for clarification from NI&S to resolve the issue.

1.2 BIDDING REQUIREMENTS

- A. Refer to 27 05 00 COMMON WORK RESULTS FOR COMMUNICATIONS for the minimum qualifications for the Communications Contractor.
 - a. Proof of the Communication Contractor's current enrollment in the Siemon Company's Certified Installation Program is required to be provided with project bid.
 - b. Proof of the Communication Contractor's current enrollment in the Optical Cable Corporation Certified Multimedia Design & Integration Specialist Program is required to be provided with project bid.
- B. Contractors will provide pricing options for a complete Category 6 or a complete Category 6A structured cabling solution based on the requirements found in these Division 27 specifications. VT University Design & Construction (UDC) and NI&S will coordinate with the building occupant's representative to determine the department's bandwidth requirements and will specify the applicable solution for each project.
 - a. A complete structured cabling system, as described within these specifications, includes the following:
 - i. Equipment Rooms (ERs) / Telecommunication Rooms (TRs)
 - ii. Copper and fiber backbone cabling & connectivity
 - iii. Copper horizontal cabling (station cabling) & connectivity
 - iv. Grounding and bonding of telecommunications pathways and equipment
 - v. Labeling & Testing
 - vi. Firestopping
 - b. A complete structured cabling system, as described within these specifications, does not include the following:
 - i. Outside Plant pathways and backbone cabling
 - ii. Network Electronics
 - iii. Uninterrupted power supplies / power strips
- C. Refer to 27 05 00 for firestop requirements and refer to the Architectural drawings for ratings of existing and new walls, floors, and other surfaces in the project area.
 - a. The base bid for communications cabling project is required to include all firestop installation and materials for all pre-existing and new communication cabling in the project area.

PART 2 – MATERIALS

2.1 THIS SECTION NOT USED

PART 3 - EXECUTION

3.1 THIS SECTION NOT USED

END OF SECTION 27 00 00

SECTION 27 01 00
OPERATION AND MAINTENANCE OF COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Forms, and Conditions of the contract, including Construction Manager/General Contractor (CM/GC) agreement including exhibits and other VT Design and Construction Standards Division 1 specification sections, apply to this section.

1.2 CONTRACT ADMINISTRATION

- A. The contractor shall carefully study and compare the contract documents and shall at once report to UDC and NI&S any error, inconsistency or omission identified. If the contractor performs any construction activity knowing it involves a recognized error, inconsistency or omission in the contract documents without such notice, the contractor shall assume appropriate responsibility for such performance and shall bear an appropriate amount of the attributable cost for correction.
- B. The Contractor shall advise UDC and NI&S as early as possible of any product delays and minimum quantity requirements that may affect the project timeline. Should conflicts, discrepancies, deficiencies, or errors arise which require changes in the Contract Documents, immediately notify UDC and NI&S. Failure to do so shall be interpreted as the intention of the Contractor to supply all necessary labor and materials for the suitable completion of this work. Obtain written approval on necessary adjustments before the installation is started.

1.3 PROJECT MANAGEMENT AND QUALITY ASSURANCE

- A. The Contractor shall designate and identify a Project Manager to oversee the project work specified in this Division and to attend all project meetings as a representative of the Contractor. The Contractor's Project Manager shall have the authority to act for the Contractor, and all communications given to the Project Manager will be deemed to have been given to the Contractor.
- B. The Contractor shall not begin construction on any project without written notice to proceed.
- C. All additional costs must be approved in writing with a change order signed by the UDC Project Manager.

1.4 JOB SUPERVISION

- A. Designate and identify job supervisor in advance.
- B. Provide no more than one supervisor per job.
- C. Provide one primary contact, one backup contact.
- D. Maintain the following information on the job site:
 - a. VT NI&S Standards specifications (Division 27).

- b. All project related drawings (drawings to include NI&S provided H-Link / Portal identification information – see Section 27 17 00: Testing, Identification and Administration).
- c. All addenda's.
- d. Submittals.
- e. All Change Orders.
- f. Any inspection reports from NI&S and/or Structured Cabling System manufacturer.
- g. Test results.
- h. Schedule and outage logs.
- i. As-built drawings set showing all changes.
- E. Assist NI&S and manufacturers' representatives in performing periodic inspections for evaluation and functional testing of communications subsystems or sections.
- F. Assist NI&S and manufacturers' representatives in performing evaluation and functional testing of complete communications system(s).
- G. Conduct an overall quality assurance program.
- H. Apply and install materials, equipment, and specialties in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and these specifications shall be referred in writing to NI&S for resolution.
- I. All products, components, devices, equipment and materials shall be new and unused, clean, free from defects, and free from damage and corrosion.
- J. Installation and service shall be performed by manufacturer trained and certified personnel.

1.5 SUBMITTALS

- A. The Contractor shall submit for review and approval by NI&S a complete list of all materials, components, equipment, systems, and products proposed. Any requests for substitutions must be submitted with complete product data.
- B. Product Data
 - a. Product submittals shall show, as a minimum, the following:
 - i. Manufacturer, color, complete model and part number.
 - ii. Dimensions.
 - iii. Complete technical specifications and performance data.
 - iv. Any other pertinent information necessary to determine adequacy for the intended application.
- C. When not provided by the project A&E the Contractor shall submit for review and approval by NI&S a complete set of shop drawings detailing the Contractor's design plans for each specification section. Shop drawings must include an overall site plan with any outside plant telecommunications pathways shown, exterior and/or interior cable pathway details (including quantity and sizes), room construction plans (including wall and rack details, equipment elevations, grounding systems, conduit pathways, etc.), copper and fiber backbone cabling plans, work area outlet details (including outlet labeling plans).

- D. Two sets each of hard copy and electronic shop drawings are required.
- E. Generate shop drawings using the most current VT CAD Standards. Current standards for New Construction and Renovation Projects can be found at:
<http://www.facilities.vt.edu/udc/designstandards.asp> .

1.6 SUBSTITUTIONS

- A. Requests to substitute for specified items or previously approved materials or equipment shall be submitted by the Contractor to UDC and NI&S for review. Substitution requests shall include all required submittals and shall be complete with reasons for substitutions and savings which will accrue to the project if substitutes are approved. Substitutes will be considered only if equal or superior to those specified and do not void specified cable system manufacturer's warranties.

1.7 STATEMENT OF WARRANTY

- A. The Contractor shall provide statements of warranty based on both the structured cabling and fiber optic system manufacturers' performance warranties as well as the Contractor's parts and labor warranty.

1.8 PERIODIC FIELD OBSERVATION REPORTS

- A. NI&S and cabling systems manufacturers' warranty representatives will conduct site visits as required to monitor the progress and quality of the workmanship, the work environment, as well as the surrounding facility. Any item found by NI&S and/or the cabling system' representatives to be deficient will be documented in a Periodic Field Observation Report.
- B. The Contractor shall take appropriate action to immediately correct and rectify any items deemed unsatisfactory by NI&S and/or the cabling systems manufacturers' warranty representative. The Contractor shall not wait for a hard copy of the periodic field observation report if the action required to rectify the situation is obvious and clear.

1.9 INSPECTIONS AND TESTS

- A. The Contractor shall furnish, without additional charge, all test equipment with up to date calibration, instruments, facilities, labor, and material needed to perform safe and convenient inspection and testing.
- B. Prior to beginning work, the Contractor shall submit to NI&S a complete project schedule and timeline including installation, inspection, and testing for each project area so that interim inspections can be conducted as work progresses. NI&S shall not be obligated to inform the Contractor of its intent to inspect job sites while work is in progress.
- C. The Contractor shall perform pre-testing of the installed telecommunications systems to determine compliance and notify NI&S personnel when the system is ready for final inspection and testing.
- D. Overhead work shall not be covered up or enclosed until inspected by NI&S personnel or other proper authorities. Should any work be covered up or enclosed before such inspection, it shall be uncovered, inspected, and after approval, restored by the Contractor to finished condition at no additional cost to the project.
- E. All work that is determined to be unsatisfactory shall be corrected immediately. The Contractor shall, without charge, replace any material or correct any workmanship found by NI&S not to conform to the specifications, unless NI&S consents to accept such material or workmanship with appropriate adjustment in price. The Contractor shall

promptly segregate and remove rejected material from the premises. The Contractor will pay the additional cost of any test or inspection of the replaced material or corrected workmanship.

- F. The Contractor shall submit final test results as described in this specification for review and acceptance by NI&S and the cabling systems manufacturers' warranty representatives.

1.10 CONTINUITY OF SERVICES AND SCHEDULING

- A. The building may be in use during construction operations. Insofar as possible, the Contractor shall employ such methods or means as will not cause interruption of, or interference with, the owner's scheduled use of the building and will maintain existing systems in operation within all rooms outside of the scope of the project at all times.
- B. For areas under renovation, coordinate all installation activities with the UDC project manager and other trades for renovations of architectural, mechanical, and/or electrical facilities. Insofar as possible, the Contractor shall employ such methods or means as will not cause interruption of, or interference with, the work of any other contractor.
- C. Moving or removing any facility related to providing telecommunications services must be done under the supervision of NI&S so as not to cause interruption of the project work or of University operation.
- D. Disruption of critical services will require after hour or weekend working constraints.
- E. Existing communication services shall be interrupted only with consent from UDC and NI&S. An advance warning time of seven working days shall be given. Such interruptions shall be preceded by all possible preparations which will minimize down time to expedite that particular phase of the work pursuant to good workmanship. This shall be done during regular and/or premium time as approved by UDC without additional expense to the project.
- F. Adjust work schedule within reason (weekly), as per direction of UDC, and coordinate with work or other trades in order to make portions of project available as soon as possible.
- G. All expenses due to untimely or improperly coordinated work shall be the responsibility of the Contractor.

1.11 USE OF CABLE PRIOR TO ACCEPTANCE

- A. The Contractor shall permit the placement and installation by NI&S of cross-connects, patch cords, and/or equipment onto cable and terminations installed under this contract, prior to substantial completion of the contract as necessary. Such placement or installation shall not evidence completion of the work or portion thereof, nor signify NI&S acceptance of the work or portion thereof.

1.12 FINAL ACCEPTANCE AND WORK CLOSEOUT

- A. Contractor shall inspect the entire telecommunications system installation to assure all work is completed and all systems are completely operational before calling for final inspection, testing and acceptance of work.
- B. Punch list closeout:
 - a. Notify NI&S when telecommunications work is ready for final inspection and punch list preparation.
 - b. Resolve all punch list items before final invoicing.
 - c. The Contractor shall submit for review and approval by NI&S a complete set of as-built drawings including:
 - i. Cover with legends.

- ii. Site plan with Outside Plant building entrance conduits shown.
 - iii. Riser diagrams showing conduit (include size and quantity), grounding, and all backbone cabling (multi-pair copper, multi-mode fiber, single-mode fiber and CATV).
 - iv. Floor Plans with all outlet locations.
 - v. ER details with Footprint, Equipment Rack Layout, conduit locations and Wall Design.
 - vi. All additional TR details with Footprint, Equipment Rack Layout, conduit locations and Wall Design.
 - vii. Horizontal pathway details including paths for all cable tray and conduits. Details must include quantity and sizes of all horizontal pathways.
 - viii. Details sheet with Faceplates, Wireless Plates (Surface Box), Wireless Boxes, Camera Box, Floor Box, Box Assembly, etc.
 - d. Generate as-built drawings using the most current VT CAD Standards. Current standards for New Construction and Renovation Projects can be found at: <http://www.facilities.vt.edu/udc/designstandards.asp>.
 - e. Two sets each of hard copy and electronic as-built drawings are required.
 - f. Final payment will not be authorized until all punch list items have been resolved and completed to the satisfaction of UDC and NI&S with as-built files turned in.
- C. After the successful installation inspections and functional testing by NI&S and the Contractor, NI&S will determine if there are any open issues or discrepancies and notify the Contractor via the UDC Project Manager. Upon completion or determined failure, NI&S will issue written notification to the Contractor as to the status of the installation acceptance.

PART 2 – MATERIALS

2.1 THIS SECTION NOT USED

PART 3 - EXECUTION

3.1 THIS SECTION NOT USED

END OF SECTION 27 01 00

SECTION 27 05 00
COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Forms, and Conditions of the Contract, including Construction Manager/General Contractor (CM/GC) Agreement including Exhibits and other Division 1 Specification Sections, apply to this section.
- B. Design, manufacture, test, and install telecommunications cabling networks per manufacturer's requirements and in accordance with NFPA-70 (2014 edition of the National Electrical Code®), IEEE C2 2012 (NEC 2012), state codes, local codes, requirements of authorities having jurisdiction, and particularly the following standards:
 - a. ANSI/NECA/BICSI-568-2006 -- Standard for Installing Commercial Building Telecommunications Cabling
 - b. ANSI/TIA/EIA Standards:
 - i. ANSI/TIA/EIA-568-C.0-2 – Generic Telecommunications Cabling for Customer Premises – Addendum 2, General Updates
 - ii. ANSI/TIA/EIA-568-C.1 -- Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements
 - iii. ANSI/TIA/EIA-568-C.2 -- Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components
 - iv. ANSI/TIA/EIA-568-C.3-1 -- Optical Fiber Cabling Components Standard
 - v. ANSI/TIA/EIA-569-C -- Commercial Building Standard for Telecommunications Pathways and Spaces
 - vi. ANSI-J-STD-607(B) -- Commercial Building Grounding and Bonding Requirements for Telecommunications
 - vii. TIA-526-7 –OFSTP-7 --Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - viii. TIA-526-14-B –OFSTP-14-B --Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - ix. ANSI/TIA/EIA-758(B) -- Customer-Owned Outside Plant Telecommunications Cabling Standard
 - c. Install cabling in accordance with the most recent edition of BICSI® publications:
 - i. BICSI – Telecommunications Distribution Methods Manual
 - ii. BICSI – Installation Transport Systems Information Manual
 - iii. BICSI – Outside Plant Design Reference Manual
 - iv. BICSI – Wireless Design Reference Manual
- B. Federal, state, and local codes, rules, regulations, and ordinances governing the work, are as fully part of the specifications as if herein repeated or hereto attached. If the contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the owner's representative in

- writing. Where the requirements of the Virginia Tech specifications are more stringent than applicable codes, rules, regulations, and ordinances, the specifications shall apply.
- C. Some differences exist between the standards listed above and the Virginia Tech specifications detailed in this document. These differences may include room construction specifications, work area outlet quantities and configurations, etc. Where differences occur, the specifications detailed herein shall apply unless not specifically allowed by code.
 - D. Maintain separate sets of redlined record drawings for the communications work, which show the exact placement, and identification of as-built system components. These are subject to weekly review by the CM, Owner, or its representative.
 - E. Provide communication room record drawings which indicate exact placement for all components; e.g., conduit, wireway, cable tray, backboards, equipment cabinets, equipment racks, and cross-connect equipment, etc.
 - F. Provide communication wiring and cabling record drawings and schedules which indicate exact placement, routing, and connection details for all components, e.g., twisted-pair cables, splices, cable cross-connect termination locations, enclosures, telecommunications outlets, and cross-connect jumpers, patch cords, etc.
 - G. Cabling Administration Drawings: Show building floor plans with all telecommunications outlets identified including NI&S-provided outlet/cable designations for each location. Identify labeling convention and show labels for TRs and ERs, riser pathways and backbone cables, entrance pathways and termination panels/cabinets.

1.2 SCOPE OF WORK

- A. Work includes, but is not limited to, the following:
 - a. Placement of Telecommunications Room (TR) and Equipment Room (ER) hardware including equipment racks, cable routing hardware, copper and fiber termination equipment, and grounding and bonding.
 - b. Placement of and additions to interior telecommunications pathways including conduit, cable tray, pullboxes, and metallic surface-mount raceway systems.
 - c. Placement of and additions to exterior telecommunications pathways including building entrance conduit systems.
 - d. Installation and termination of backbone cabling including multi-pair copper cabling, coaxial cabling, and single-mode and multimode fiber optic cabling.
 - e. Installation and termination of horizontal cabling including copper UTP cabling, and coaxial cabling.
 - f. Testing, identification, and administration for the above telecommunications systems.
 - g. Removal of existing horizontal cabling, terminations, and outlets in coordination with electrical contractor for removal of associated conduit in areas where renovations require demolition of existing telecommunications outlets.
- B. All work shall be conducted in coordination with NI&S and other building trades.
- C. The work covered by this Division consists of furnishing all materials, accessories, connectors, supports, equipment, tools, setup, preparation, labor, supervision, incidentals, transportation, storage, and related items and appurtenances, and performing all operations necessary to complete the telecommunications work as indicated in the project drawings and specified herein. It is the intent and purpose of this specification to have,

upon completion of the project, a “turn-key” telecommunications system. This system shall be designed, built, coordinated and integrated with the existing telecommunications system and complete and operable in all respects to which, upon receiving activation orders from the building’s occupants, NI&S can deploy network electronics to successfully integrate the cabling system into the campus network.

- D. Completely install, connect, and test all systems, equipment, devices, etc., shown or noted or required to leave ready for satisfactory operation. Provide any minor items omitted from the design, but obviously necessary to accomplish the above intent.
- E. All telecommunications designs for VT buildings on and off campus must be approved by NI&S for compliance to the Virginia Tech standards. Any design outside of these standards must be approved and include a written agreement for the design from NI&S.
- F. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:
 - a. Cables
 - b. Factory Assembled Products
 - c. Compatibility of Related Equipment
 - d. Special Tools and Kits
 - e. Firestop and Penetration Seals
 - f. Anchoring and Supports
 - g. Grounding and Bonding
 - h. Cutting and Patching
 - i. Concealment
 - j. Equipment Modification

1.3 GLOSSARY

A.	ANSI	American National Standards Institute
B.	ASTM	American Society of Testing and Materials
C.	BICSI	Building Industry Consulting Services International
D.	FCC	Federal Communications Commission
E.	IEEE	Institute of Electrical and Electronics Engineers
F.	ISO	International Organization for Standardization
G.	NEC	National Electrical Code
H.	NEMA	National Electrical Manufacturer’s Association
I.	NESC	National Electrical Safety Code
J.	NFPA	National Fire Protection Association
K.	NI&S	Network Infrastructure & Services
L.	OEM	Office of Emergency Management
M.	OSHA	Occupational Safety and Health Administration
N.	TIA	Telecommunications Industry Association
O.	VT	Virginia Polytechnic Institute and State University (Virginia Tech)
P.	VTPD	Virginia Tech Police Department
Q.	UBO	University Building Official
R.	UDC	University Design & Construction
S.	UFBC	Uniform Fire Prevention and Building Code
T.	UL	Underwriter’s Laboratories, Inc.

1.4 DEFINITIONS

- A. Every effort has been made to use industry standard terminology throughout this specification, but industry standard terminology is not used by all manufacturers and, in many cases, industry standard terminology does not exist. Contractor shall notify UDC &

NI&S Personnel to define terminology used in specifications if they believe any questions could arise.

a.	Approved/Approval	Written permission to use a material or system
b.	Contractor	Telecommunications Contractor performing work under Division 27
c.	Engineer	Telecommunications engineer for Division 27
d.	Equal/Equivalent	Equally acceptable as determined by NI&S
e.	Final Acceptance	NI&S acceptance of the project from Contractor
f.	Furnish	Supply and deliver to installation location
g.	Inspection	Visual observation or cable certification testing
h.	Install	Mount and connect equipment and associated materials as required to make ready for use
i.	Jack	Modular connector for station cabling medium (UTP copper, fiber, coax) at work-area outlet.
j.	Outlet	Box and faceplate to accommodate up to six (6) modular jacks at the work-area.
k.	Pull-Box	Box to be used for pull-through of cabling in a conduit run. Not to be used as a junction box.
l.	Provide	Furnish and install complete with all details and ready for use
m.	Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use
n.	Replace	Remove and provide new item
o.	Telecommunications	All work specified in Division 27

1.5 CONTRACTOR QUALIFICATIONS

- A. The Contractor shall at a minimum possess the following qualifications:
- Be in business a minimum of five (5) years.
 - Contractor shall demonstrate satisfaction of sound financial condition and can be adequately bonded and insured if the project deems necessary.
 - Possess those licenses/permits required to perform telecommunications installations in the specified jurisdiction.
 - Personnel knowledgeable in local, state, province and national codes and regulations. All work shall comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall be followed.
 - Must possess current liability insurance certificates.
 - Contractor must employ at least one currently registered BICSI RCDD having documented experienced with structured cabling design equivalent to the scope of work found in these specifications.
 - Provide at least three references from customers where the type and size of installation provided in this specification was successfully completed within the past five years.
 - Must have personnel proficient in the use of Computer Aided Design and possess and operate CAD software using .DWG or .DXF format.
- B. Required Contractor Training:
- The Contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to data, voice and imaging network

systems. The Contractor shall at a minimum possess the following qualifications:

- i. Personnel trained and certified in the design, installation, and certification of the Siemon Cabling System for horizontal and backbone UTP copper cable distribution and the Optical Cable Corporation System for backbone fiber riser distribution.
 - ii. Personnel trained and certified in the design, installation, and certification of Optical Cable Corporation (OCC) fiber optic cabling and components via OCC's MDIS (Multi-media Design and Integration Specialist) program.
 - iii. Personnel trained in the installation of pathways and support for housing horizontal and backbone cabling.
- b. The Contractor shall show proof of current enrollment in the Siemon Cabling System's cabling partners program via an updated certificate given after attending the CI-301 training course or an on-line re-certification class given every two years.
 - c. The Contractor shall show proof of current enrollment in Optical Cable Corporation's (OCC) MDIS (Multi-media Design and Integration Specialist) program.
- C. Contractor Responsibility:
- a. Contractor shall be obligated to exercise the highest standards of care in performing its obligations as defined in this request for proposal.
 - b. Contractor acknowledges that NI&S will rely on contractor's expertise, ability and knowledge of the system being proposed and shall be obligated to exercise the highest standards of care in performing its obligation as defined in these specifications.
- D. Manufacturer Quality & Product Substitutions
- a. All telecommunications connecting hardware and cable must be made by an ISO 9001:2000 Certified Manufacturer.
 - b. All products must meet the technical requirements listed herein. Any products not meeting these requirements will not be considered.

1.6 DRAWINGS AND SPECIFICATIONS

- A. It is the intention of these specifications and related project drawings to call for finished work, tested and ready for operation in complete accordance with all applicable codes, regulations, standards, and ordinances.
- B. These specifications and the project drawings are complimentary, and what is called for in either of these shall be binding as though called for by both. Should any conflict arise between the drawings and specifications, such conflict shall be brought to the attention of the UDC Project Manager for resolution. If the Contractor fails to contact the Project Manager in writing of any conflict between the specifications and the project drawings, the Contractor shall be subject to re-work the area of conflict at the Contractor's cost.
- C. Omissions from the specifications and/or project drawings or the incorrect description of details of work which are evidently necessary to carry out the intent of the specifications and project drawings, or which are customarily performed, shall not relieve the Contractor from performing such omitted or incorrectly described detail of the work.
- D. The telecommunications and technology project drawings are diagrammatic and indicate general design, layout, and arrangement of equipment and various systems. Being diagrammatic, the drawings may not necessarily show all details such as pull-boxes,

- conduit runs or sizes, etc., necessary for a complete and operable system. Unless detailed dimensioned drawings are included, exact locations are subject to approval of UDC.
- E. The amount of varying types of telecommunication symbols should be kept to a minimum. A number should be placed next to each symbol to indicate the quantity of cables to be located at each data outlet box.
 - F. All telecommunications cables intended to be connected to the University's network should be shown on the telecommunications drawings regardless if they are shown on AV, Security, etc. so that the cable plant infrastructure is clearly defined.
 - G. Do not scale project drawings for dimensions. Take all dimensions and measurements from the site and actual equipment to be furnished. All dimensions, measurements, and the location and existence of underground equipment or facilities must be verified in the field since actual locations, distance, and elevations will be governed by actual field conditions. Contractor shall be responsible for all measurements taken from the field.

1.7 EXAMINATION OF PROJECT SITE

- A. Prior to any project work, examine the project site carefully, including all project drawings showing existing systems and equipment. The Contractor shall make themselves fully informed of and shall identify all utility, state, and local requirements that will affect the telecommunications work at the project site.
- B. It shall be the Contractor's responsibility to determine if the installation of the proposed systems will affect the operation or code compliance of existing systems. Only while under NI&S supervision, relocate, modify, or otherwise revise existing telecommunications systems as required to maintain operational integrity and code compliance.
- C. The Contractor shall become familiar with the local conditions under which the work is to be performed and correlate the on-site observations with the requirements of the specifications and project drawings. No allowance will be made for claims of concealed conditions which the Contractor, in exercise or reasonable diligence in examination of the site, observed or should have observed.
- D. Before ordering any materials or doing any project work, verify all measurements and be responsible for correctness of same. No extra charge or compensation will be allowed for duplicate work or material required because of unverified differences between actual dimensions and the measurements indicated on the project drawings. Any discrepancies found shall be submitted in writing to the UDC Project Manager for consideration before proceeding with the project work.

1.8 WORKMANSHIP, WARRANTY, AND SUPPORT

- A. Materials and workmanship shall meet or exceed industry standards and be fully guaranteed for one full year from final acceptance for each project. Cable integrity and associated terminations shall be thoroughly inspected, fully tested and guaranteed as free from defects, transpositions, opens/shorts, tight kinks, damaged jacket insulation, etc.
- B. Furnish a written warranty to VT for a minimum of:
 - a. One-year materials warranty on parts and labor to repair/replace defective telecommunications materials specified herein. This warranty only applies to materials provided by Contractor and does not apply to materials provided by NI&S.
 - b. One-year installation workmanship warranty on parts and labor to resolve problems related to telecommunications system installation workmanship.

- c. A minimum twenty year manufacturer's performance warranty on parts and labor to repair/replace defective telecommunications cabling materials. The installer/contractor shall be certified by the following cabling systems manufacturers to provide the materials warranty.
 - i. Siemon Cabling System (Siemon System 6 or 500 MHz Z-Max 6A Cabling System Warranty – dependent on Category specified by project)
 - ii. Optical Cable Corporation (OCC) Fiber Optic Systems.
- C. The appropriate cabling system manufacturer shall be responsible for and make good, without expense to VT, any and all defects in any part of either the Siemon or OCC related systems arising during this 20 year warranty period that are due to imperfect materials, appliances, improper installation, or poor workmanship.
 - a. During the 20 year warranty period, provide all labor required to repair or replace defects in the telecommunications system, at no cost to VT.
 - b. During the 20 year warranty period, provide new materials to repair or replace defects in the telecommunications system, at no cost to VT.

PART 2 – MATERIALS

2.1 EQUIPMENT AND MATERIALS MINIMUM REQUIREMENTS

- A. All materials and equipment shall be new, free from defects, installed in accordance with manufacturer's current published recommendations in a neat manner and in accordance with standard practices of the industry.
- B. All literature, installation manuals, warranty documentation, and un-used accessories included in equipment and material packaging shall be handed over to NI&S with notes identifying installed location.
- C. Where no specific material, apparatus, or appliance is mentioned, any standard, first-class product made by reputable manufacturer regularly engaged in the production of such material may be used providing it conforms to the contract requirements and meets the approval of NI&S.
- D. Materials shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, in accordance with NFPA 255.
- E. Materials shall meet or exceed the following minimum requirements:
 - a. Where applicable, all materials and equipment shall bear the label and listing of UL. Application and installation of all listed equipment and materials shall be in accordance with such labeling and listing.
 - b. Equipment shall meet all applicable FCC regulations.
 - c. Electrical equipment and systems shall meet UL standards and requirements of the NEC. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with these requirements.
 - d. The listing of a manufacturer as "acceptable" does not include acceptance of a standard or cataloged item of equipment. All equipment and systems must conform to the specifications herein and meet the quality of the specified item.
 - e. Materials and equipment shall bear the manufacturer's name or trademark and model/serial number permanently marked.

2.2 CABLES

- A. All telecommunications cabling inside the building shall be UL listed and marked type CM, CMR, CMP, CATV, CATVR or CATVP and shall be installed in accordance with NEC articles 300-22(C)(2), 800-49, 800-50, 800-51, 800-52, 800-53, and 820. The substitutions listed in articles 800.154 and 820.154 shall be permitted.

- B. All fiber optic cable inside the building shall be UL listed and marked type OFN, OFNR, or OFNP and shall be installed in accordance with NEC articles 300-22, 770-49, 770-50, 770-51, 770-52, and 770-53.

2.3 FACTORY ASSEMBLED PRODUCTS

- A. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for the final assembled unit.
 - a. All components of an assembled unit need not be products of the same manufacturer.
 - b. Constituent parts, which are alike, shall be the product of a single manufacturer.
 - c. Components shall be compatible with each other and with the total assembly for intended service.
 - d. Contractor shall guarantee performance of assemblies of components and shall repair or replace elements of the assemblies as required to deliver the specified performance of the complete assembly.

2.4 COMPATIBILITY OF RELATED EQUIPMENT

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that a complete and fully operational system will result.

2.5 SPECIAL TOOLS AND KITS

- A. The Contractor shall furnish any special installation equipment, tools, or kits necessary to properly complete the telecommunications system installation. This may include, but is not limited to, tools for pulling, splicing, terminating, and testing the cables, communication devices, stands for cable reels, cable winches, assembly and adjustment devices, etc.

2.6 FIRESTOPS AND PENETRATION SEAL MATERIALS

- A. Use qualified systems to firestop through penetrations in fire-rated walls and floors for pipes, cables, conduits, ducts, inner-ducts, and cable trays.
- B. Firestopping for openings through fire and smoke-rated walls and floor assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Firestop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Firestops" designated by ASTM E814.
- C. Inside all conduits, the firestop system shall consist of a dielectric, water-resistant, non-hardening, permanently pliable/re-enterable putty along with appropriate damming or backer materials (where required). The sealant must be capable of being removed and reinstalled and must adhere to all penetrants and common construction materials and shall be capable of allowing normal cable movement without being displaced.
- D. Foam sealant shall meet all fire test and hose stream test requirements of ASTM E-119-73 and shall be UL classified as a wall opening protective device.
- E. Provide devices/systems fire tested by a third party according to ASTM E 814 (or UL 1479) tested under positive pressure.
- F. Provide only material combinations that are qualified by independent agencies based on the material's performance when tested in a particular configuration.
- G. Match the thickness (and/or depth) of firestop materials to that recommended by the manufacturer.
- H. Per the University Building Official (UBO) all firestop material must be red in color.
- I. Thickness of materials must be established by formal ASTM E814 or UL 1479 tests.

- J. Firestop for fire-rated floors and walls:
 - a. Hilti Firestop Systems
 - b. 3M Fire Protection
 - c. Others as approved by UDC & NI&S

2.7 ANCHORING MATERIALS AND SUPPORTS

- A. Metal bars, plates, channel, tubing, etc. shall conform to ASTM Standards:
 - a. Steel plates, shapes, bars, and grating – ASTM A36
 - b. Cold-formed steel tubing – ASTM A500
 - c. Hot-rolled steel tubing – ASTM A501
 - d. Steel pipe – ASTM A53, Schedule 40, welded
- B. Metal fasteners shall be zinc-coated.
- C. Anchoring Materials:
 - a. Structural Steel
 - b. Steel Channel: Galvanized or painted
 - c. Uni-Strut

2.8 GROUNDING AND BONDING MATERIALS

- A. Compression Connectors
- B. Bonding Conductor: 6 AWG minimum copper
- C. All grounding equipment shall be UL listed for that purpose.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. The approximate locations of existing and new telecommunications outlets, cabling and equipment will be indicated on the project drawings; however, the drawings are not intended to give complete and accurate information. Contractor is responsible to field verify existing outlets and cabling prior to submitting quote. Determine the exact location after thoroughly examining the general building plans and by actual measurements before and during construction, subject to the approval of UDC and NI&S.
- B. Before construction work commences, visit the site and identify the exact routing for all horizontal pathways and equipment placement. Verify all dimensions, locating the work and its relation to existing work, all existing conditions and their relation to the work and all man made obstructions and conditions, etc. affecting the completion and proper execution of the work as indicated in the project drawings and specifications.
- C. If core drills are required, the exact core locations shall be identified and coordinated with the UDC, University Building Official (UBO), and VT Health & Safety Asbestos Management plan as necessary. Where required for inspection, Contractor shall retain removed cores and label with location information where the core was removed. Refer to UDC and UBO for all coring requirements.
- D. All equipment locations shall be coordinated with UDC, other trades and existing conditions to eliminate interference with required clearances for equipment maintenance and inspections.
- E. Coordinate work with UDC, other trades and existing conditions to determine exact routing of cable, cable tray, hangers, conduit, etc., before fabrication and installation.
- F. Install telecommunications cabling and equipment to facilitate maintenance and repair or replacement of equipment components. Provide easy, safe and code mandated clearances at equipment racks and enclosures, and other equipment requiring maintenance and operation. Coordinate with NI&S exact location and mounting height of all equipment in finished areas, such as equipment racks and termination equipment. As much as practical,

connect equipment for ease of disconnecting, with a minimum of interference with other installations.

- G. Coordinate ordering and installation of all materials with long lead times or having major impact on work by other trades so as not to delay the job or impact the schedule.
- H. Set all equipment to accurate line and grade, level all equipment and align all equipment components. All work shall be installed level and plumb, parallel and perpendicular to other building systems and components.
- I. Provide all scaffolding, rigging, hoisting and services necessary for delivery, installation, and erection of materials, equipment, and apparatus furnished into the premises. These items shall be removed from premises when no longer required. Use of University owned supplies and equipment is prohibited.

3.2 WORKMANSHIP

- A. All labor must be thoroughly competent and skilled, and all work shall be executed in strict accordance with the best practice of the trades.
- B. Good workmanship and appearance shall be considered of equal importance with telecommunications operation. Lack of quality workmanship shall be considered sufficient reason for rejection of a system in part or in its entirety. Carefully lay out all work in advance and install in a neat and workmanlike manner in accordance with recognized good practices and standards. Provide workmen who are skilled in their craft and a competent Project Manager who will be on the job at all times.

3.3 CABLES

- A. Backbone and horizontal telecommunications cabling shall be placed in separate dedicated conduit pathways. Cable trays may be shared however trays shall be clearly divided between backbone and horizontal cabling. Backbone cabling must be installed prior to horizontal cables.
- B. Telecommunications pathways shall be dedicated for use for NI&S voice, data & CATV cabling.
- C. Horizontal cabling for other services will be allowed within the NI&S pathways per the following guidelines and acceptance of written approval from NI&S. NI&S must understand and accept the services to be used on the Horizontal cabling as to not create interference with other services within the pathways. NI&S will be the sole owner of the Horizontal cabling with jacks on both ends that will be installed and tested to the TIA standards on category 6 cable or better with the Siemon standard cabling. Other terminations and systems can be reviewed by NI&S but all horizontal cabling for other services must be approved in writing from NI&S.
- D. All horizontal cabling terminating within a single faceplate must be routed to and terminated in the same ER or TR.
- E. Consolidation points and multi-user telecommunications outlet assembly (MUTOA) configurations for horizontal cabling are not currently supported by NI&S and will not be permitted.

3.4 CUTTING AND PATCHING

- A. Provide all cutting, patching and core drilling, etc., as necessary for telecommunications work. Locate holes and outlets to be drilled and coordinate with work of other trades. Obtain approval of UDC and UBO prior to cutting or core drilling holes in structural members.
- B. Cut and drill from both sides of walls and/or floors to eliminate splaying.

- C. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering and other finished surfaces. Patch openings and damaged areas equal to existing surface finish.
- D. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.
- E. All openings shall be carefully caulked or grouted as required. Spare conduits shall be tightly capped.
- F. All cutting in the building construction made necessary to admit work, repair defective materials, defective workmanship, or by neglect of the Contractor to properly anticipate his requirements, shall be done in accordance with these specifications with no additional cost to the project. Patching shall be complete in every detail. Actual work involved in these repairs shall be done by skilled craftsmen in the trades involved.
- G. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to finished areas as required by the UDC Project Manager.

3.5 CONCEALMENT

- A. Use existing conduit and cable trays where possible and practicable. Conceal all project work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impracticable, notify UDC and NI&S before starting that part of the work and install only after approval.

3.6 EQUIPMENT MODIFICATION

- A. Where existing equipment is to be modified, Contractor shall furnish materials and labor as necessary to modify or add to the equipment. Modifications shall be done neatly with factory parts and assemblies approved for the application. Modification shall in no way jeopardize the compliance of existing equipment with any governing codes and regulations.

3.7 FIRESTOPS AND PENETRATION SEALS

- A. All new and pre-existing conduit and sleeve openings used for the project shall be waterproofed or fireproofed upon cable placement through such passageways in compliance with the Virginia Statewide Building Code and University Building Official standards regardless of the installation of cabling or left void.
- B. Patch all openings remaining around and inside all new and pre-existing conduit sleeves and cable penetrations to maintain the integrity of any fire-rated wall, floor, ceiling, etc.
- C. Manufacturer's installation standards shall be closely followed (minimum depth of material, use of ceramic fiber, procedures, etc.)
- D. Brick, Concrete, and Concrete Blocks Walls:
 - a. Provide metallic sleeving systems for routing of cables through these surfaces.
 - b. Ensure that sleeve extends from the front and back of the wall only far enough to attach the required bushing or collar.
 - c. Secure sleeves in place according to manufacturer's specifications.
 - d. Provide firestop seal between sleeve and wall, but do not use firestopping material to support or secure sleeve.
 - e. Firestop ends of sleeving or inner-duct after installation of cable, without exception.
- E. Floor Openings:
 - a. Install firestop materials to stop openings between sleeving (or other supporting material) and core.

- b. When coring through concrete flooring, use boots and packing materials to fashion core before installing firestopping materials.
 - c. If rectangular openings exist in concrete floors, use steel sleeving to fashion opening before installing firestopping materials.
 - d. Firestop openings in all un-used telecommunications designated slots, sleeves or ducts.
 - e. Firestop openings in slots, sleeves or ducts after installation of cable, without exception.
- F. Cable Trays: All new cable tray pathways penetrating fire-rated walls should be fully closed with Hilti CFS-BL firestop bricks or equivalent fire stopping system approved NI&S.
- a. Install the system according to the manufacturer's instructions.
 - b. Firestop materials must be easily removable if required to provide for installation of cable.
- G. Fire-Rated Gypsum Walls:
- a. Sleeve all penetrations of gypsum walls used for cable routing if cable is not in continuous conduit with Hilti Speed Sleeve product or equivalent fire stopping system approved NI&S.
 - b. Firestop seal between sleeve, conduit, or inner-duct and wall on both sides of the wall.
 - c. Use qualified firestop systems to seal penetrations in gypsum wallboard assemblies.
 - d. Verify that penetration conditions fall within the following firestop system parameters:
 - i. Hourly rating.
 - ii. Opening size.
 - iii. Annular space.
 - e. Install the firestop system symmetrically on both sides of the wall.
 - f. Install the materials according to manufacturer-tested methods.
- H. Other Firestopping:
- a. Firestop through penetrations according to the guidelines for the basic construction of the two outermost layers of the combination wall.
 - b. Firestop load-bearing stud walls that are part of combination walls by enclosing (i.e., boxing) the penetration in the cavity.
 - c. Firestop partial penetrations according to the recommendations for the type of wall being penetrated.
 - d. Firestop any penetrations which violate the fire-rating integrity of vertical shafts.
 - e. Firestop openings around outlet boxes installed in fire-rated walls, on both sides.
- I. Firestop Installation Methods:
- a. Use drop cloths to protect other surfaces when installing.
 - b. Firestop completely around each cable individually – do not stop bundles of cables.
 - c. If using putty around a vertical penetration, use putty to build flooring of seal, fill with fiber or rock wool to required thickness, then top with putty according to Manufacturer's specifications.
 - d. The methods used shall incorporate qualities that permit the easy removal or addition of conduits or cables without drilling or use of special tools.
 - e. The product shall adhere to itself to allow repairs to be made with the same material and to permit the vibration, expansion and/or contraction of any items

passing through the penetration without cracking, crumbling, and resulting reduction in fire rating.

- J. The installed firestop system shall meet the requirements of “Fire Tests of Through-Penetration Firestops” designated ASTM E814.
- K. Seal all foundation penetrating conduits and all service entrance conduits and sleeves to eliminate the intrusion of moisture and gases into the building. This requirement also includes spare conduits.
- L. Spare conduits shall be plugged with removable approved, fire-rated plugs.
- M. All service entrance conduits through the building shall be sealed or resealed upon cable placement with a removable waterproof duct seal.
- O. The firestop system shall be submitted to UDC prior to starting construction with a list or map of each location and system number used for the project. Inspections and approval of installed firestop systems or areas in which firestop material was or should be used will be at the discretion of the UDC Project Manager and the UBO.

3.8 ANCHORING METHODS

- A. Anchor and brace all cabling, material, and equipment installed under this Division as required by all codes, regulations, and standards. Provide required supports, beams, angles, hangers, rods, bases, braces, straps, struts, and other items to properly support project work. Supports shall meet the approval of UDC.
- B. Supports shall be fabricated from structural steel, steel channel, or unistrut, rigidly bolted or welded to present a neat appearance.
- C. Fastenings and supports shall be adequate to support loads with ample safety factors.
- D. Fasten hanger rods, conduit clamps, outlet boxes, and pull-boxes to building structure.
- E. Use toggle bolts, spider type expansion anchors, or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls.
- F. Use lead expansion shields or expansion anchors or preset inserts in solid masonry walls.
- G. Use self-drilling anchors or lead expansion anchor on concrete surfaces.
- H. Use sheet metal screws in sheet metal studs.
- I. Use wood screws in wood construction.
- J. In pre-cast structures, use cast-in inserts wherever possible. Expansion anchors can be used with caution, but only with prior approval.
- K. In cast-in-place concrete, use expansion anchors, preset inserts, or self-drilling masonry anchors.
- L. Use lead expansion anchors or preset inserts on metal surfaces.
- M. Do not fasten supports to piping, ceiling support wires, ductwork, mechanical equipment or conduit.
- N. Power-actuated anchors, plastic or fiber expansion anchors, and drive pin anchors are prohibited.
- O. Do not drill structural steel members.
- P. Any anchoring must be able to be unsecured and removed should relocation be required.
- Q. Where necessary and with approval from UDC, modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit project work. If necessary in stud walls provide special supports from floor to structure above.
- R. Support surface mounted cabinets, enclosures and panel boards with a minimum of four anchors.
- S. On exterior concrete walls below grade, provide 1” steel channel stand-offs for cabinets and raceways.
- T. Use stud bridges at top and bottom of cabinets and enclosures that are flush mounted on hollow drywall walls.

- U. For precast panels/planks and metal decks, support communication work as determined by manufacturer and UDC.

3.9 GROUNDING AND BONDING

- A. Bond all new metallic cable shields and metallic supporting structures, in all equipment rooms and service entrances, including racks, frames, protectors and cabinets to the telecommunications grounding busbar (TGB), according to the manufacturer's specifications and as described in Section 27 11 00.
- B. Do not make connections between the telecommunications busbar system and building electrical grounds, or other types of connections, without UDC approval.
- C. Bond metallic surfaces of telecommunications hardware with #6 AWG grounding wire as straight as possible to the ground source.
- D. Ensure that the grounding system is physically secured.
- E. All grounding conductors leaving the ERs and TRs shall be in a separate conduit from all communication cabling.
- F. All grounding items shall be installed in complete compliance with Division 16 and NEC.

END OF SECTION 27 05 00

SECTION 27 05 28
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Forms, and Conditions of the Contract, including Construction Manager/General Contractor (CM/GC) Agreement including Exhibits and other Division 1 Specification Sections, apply to this section.

1.2 SCOPE OF WORK

- A. Provide all services labor, materials, tools, and equipment required for the complete and proper installation of interior telecommunications pathways as called for in these specifications and related drawings.
- B. This section includes minimum requirements and installation methods for the following:
 - a. EMT Conduit and Cable Tray Systems
 - b. Surface Metal Raceway Systems
 - c. Telecommunications Outlet Boxes

1.3 QUALITY ASSURANCE

- A. All installation work for the new interior telecommunications pathways shall be performed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated shall be subject to the control of UDC.
- B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval of UDC based on submittals provided.
- C. Materials and work specified herein shall comply with the applicable requirements of:
 - a. ANSI/NFPA 70 – National Electrical Code including, but not limited to, the following articles:
 - i. 250 – Grounding
 - ii. 300 – Wiring Methods
 - iii. 314 – Outlet, Device, Pull, and Junction Boxes; Conduit Bodies; Fittings; and Manholes
 - iv. 342 – Intermediate Metal Conduit: Type IMC
 - v. 358 – Electrical Metallic Tubing: Type EMT
 - vi. 386 – Surface Metal Raceways
 - vii. 392 – Cable Trays
 - viii. 770 – Optical Fiber Cables and Raceways
 - b. ANSI/TIA-568-C.0-2 – Generic Telecommunications Cabling for Customer Premises – Addendum 2, General Updates
 - c. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard
 - d. ANSI/TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces, including applicable addendum
 - e. ANSI/TIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications
 - f. BICSI Telecommunications Distribution Methods Manual

1.4 SUBMITTALS

- A. As-built drawings (as required per Section 270100)

PART 2 – MATERIALS

2.1 EMT CONDUIT, OUTLET BOXES, AND CABLE TRAY SYSTEMS

- A. Electrical Metallic Tubing (EMT): Electro-galvanized steel tubing 1” and larger diameter per project requirements:
 - a. Conduit joint couplings and connectors: steel double set screw indenter fittings.
 - b. Insulated metallic bushings for 1” and larger conduit.
 - c. Insulated metallic bushings with grounding lugs as required.
 - d. Conduit sweeps: minimum 10 times the conduit inside diameter.
 - e. Include required conduit straps, and hangers, heavy-duty malleable iron or steel.
 - f. Perforated pipe strap, j-hooks, bridle rings, or wire hangers are not permitted.
 - g. LB fittings and plastic fittings are not permitted.
 - h. Conduits connecting one outlet box to another outlet box are not permitted.
- B. Conduits feeding surface metal raceways shall be sized to allow for no greater than 40% fill when horizontal station cables supporting the raceway outlets are installed.
- C. The standard outlet box shall consist of a nominal 4" x 4" x 2 ¼" metal box, with a 4" X 4" drywall ring with mounting holes for a double gang faceplate.
- D. If a standard 4" x 4" x 2 ¼" metal box is not feasible, NI&S must approve the substitute in order to ensure compatibility with NI&S-supplied hardware, compliance with standards, and life-cycle maintainability.
- E. Emergency phones - internal
 - a. A number of “push-to-talk” emergency phones may be located on each floor of a building. The number and location of the phones is determined by the VT Office of Emergency Management (OEM) and the VT Police Department (VTPD). The physical requirements for the infrastructure to support the phones are a flush mount 4" x 4" back box with a minimum 2 ¼" depth. One 1” conduit shall be routed from the back box to within 12” of the nearest cable tray or homerun to the nearest communications room. The mounting height should meet ADA requirements (coordinate with UDC for final box elevation). The back box faceplate mounting hole pattern shall be designed to accept the Viking 1600A push-to-talk device without the use of additional mounting equipment.
- F. Pull-boxes: Minimum 14 gauge galvanized steel with screw fastened cover and trim for flush or surface mounting as required for project. Dimensions as required for project.
 - a. Box extensions are prohibited for new construction however they are permitted on remodel work to extend existing installations.
- G. Metal Flex Conduit (3/4”) and deep Cut-In Boxes for outlets in existing walls for remodel projects only.
- H. Muletape: use polyester or aramid line with a minimum pull tensile strength of 200 pounds for installing backbone cable in riser conduits. Contractor shall install and secure muletape in all telecommunications conduits for future cabling installations.
- I. Poly line: use poly pull line with a minimum pull tensile strength of 200 pounds for installing station cabling in horizontal pathways. Contractor shall install and secure poly lines in all horizontal telecommunications pathways for future cabling installations.
- J. Cable Trays in Ceiling Areas:
 - a. Welded wire mesh cable system sized to accommodate all necessary project cabling and future growth.
 - b. Include components, and compatible fittings designed and manufactured by the cable tray manufacturer as required for a fully installed electrically continuous system.

- c. Include support kits, brackets, threaded rod hangers, lateral threaded rod braces, and other anchors and supports as required as specified in Section 27 05 00.

2.2 SURFACE METAL RACEWAY SYSTEMS

- A. Surface Metal Raceway Systems (SMRS):
 - a. Include all parts and components: base and cover, compatible fittings, insulated bushings, and supports designed and manufactured by the raceway manufacturer as required for a complete installation.
 - b. Where raceways will support work area outlets, provide appropriate adapters which will accept NI&S standard modular outlet jacks.
 - c. Where power and communications cabling must be run within the same raceway Contractor shall provide and install a solid metallic separation device manufactured specifically for the installed raceway system.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which the new interior telecommunications pathways are to be installed. Provide notification, in writing, of conditions detrimental to proper completion of the work.
- B. Verify field measurements and pathway routing conditions are as shown on project drawings. Provide notification, in writing, of conditions deviating from drawings.
- C. Beginning of telecommunications pathway installation indicates Contractor acceptance of existing conditions.

3.2 INSIDE CABLE TRAY INSTALLATION

- A. Cable trays provide critical cable management and allow access to horizontal wiring, which is essential for initial installation and future growth. Cable tray systems shall originate in the ER/TR and extend the entire length of the main hallways. Cable trays shall form part of a continuous cable pathway connected to the serving ER/TR.
- B. Cable tray capacity shall be determined by the number of telecommunications outlets that will be served. Larger cable trays should be used in areas that have high-density telecommunications requirements. The dimensions of the cable tray may vary to accommodate the space available as long as the required capacity is maintained. Capacity requirements shall be specified by NI&S. Cable trays shall not be filled greater than the NEC maximum fill for the tray selected.
- C. The size of the cable tray may be incrementally decreased the further it extends away from the ER/TR, depending on the specific requirements of the areas being served by that cable tray. This is to be coordinated with NI&S.
- D. There must be least 3 inches of clear space above the cable tray for access (6 inches is preferable).
- E. All telecommunications cable trays shall have a minimum of 12" clearance from any sort of light fixtures (incandescent, fluorescent or other).
- F. No conduits, pipes, wires, threaded rod, grounding hardware or any other obstruction may penetrate the interior area of the tray where the cables are to be routed.
- G. All screws, bolts, etc. used to connect the sections of tray must be installed so that they do not obstruct the installation of the cabling.
- H. Cable trays are to be installed at the same elevation within the ceiling throughout the building floor.

3.2 INSIDE CONDUIT INSTALLATION

- A. The electrical contractor will provide clean, dry and debris free conduits, to be used solely by NI&S to provision telecommunications services.
- B. Conduits shall either be continuous "home-run" from the telecommunications outlet box to the equipment room, or shall be run from the outlet box and stubbed out within 1 foot of a cable tray that runs continuously to the equipment room. In the case of a renovation where there is no cable tray available, the conduit for the outlet box should be routed to an accessible ceiling area in the corridor.
- C. The standard station-cable conduit size is 1-inch diameter minimum. The 1-inch diameter minimum may be increased depending upon the size and number of cables to be installed. Minimum conduit diameter shall be determined by NI&S based on the quantity and size of cable required.
- D. Perform installation of routing hardware as specified in Section 270500 including anchoring and supports, grounding and bonding, firestop, etc. Use anchors for attachment to surface. Use of adhesives is prohibited.
- E. The contractor shall install threaded bushings on all conduit ends.
- F. The maximum conduit length is 30 m (100 ft.) between pull boxes or pull points, with no more than two 90 degree bends between pull boxes or pull points.
- G. No unnecessary junction boxes, troughs, etc. will be installed in the conduit pathway between the outlet box and either the cable tray or the telecommunications equipment room. And the conduits are to be installed in the most direct route from the outlet box to either the cable tray or the telecommunications equipment room.
- H. All conduit bends shall be sweeps with minimum bend radii as specified in the appropriate standards. There shall be no hard 90 degree bends.
- I. The contractor shall provide a pull string (minimum pull strength of 200 pounds) in each conduit. Pull strings must be tied off at both ends of the conduit to prevent loss of the pull string.
- J. All conduits from a room must be run to the same cable tray or equipment room, *i.e.*, if there is more than one cable tray adjacent to a room, the conduits from a room cannot be "split" between the trays.

3.3 SURFACE METAL RACEWAY INSTALLATION

- A. Place new surface metal raceway systems as shown on the project drawings.
- B. Perform installation of routing hardware as specified in Section 270500 including anchoring and supports, grounding and bonding, firestop, etc. Use anchors for attachment to surface. Use of adhesives is prohibited.
- C. Collector/distribution surface raceway shall be 25' ± 5' between pull-boxes. Surface raceway and boxes shall be upsized per fill in area.
- D. Cut raceways square and ream ends to remove burrs at raceway connections to outlets.
- E. Install raceways parallel or perpendicular to building walls, floors and ceilings.
- F. When installing through false ceiling, extend raceway above top of ceiling grid to a pull box feeder system or within 6" of the cable tray. Notch ceiling panel to size of raceway.
- G. Coordinate raceway runs with other trades.
- H. Ceiling tile shall be removed as necessary for the raceway installation and put back in place without damaging or dirtying any of the tiles or supporting framework. Ceiling tile shall be handled with clean hands so that no fingerprints or marks are left on the tiles. The contractor is responsible for the cost of repair or replacement of any damaged or dirtied tiles or ceiling hardware.
- I. Conduits feeding raceway shall be sized to accommodate the number of cables needed in the raceway and allow for future growth. Coordinate conduit sizing with NI&S.

3.4 TELECOMMUNICATIONS OUTLETS

- A. It is the responsibility of UDC to coordinate with the departments moving into the space(s), and with NI&S, to determine the location and number of telecommunications outlet boxes required in each space.
 - a. Unless otherwise noted, outlet boxes shall be located as follows (dimensions are above finished floor to center line of boxes):
 - i. Standard telecommunications outlets: 1'6"
 - ii. Wall-mount telephone outlets: 4'6"
 - iii. ADA Wall mount telephone outlets: 4'0"
 - b. All ADA standards shall be met when applicable.
 - c. Adjust outlet box locations so that they will be symmetrically located and not interfere with other equipment.
 - d. Where outlets of other types are adjacent, coordinate heights to be similar where possible.
 - e. Where outlets are located on masonry walls, adjust box location to set in corner of block or brick.
 - f. Back to back outlet boxes are not permitted. Separate boxes a minimum of 6" in standard walls and a minimum of 2' in acoustical walls.
 - g. Where conflicts are noted for outlet box locations, coordinate with UDC and NI&S.
- B. Support outlet boxes from building construction. Do not support from other installed systems (e.g. ceiling support wiring, conduit or raceways).
- C. Telecommunications outlet boxes that support devices for wireless access points and emergency notification reader boards will be part of the cabling design. The electrical contractor will install conduit from the outlet box to within one foot of the cable tray, or to the ER/TR.
 - a. The Wireless Access Point outlet boxes should be placed in locations designated by NI&S. The outlet boxes should be placed above accessible ceilings where possible. If a ceiling mount is not possible then the outlet boxes should be placed 12" below the ceiling in the locations designated by NI&S.
 - b. Reader board outlet boxes should be placed in locations designated by OEM & VTPD. The outlet boxes should be placed below the ceilings as close as possible to the reader board location as noted on the project drawings.

3.6 AS-BUILT DRAWINGS

- A. Mark the project drawings with notations reflecting any variations from the base specifications and drawings including as-built conduit and cable tray routing.
- B. Comply with construction drawings as-built requirements as described in Section 27 01 00.

END OF SECTION 27 05 28

SECTION 27 05 43

EXTERIOR UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Forms, and Conditions of the Contract, including Construction Manager/General Contractor (CM/GC) Agreement including Exhibits and other Division 1 Specification Sections, apply to this section.
- B. UDC Standards:
 - a. Virginia Tech Design and Construction Standards (Revised August, 2006)

1.2 SCOPE OF WORK

- A. Provide all services, labor, materials, tools, and equipment required for the complete and proper installation of exterior telecommunications pathways as called for in these specifications and related drawings.
- B. This section includes minimum requirements and installation methods for the following:
 - a. Building entrance conduits.
 - b. ER/TR conduits extending from building entrance (where applicable).

1.3 QUALITY ASSURANCE

- A. All installation work for the new exterior telecommunications pathways shall be performed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated shall be subject to the control of UDC.
- B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval of UDC and NI&S based on submittals provided.
- C. Materials and work specified herein shall comply with the applicable requirements of:
 - a. ANSI/NFPA 70 – National Electrical Code including, but not limited to, the following articles:
 - i. 314 – Outlet, Device, Pull-Boxes; Conduit Bodies; Fittings; and Manholes
 - ii. 344 – Rigid Metal Conduit: Type RMC
 - b. IEEE/NESC – National Electrical Safety Code
 - c. NEMA Standards including, but not limited to:
 - i. NEMA, RN1, 1986 PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
 - d. UL Standards including, but not limited to:
 - i. UL 6, 1981 Rigid Metal Electrical Conduit
 - e. ANSI-C80.2, 1983 Specification for Rigid Steel Conduit, Enameled
 - f. ANSI/TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces
 - g. ANSI/TIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications
 - h. ANSI/TIA-758-A – Customer Owned Outside Plant Telecommunications Cabling Standard (including all applicable addenda)
 - i. BICSI Telecommunications Distribution Methods Manual
 - j. BICSI Customer-Owned Outside Plant Manual

1.4 SUBMITTALS

- A. As-built drawings (as required per Section 27 01 00)

PART 2 – MATERIALS

2.1 CONDUIT SYSTEM

- A. Metallic Conduit:
 - a. Galvanized rigid conduit (GRC) with PVC coating (for building entrances).
 - b. Intermediate metal conduit (IMC) or rigid steel conduit (for extending entrance conduit).

PART 3 - EXECUTION

3.1 CONDUIT SYSTEM PLACEMENT

- A. Each building is required to have two diverse building entrances for survivability. Each building entrance must have a separate inside plant pathway to ER/TRs to be specified by NI&S. The location of these building entrances shall be determined in collaboration with NI&S and UDC.
- B. Each building entrance shall consist of a minimum of two 4 inch conduits and two 2 inch conduits of IMC or rigid steel conduit extended a minimum of 10 feet from the foundation wall or into undisturbed soil. The exact size and number of conduits required depends on the requirements of the building being served and shall be specified by NI&S. These conduits are solely intended for the provisioning of telecommunications services by NI&S. The use of these conduits is managed and documented solely by NI&S.
- C. Additional conduit shall be provisioned as required to support other services (*e.g.*, building control systems) that run over non-NI&S cable plant.
- D. The conduit pathway within the building shall be continuous rigid or intermediate conduit in cases where the distance between the termination location and the building entrance is greater than 15m (49ft).
- E. All conduit bends will have a radius no less than nine times the internal diameter of the conduit with a minimum radius of 36".
- F. No bends will be greater than 90-degrees.
- G. No more than two 90-degree bends in a run between pulling points.

3.2 AS-BUILT DRAWINGS

- A. Mark the project drawings with notations reflecting any variations from the base specifications and drawings including as-built conduit routing.
- B. Comply with construction drawings as-built requirements as described in Section 27 01 00.

END OF SECTION 27 05 43

SECTION 27 11 00
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Forms, and Conditions of the Contract, including Construction Manager/General Contractor (CM/GC) Agreement including Exhibits and other Division 1 Specification Sections, apply to this section

1.2 SCOPE OF WORK

- A. Provide all services, labor, materials, tools, and equipment required for the complete and proper installation of communications equipment within the Equipment Rooms (ERs) and Telecommunications Rooms (TRs) as called for in these specifications and related drawings.
- B. This section includes minimum requirements and installation methods for the following:
 - a. Equipment Racks and Cable Routing Hardware
 - b. Copper Termination Equipment
 - c. Fiber Termination Equipment
 - d. Grounding and Bonding

1.3 QUALITY ASSURANCE

- A. All installation work in the TRs and the ERs shall be performed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated shall be subject to the control of UDC.
- B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval of NI&S based on submittals provided.
- C. Materials and work specified herein shall comply with the applicable requirements of:
 - a. ANSI/NFPA 70 – National Electrical Code (NEC) Articles 250, 300, and 645 (2014 edition of the National Electrical Code®)
 - b. ANSI/TIA-568-C.0-2 – Generic Telecommunications Cabling for Customer Premises– Addendum 2, General Updates
 - c. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard
 - d. ANSI/TIA-568-B.2 – Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted-Pair Cabling Components, including applicable addendum
 - e. ANSI/TIA-568-C.3 – Optical Fiber Cabling Components Standard
 - f. ANSI/TIA-569-C – Commercial Building Standard for Telecommunications Pathways and Spaces
 - g. ANSI/TIA-604 Series – Fiber Optic Connector Intermateability Standards
 - i. ANSI/TIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications
 - j. BICSI Telecommunications Distribution Methods Manual

1.4 ARCHITECTURAL REQUIREMENTS

- A. New Telecommunications Rooms (TRs) and Equipment Rooms (ERs) shall be designed in compliance with the space, electrical, and environmental requirements of ANSI/TIA-569-C – Commercial Building Standard for Telecommunications Pathways and Spaces.

Smaller spaces or enclosures shall not be acceptable without prior written approval from NI&S.

- B. Any or all functions of a TR may be provided by an ER.
- C. The ER and TRs shall be dedicated to the telecommunications function and related support facilities. For security purposes, non-NI&S systems shall not be co-located in the ER and TRs. The ER and TRs shall not be shared with electrical installations other than those supporting telecommunications. Equipment not related to the support of the ER or TRs (*e.g.*, piping, HVAC systems, pneumatic tubing) shall not be installed in, pass through, enter, or be stored in the ER or TRs.
- D. ER and TR design, including location, should be developed in accordance with the security and disaster avoidance plans of the building.

1.5 ROOM SIZE AND SPACING

- A. There shall be a minimum of one TR per floor. Exceptions may be approved by NI&S where conditions warrant. Additional rooms shall be provided when:
 - a. The floor area to be served exceeds 10,000 sq. ft.; or
 - b. The horizontal cable distance from the ER/TR to the work area exceeds 90 m (295 ft.).
- B. ER and TR room sizes
 - a. ER/TR size shall be determined by NI&S based on the size and program of the building.
 - i. The minimum ER size is 10' x 15'.
 - ii. The minimum TR size is 10' x 10'.

* Note: Special purpose rooms, such as laboratories, computer rooms and certain instructional spaces, may have a varying density of communications outlets. The size of the ER/TR serving these rooms shall be sized accordingly, as determined by NI&S.

1.6 LOCATION

- A. Each ER/TR shall be located as close as practical to the center of the area served.
- B. ER/TR doors shall open directly onto a hallway to facilitate the movement of large equipment and 24x7 maintenance access.
- C. Access through ER/TRs to other areas of the building, including electrical vaults, shall not be permitted.
- D. ER/TRs should be located away from sources of electromagnetic interference. Special attention shall be given to electrical power supply transformers, motors, generators, x-ray equipment, and radio/radar transmitters.
- E. TRs on multiple floors should be stacked over/under the ER wherever practical and as close as possible to vertical stacks. Depending on building size, there may be multiple TRs per floor. Should this be required, there will need to be multiple TR stacks.
- F. ER/TRs shall be located as close as practical to the location where the vertical backbone cable pathways rise throughout the building. This requirement reduces the length and quantity of the associated pathways.
- G. The ER shall not be located below grade or below the 100-year flood plain unless preventive measures against water infiltration are employed.
- H. ER/TRs shall be positioned such that the risk of water infiltration from in-building systems is minimized. Possible sources of such water infiltration include domestic water supply and drains, fire sprinkler supplies, roof drains, HVAC condensation and drains.
- I. ER/TRs shall be positioned away from sources of high quantities of airborne particulates (*e.g.*, dust).

1.7 POWER

- A. A separate supply circuit serving the ER shall be provided and terminated in its own electrical panel in the ER. The electrical panel in the ER shall be sized to meet the projected power requirements of service to the ER and all TRs, and shall be used only to provide power to the ER/TRs.
- B. Each TR shall have an electrical panel located in the TR that is fed from the electrical panel in the ER.
- C. The electrical panel in the ER shall be connected to an emergency power system (generator).
- D. Each ER and TR shall have two 30 amp 208volt circuits terminated on L6-30R at rack location specified by NI&S. One circuit from ER or TR emergency panel and one from building utility power to provide redundancy on network equipment having dual power supplies.
- E. Each equipment rack (ER and TR) will require one 20 amp 120volt receptacle (5-20R) circuit originating from emergency panel in room.
- F. Device boxes shall be extended to the top of each equipment rack via flexible conduit. Device boxes shall be mounted to a backplate which shall have accessible screws securing it to the rack location specified by NI&S.
- G. In order to provide capacity for growth, in addition to circuits required for equipment racks, all new electrical panels for ER/TRs will also include:
 - a. One 20 amp 120 volt single-pole circuit
 - b. One 20 amp 208 volt double-pole circuit
 - c. One 30 amp 208 volt 3-phase circuit
- H. Each of these circuits will be landed (terminated) on the breaker and extended into individual four inch junction boxes located within 12 inches of the bottom of the panel. These junction boxes shall have blank covers with the panel and breaker information clearly marked.
- I. In addition, identified and marked utility duplex outlets shall be placed at 6 foot intervals around the perimeter walls, at a height of 18 inches above the floor. Duplex utility outlets shall be provisioned on normal building power and not tied back to the electrical panel in the ER/TR.

1.8 EQUIPMENT BONDING AND GROUNDING

- A. Grounding systems installed by or for NI&S are for NI&S use only; all other use is strictly prohibited.
- B. All stranded grounding conductors shall be insulated and color-coded (green with yellow trace).
- C. There shall be at least one grounding conductor, the Telecommunications Bonding Backbone (TBB), for each riser stack. The TBB must be continuous and unbroken from the building central grounding point through each ER/TR in the stack. Minimum grounding conductor size is specified in the table below.
- D. Virginia Tech requires that a Terminal Grounding Bar (TGB) be installed in each ER and TR and tied to the TBB. For the TGB, use a Panduit grounding bar, (part number GB2B0312TPI-1), or equal. The TBB shall be tapped in each ER/TR and connected to the TGB in the ER/TR. Minimum grounding conductor size for the connection between the TGB and the TBB is specified in the table below.
- E. All grounding conductor terminations shall be compression crimped (no threaded compression lugs).

- F. In buildings with more than one TBB, the TBBs shall be bonded together at the top floor and at a minimum of every third floor in between. Minimum grounding conductor size is specified in the table below.
- G. Table of Minimum Grounding Conductor Sizes

Sizing of the Grounding Conductor	
Length linear m (ft)	Size (AWG)
less than 4 (13)	6
4 - 6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10 - 13 (34-41)	1
13 -16 (42 -52)	1/0
16 - 20 (53 - 66)	2/0
greater than 20 (66)	3/0

- H. Provide and install Panduit RGS134 grounding strip kits for threaded rails on front left side of each equipment rack.
- I. Ground all equipment racks and building entrance protectors to the TGB using #6 ground conductor.
- J. The contractor shall install NI&S-provided labels on grounding conductors every 5-20' as required by the cable path.
- K. The contractor shall ground all metal cable trays by connecting them to the central building grounding point per applicable specifications.

1.9 ENVIRONMENTAL CONSIDERATIONS

- A. ER/TRs typically require cooling year-round due to the heat generated by telecommunications equipment. The HVAC system shall be capable of maintaining the temperature between 64 degrees F and 78 degrees F in each ER/TR, with relative non-condensing humidity maintained within the range of 30 to 50%.
- B. Each ER/TR shall have its own thermostat controlling the temperature for that room. Thermostat will be hard wired (no battery powered remote thermostats).
- C. In some cases, the ER/TR HVAC system(s) should be on the building emergency power system (as determined by NI&S).
- D. A positive air pressure shall be maintained with a minimum of one air change per hour, or as required by applicable code.
- E. Heat rejection specifications for each ER/TR is determined from the number of telecommunications outlets served by each particular room and the type of equipment used to provision services. Specific heat rejection values for ER and TRs shall be coordinated with NI&S.
- F. The preferred location for a Fan Coil Unit (FCU) is above the equipment room entry door to minimize the impact on the usable space within the equipment room.

1.10 CONSTRUCTION

- A. A minimum of one wall shall be covered with 19 mm (3/4 in.) A-C plywood, void free, 2.4 m (8 ft.) high and securely fastened to the wall, capable of supporting attached

equipment. Plywood shall be fire-rated (fire retardant) plywood. The location is to be coordinated with NI&S.

- B. Lighting shall be a minimum of 500 lux (50 foot candles) measured 1 m (3 ft.) above the finished floor, mounted 2600 mm (8.5 ft.) minimum above finished floor. NI&S requires that at least two lighting fixtures be installed per ER/TR. These lights shall be installed in front and behind the telecommunication equipment rack(s). The location of the lighting fixtures is to be coordinated with NI&S. Lighting shall be controlled by one or more switches located near the entrance door(s) to the room. Dimmer switches shall not be used. At least one light per ER/TR shall be on the building emergency lighting circuit.
- C. False ceiling shall not be provided.
- D. For ER/TRs, the minimum clear height in the room shall be 2.4 m (8 ft.) without obstructions.
- E. The door shall be a minimum of 0.9 m (36 in.) wide and 2 m (80 in.) high, without door sill, hinged to open outward (codes permitting) and fitted with a lock. The doors shall have a lever handle, store room lock, pick guard and shall be keyed to the next available core in the 102 series. The locks for the ER and TRs shall not be on the building master keys. These locks shall be incapable of remaining in an unlocked state when the key is removed. The door shall be equipped with an auto closing device. A door sweep shall be installed at the bottom of the door and shall be consistent with other door sweeps throughout the building. The fire rating of the door shall be consistent with the fire rating of the walls of the room. On outward opening doors, the hinges shall be of the anti-tampering type. These hinges shall be consistent with and match similar mechanisms throughout the building.
- F. Floors and walls shall be finished with a static free treatment or sealed to minimize dust; finishes shall be light in color to enhance room lighting.
- G. Floor loading capacity of ER/TRs shall be at least 50 lb/sq. ft. The architect/engineer shall verify that concentrations of proposed equipment do not exceed the floor loading limit, which may require increasing the floor loading capacity in some cases.

1.11 FIRE PROTECTION

- A. The contractor shall provide fire protection to the room as required by code.
- B. Sprinkler heads, if required, shall be provided with wire cages to prevent accidental operation.

1.12 PATHWAYS AND ROOM PENETRATIONS

- A. The size and number of sleeves, conduits and/or cable trays used for riser and horizontal pathways depends on the requirements of the area served. The size and number of sleeves, conduits and/or cable trays required shall be specified by NI&S.
- B. Sleeves or slots shall not be left open except during cable installation and shall be properly firestopped per applicable codes. The interior of all sleeves or slots shall be firestopped in the ER/TR by The Contractor after cable installation. Red firestopping material shall be used in all cases.
- C. For any multi-story building, Contractor shall provide a schematic riser diagram depicting telecommunications infrastructure to include Outside Plant main feed, OSP redundant feed, riser conduits (noting size and quantity), cable trays and transitions from cable trays to sleeves and a typical station cable conduit and outlet box.

1.13 SUBMITTALS

- A. As-built drawings (as required per Section 270100)

PART 2 – MATERIALS

2.1 EQUIPMENT AND MATERIALS MINIMUM REQUIREMENTS

- A. Floor-Mount Equipment Rack
 - a. Ortronics Mighty Mo 6: OR-MM6716
 - i. 84” high with 44 rack spaces (1 rack space = 1- $\frac{3}{4}$ ”)
 - ii. EIA-310-D standard 5/8” 5/8” 1/2” hole pattern
 - iii. EIA channel width of 16.25” with double-sided 12/24 tapped screw holes.
 - iv. Lightweight high strength aluminum construction with black finish.
 - v. 26.25” deep base with four (4) $\frac{3}{4}$ ” bolt down holes and equipped with hardware for permanent mounting on concrete floor.
 - vi. Static capacity 1500 lbs.
 - vii. Bend radius control with integrated cable trough and waterfalls.
 - viii. Rack installation kit.
- B. Vertical Wire Management
 - a. Ortronics Vertical Wire Management Cage: OR-MM6VML706
 - i. 77.18” high by 6” wide by 6.13” deep.
 - ii. Swing out latches allow for addition/deletion of cables without affecting adjacent cables.
 - iii. Mounted on the front flange of Mighty Mo 6 racks when two or more are installed in a row, on a single rack or the end of a row.
 - iv. Creates a 2” channel between racks for front to back routing of equipment cables and patch cords.
 - v. Includes all mounting brackets.
- C. Vertical Grounding Strip Busbars for New Install Racks and Cabinets:
 - a. Panduit Grounding strip for threaded rails: RGS134-1Y
 - i. Provides clean bond to any rack mounted equipment regardless of whether or not equipment has an integrated grounding terminal.
 - ii. Bonds full 45 RU per rack.
 - iii. Comes in EIA Universal mounting hole pattern.
 - iv. Complies with US and International grounding requirements.
 - v. Busbar Installation kit.
- D. Cable Tray
 - a. Cable tray shall be installed above the racks to facilitate routing of cables from room entrance conduits.
 - b. Carbon steel wiremesh cable tray with electroplated zinc finish:
 - i. 2” Deep, 12” Wide, 10” Length: Cablofil CF54/300EZ
 - c. Include support kits, brackets, splice kits, end caps, etc. as required for complete installation.
- E. Plywood Backboard: $\frac{3}{4}$ ” A-C fire-resistant or non-combustible plywood backboard, void free, 8’ high.
- F. Category 6 compliant $\frac{1}{2}$ D-Rings and D-Rings wall-mount nominal 2” 4” or 6” as required.
- G. Velcro cable ties for cable routing and management as required. The use of “tie-wraps” is prohibited.
- H. Building Entrance Terminals
 - a. Circa BET: 188B1-100-25
 - i. 100 pair capacity
 - ii. 25’ stub in / 110 block out
 - iii. Accepts 5-pin Surge Protection Modules

- b. Circa Surge Protection Modules: 4B1S-300
 - i. 5 PIN solid state protector module.
 - ii. Includes PTC (positive temperature coefficient) technology. Self-resetting current limiters which provide effective protection from 'sneak current' faults.
- I. S110 wiring block – rack mounted
 - a. S110 19” Field Termination Panel (Tie to Building Entrance Protector)
 - i. Siemon S110A2-100RWM
 - b. Siemon S110 19” Field Termination Panel (Copper Riser)
 - i. Siemon S110A2-(XXX)RWM – Use (XXX) to specify 100 or 200 pair panels sized per project.
 - c. 110 blocks shall possess the following characteristics:
 - i. Be made of flame-retardant thermoplastic, with the base consisting of horizontal index strips for terminating up to 25-pairs of conductors.
 - ii. Have detachable stand-off legs on the 100-pair base.
 - iii. Contain access openings for rear to front cable routing to the point of termination.
 - iv. Have termination strips on the base to be notched and divided into 5-pair increments.
 - v. Have clear label holders with the appropriate colored inserts available for the wiring blocks. The insert labels provided with the product shall contain vertical lines spaced on 2-, 3-, 4- and 5-pair circuit sizes and shall not interfere with running, tracing or removing patch cords. Label holders must be capable of mounting between each row of connecting blocks.
 - vi. Bases are attached to 19” panels for rack mounting with cable management hardware.
 - vii. Have connecting blocks used for either the termination of cross-connect (jumper) wire or patch cords. All connecting blocks shall have color-coded tip and ring designation markers and be of single piece construction.
 - viii. Have connecting blocks with a minimum of 200 re-terminations without signal degradation below standards compliance limit.
 - ix. Support wire sizes: Solid 22-26 AWG (0.64 mm - 0.40 mm), and 7-strand wires.
 - b. Must be Communications Circuit Accessory Listed per Underwriters Laboratories Standard UL 1863.
 - c. Meet the following performance specifications:

Parameters	Performance @ 100MHz
Insertion Loss	0.4 dB
NEXT	43.0 dB
FEXT	35.1 dB
Return Loss	20.0 dB

- J. All Category 6 or 6A-termination panels shall facilitate cross-connection and inter-connection using modular patch cords and shall conform to EIA standard, 19-inch relay rack mounting requirements.
 - a. Cat 6 Patch Panel -Siemon: Z6-PNL-24K

- i. Includes 24 Z-MAX™ Panel outlets.
 - ii. Made of lightweight, high strength steel with durable black finish in 24 port 1U configuration.
 - iii. Panel outlets feature angled IDC contact pattern to exploit the widest outlet cross-section to minimize alien crosstalk.
 - iv. Have a quick release lever that allows individual outlets to be easily removed even in tight installations.
 - v. Have port identification numbers on the front of the panel.
 - vi. Accommodate 24 ports for each rack mount space (1RMS = 44.5 mm [1.75 in.]).
 - v. Come equipped with integrated rear wire management system.
 - vi. Be provided with high visibility snap-on magnifying label holders that contain paper labels or Z-MAX icons for port identification.
 - b. Cat 6A Shielded Patch Panel -Siemon: Z6AS-PNL-24K
 - i. Includes 24 shielded Z-MAX™ Panel outlets.
 - ii. Made of lightweight, high strength steel with durable black finish in 24 port 1U configuration.
 - iii. Panel outlets feature angled IDC contact pattern to exploit the widest outlet cross-section to minimize alien crosstalk.
 - iv. Have a quick release lever that allows individual outlets to be easily removed even in tight installations.
 - v. Have port identification numbers on the front of the panel.
 - vi. Accommodate both 24 ports for each rack mount space (1RMS = 44.5 mm [1.75 in.]).
 - v. Come equipped with integrated rear wire management system.
 - vi. Be provided with high visibility snap-on magnifying label holders that contain paper labels or Z-MAX icons for port identification.
- K. Rack Mount Optical Fiber Panel/Enclosure
 - a. Rack-mount fiber cabinet - Optical Cable Corporation (OCC): RTC2U6APB-RS2U2T. Including (1) RS2U2T splice kit
 - i. The rack mount optical fiber panel/enclosure shall be constructed of all steel and equipped with either removable front and rear access to fibers or a sliding drawer to access fibers.
 - ii. The rack mount optical fiber panel/enclosures shall be available with locking capabilities for security.
 - iii. The rack mount optical fiber panel/enclosure shall be capable of terminating tight-buffered or loose tube optical fiber cable.
 - iv. The rack mount optical fiber panel/enclosure shall provide for bend radius control throughout the panel as well as storage space for slack cabling.
 - v. The rack mount optical fiber panel/enclosure shall provide labeling space to facilitate port identification according to TIA 606A standards.
 - vi. The panel/enclosure shall meet or exceed the performance criteria per ANSI/TIA-568-C.3.
 - vii. The rack mount optical fiber panel/enclosure shall be equipped with optical fiber adapter panels and corresponding pre-terminated pigtail fiber optic assemblies.
- L. Optical Fiber Adapter Panels and Pre-Terminated Pigtails

- a. Field terminated fiber connectors will not be accepted. Factory polished pigtail assemblies for all fiber ends must be fusion sliced to the installed cabling.
- b. The multimode optical fiber adapter panels and pre-terminated pigtail fiber optic cable assemblies shall be configured with six dual port multimode SC adapters.
- c. The single-mode optical fiber adapter panels and pre-terminated pigtail fiber optic cable assemblies shall be configured with six dual port single-mode SC APC adapters.
- d. Fiber Adapter Panels
 - i. OCC 6112DSC50G - Adapter Plate, 12-port, Dual SC, 50µm 10GbE Multimode, Composite Sleeve .
 - ii. OCC 6112SMDSCAPC - Adapter Plate, 12-port, Dual SC, Single-mode, Angled Polish, Ceramic Sleeve.
- e. Pre-Terminated Pigtails
 - i. OCC P5GSC12-3M – Factory Terminated Pigtail Assembly, 12-fiber 50µm OM3 Color-Coded 900 µm Multimode Fiber Stock, 3 Meter lengths , Pre-Polished SC Connectors .
 - i. OCC P8SCAPC12-3M – Factory Terminated Pigtail Assembly, 12-fiber Color-Coded 900 µm Single-Mode Fiber Stock, 3 Meter lengths, Pre-Polished SC APC Connectors.

2.2 GROUNDING AND BONDING

- A. #4 and #6 AWG wire suitable for grounding application.
- B. All connectors and clamps shall be compression type.
- C. Terminals shall be solderless compression type, copper long-barrel NEMA two bolt.
- D. Telecommunications Bonding Backbone (TBB): Minimum No. 6 AWG insulated copper conductor.
- E. Telecommunications Main Grounding Busbar (TMGB): Minimum 6.3 mm thick x 100 mm wide predrilled copper busbar with standard NEMA bolt hole sizing and spacing.
- F. Telecommunications Grounding Busbar (TGB): Minimum 6 mm thick x 50 mm wide predrilled copper busbar with standard NEMA bolt hole sizing and spacing.
- G. All grounding equipment shall be UL listed for that purpose.

PART 3 - EXECUTION

3.1 EQUIPMENT RACKS AND CABLE ROUTING HARDWARE IN TELECOMMUNICATIONS ROOMS

- A. The Equipment Rooms (ERs) and Telecommunications Rooms (TRs) may be equipped with some existing hardware, such as plywood backboards, grounding bus bars, equipment racks, ladder cable tray, horizontal and vertical cable management, and copper and fiber termination equipment. Existing hardware already be in place will be shown on the project drawings.
- B. Examine ERs, TRs, and verify conditions are as shown on project drawings. Provide notification in writing of conditions deviating from drawings or detrimental to proper completion of the work.
- C. Beginning of installation in the ERs and TRs indicates contractor acceptance of existing conditions.
- D. The quantity of equipment racks can vary based on the number of outlets being served by each ER/TR. At a minimum provide and install two racks per ER/TR in new construction projects.
 - a. Some renovation projects or smaller new constructions projects may require less than two racks or wall mount type racks. Obtain approval from NI&S prior to

construction for all equipment room designs which include these types of non-standard projects.

- E. The contractor shall obtain NI&S approval of the proposed equipment rack layout prior to installation.
- F. All equipment racks shall be securely anchored to the concrete floor using minimum 3/8" hardware or as specified by rack manufacturer.
- G. Install new vertical wire managers on each side and between all equipment racks.
- H. Install grounding strip on front left side of each equipment rack and bond to TMGB with a minimum No. 6 AWG insulated copper conductor.
- I. Install new cable tray for cable routing in the ERs and TRs above the equipment racks. All cable tray shall be securely anchored to the walls with support kits and brackets as specified by manufacturer.
- J. Install plywood backboard on the walls in the ERs and TRs as required for the project. All plywood backboard shall be securely anchored to the walls.
- K. All new 4-pair UTP cables shall be supported using only Category 6 compliant materials and equipment: cable tray, D-rings, and cable management hardware and shall be manufactured to allow for installation of Category 6 cables without damaging or otherwise distorting the cable's jacket material. All cable management hardware shall allow for cables to be neatly dressed-out in the ERs and TRs.
- L. Bend radius of the multi-pair copper cable shall not exceed 10 times the outside diameter of the cable during installation or at rest.
- M. Place copper cables transitioning between the cable trays and cabinets or racks in a neat and orderly manner per NEC 318.11(b) requirements. Velcro tie-wrap shall be used for supporting multi-pair copper cables.
- N. To reduce untwisting of pairs, maintain the twisted pair cable jacket as close as possible to the point of termination.
- O. Multi-pair Cable: Strip back only as much cable jacket as is minimally required to terminate on connecting hardware.
- P. Use wiring block manufacturer's recommended tools with the proper-sized blades for all multi-pair copper punch downs.
- Q. Bend radius of the optic fiber cable shall not exceed 15 times the outside diameter of the cable during installation and 10 times the outside diameter during rest.
- R. Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
- S. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.
- T. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.
- U. A maximum of 12 strands of fiber shall be spliced in each tray
- V. All spare strands shall be installed into spare splice trays.
- W. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.
- X. Firestop all sleeves and conduit openings after the cable installation is complete.
- Y. All building ERs and TRs require one wall-mount telephone outlet on the plywood backboard.
- Z. The contractor shall obtain NI&S approval of the proposed hardware equipment layout prior to installation.
- AA. NI&S standard rooms have copper termination equipment in the left side rack. Starting at the top with the building entrance tie cable 110 block (ER Only) and then the copper riser

cable 110 blocks (TRs – top position). Install 110 horizontal cable management between each 110 block. Category 6 or 6A patch panels are installed below the 110 blocks.

- BB. Fiber optic panels are installed near the top of the right side equipment rack leaving at least 4 RU space below backbone fiber panels for OSP fiber panels (Installed by others). The remaining space in the ride side rack is reserved for network electronics.

3.2 GROUNDING AND BONDING

- A. Mount new Telecommunications Main Grounding Busbar (TMGB) on plywood backboard in main ER as shown on project drawings. The location for the TMGB shall be coordinated with UDC and NI&S.
- B. Mount new Telecommunications Grounding Busbar (TGB) on plywood backboard in TRs as shown on project drawings. The location for the TGBs shall be coordinated with UDC and NI&S.
- C. Install new Telecommunications Bonding Backbone (TBB) from the TMGB in the ER to the TGBs in the TRs as shown on project drawings. Connect the TBB to the TMGB and TGBs in accordance with TIA-607 and NEC. All grounding conductors leaving the ER and TRs shall be in a separate conduit from all communication cabling.
- D. Bond all metallic surfaces of new racks, cable tray, and equipment in the TRs and ERs to the TGB or TMGB in the same room with #6 AWG grounding wire as straight as possible.
- E. Bond all metallic raceways (conduit, cable tray, etc.) entering the TRs and ERs to the TGB or TMGB in the same room with #6 AWG grounding wire as straight as possible.
- F. All grounding items shall be installed in complete compliance with Division 16 – Electrical (or CSI 2004 Division 26 - Electrical) and NEC.

END OF SECTION 27 11 00

SECTION 27 13 00
BACKBONE CABLING REQUIREMENTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Forms, and Conditions of the Contract, including Construction Manager/General Contractor (CM/GC) Agreement including Exhibits and other Division 1 Specification Sections, apply to this section

1.2 SCOPE OF WORK

- A. Provide all services labor, materials, tools, and equipment required for the complete and proper installation, splicing, and termination of new backbone cabling as called for in these specifications and related drawings.
- B. This section includes minimum requirements and installation methods for the following:
 - a. Copper Backbone Cabling
 - b. Fiber Optic Backbone Cabling
 - c. Fiber Splices
 - d. Factory Polished Fiber Pigtails
 - e. Coax Backbone Cabling

1.3 QUALITY ASSURANCE

- A. All backbone cabling installation, splicing, and termination shall be performed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated shall be subject to the control of NI&S.
- B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval of NI&S based on submittals provided.
- C. Materials and work specified herein shall comply with the applicable requirements of:
 - a. ANSI/NFPA 70 – National Electrical Code (NEC) Articles 250, 300, 645, and 770 (2014 edition of the National Electrical Code®)
 - b. IEEE/NESC – National Electrical Safety Code
 - c. ANSI/TIA-568-C.0-2 – Generic Telecommunications Cabling for Customer Premises – Addendum 2, General Updates
 - d. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard
 - e. ANSI/TIA/EIA-568-C.2 -- Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components
 - f. ANSI/TIA-568-C.3-1 – Optical Fiber Cabling Components Standard
 - g. ANSI/TIA-569-C – Commercial Building Standard for Telecommunications Pathways and Spaces
 - h. ANSI/TIA-598-C – Optical Fiber Cable Color Coding
 - i. ANSI/TIA-604-3 – FOCIS 3 Fiber Optic Connector Intermateability Standard
 - j. ANSI/TIA-606 – Administration Standard for Telecommunications Infrastructure of Commercial Buildings
 - k. ANSI/TIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications
 - l. BICSI Telecommunications Distribution Methods Manual

1.4 SUBMITTALS

- A. As-built drawings (as required per Section 270100)

PART 2 – MATERIALS

2.1 INSIDE COPPER BACKBONE CABLING

- A. Riser Rated Non-Plenum (CMR) Category 3 UTP, 24 AWG (Building Entrance Tie Cable)
 - a. 100-Pair
- B. Riser Rated Non-Plenum (CMR) Category 3 UTP, 24 AWG (ER/TR Tie Cable)
 - a. 25-Pair
 - b. 50-Pair
 - c. 100-Pair
- C. Riser Rated Plenum (CMP) Category 3 UTP, 24 AWG (ER/TR Tie Cable)
 - a. 25-Pair
 - b. 50-Pair
 - c. 100-Pair

2.2 INSIDE FIBER OPTIC BACKBONE CABLING

- A. Riser – Indoor/Outdoor Subgrouping Hybrid 8.3/125-micron, Single-mode Optical Fiber and 50/125-micron, Multimode Optical Fiber Non Conductive Riser (OFNR) Tight-Buffer Bend Tolerant Cable – OCC OC040210-05
 - a. The indoor optical fiber cabling shall include twenty four multi-mode & twenty four single-mode 900-micron tight-buffered 250-micron fibers placed in a color-coded sub-unit bundles helically stranded with aramid strength elements.
 - b. The indoor/outdoor optical fiber cabling shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3 and be UL listed in accordance with NEC section 770.179(a).
 - c. The indoor/outdoor optical fiber cables shall have sequential length markings printed on the cable jacket.
 - d. Operating temperature: -40°C to 85°C
 - e. Flex resistance: 2,000 cycles (TIA/EIA-455-104A)
 - f. Crush resistance: 2,100 N/cm (TIA/EIA-455-41A)
 - g. All single-mode and multimode fibers shall be pigtail spliced into a rack mounted optical fiber enclosure. Field terminations will not be permitted.
 - h. The loss of fiber shall not exceed 1.0 dB per kilometer @ 1550 nm and 1.0 dB per kilometer @ 1310 nm.
- B. Plenum – Indoor/Outdoor Subgrouping Hybrid 8.3/125-micron, Single-mode Optical Fiber and 50/125-micron, Multimode Optical Fiber Non Conductive Plenum (OFNP) Tight-Buffer Bend Tolerant Cable – OCC DX048KZDZ9QP
 - a. The indoor optical fiber cables shall include twenty four multi-mode & 24 single-mode 900-micron tight-buffered 250-micron fibers placed in a color-coded sub-unit bundles helically stranded with aramid strength elements.
 - b. The indoor/outdoor optical fiber cables shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3 and be UL listed in accordance with NEC section 770.179(a).
 - c. The indoor/outdoor optical fiber cables shall have sequential length markings printed on the cable jacket.
 - d. Operating temperature: -40°C to 85°C
 - e. Impact resistance: 1,000 impacts (TIA/EIA-455-25A)
 - f. Crush resistance: 1,500 N/cm (TIA/EIA-455-41A)
 - g. All single-mode and multimode fibers shall be pigtail spliced into a rack mounted

- h. optical fiber enclosure. Field terminations will not be permitted.
The loss of fiber shall not exceed 1.0 dB per kilometer @ 1550 nm and 1.0 dB per kilometer @ 1310 nm.

2.3 INSIDE COAXIAL BACKBONE CABLING

- A. Riser Rated Non-Plenum (CMR or CATVR) RG11 (Series 11), Quad Shield non-flooded cable capable of certification up to 1GHZ.
 - i. Commscope 4564604 | F11SSV
- B. Riser Rated Plenum (CMP or CATVP) RG11 (Series 11), Quad Shield non-flooded cable capable of certification up to 1GHZ.
 - i. Commscope 4103304/10 | 2287K
- C. Connectors used for terminations shall be: Thomas & Betts F11 QS Long shank hex-type crimp Series 11 connectors. Cables and connectors shall be capable of certification up to 1GHZ.

2.4 COAXIAL DEVICES AND EQUIPMENT

- A. Provided and installed by NI&S after coaxial backbone cabling commissioning.

2.5 BACKBONE CABLING INSTALLATION MATERIALS, EQUIPMENT, AND TOOLS

- A. Furnish all required materials, equipment, and tools necessary to properly complete the backbone cabling system installation including, but not limited to: tools for pulling, splicing, and terminating the cables, mounting hardware, cable ties, bolts, anchors, clamps, hangers, kits of consumables, lubricants, communication devices, stands for cable reels, cable winches, etc.
- B. Muletape: Polyester or aramid fiber.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which backbone cabling is to be installed. Provide notification, in writing, of conditions detrimental to proper completion of the work.
- B. Verify field measurements and cable routing and termination conditions are as shown on drawings. Provide notification, in writing, of conditions deviating from drawings.
- C. Beginning of backbone cabling installation indicates Contractor acceptance of existing conditions.

3.2 COPPER UTP BUILDING ENTRANCE TIE & BACKBONE CABLING INSTALLATION

- A. Perform all backbone cabling installation in conformance with manufacturer's installation guidelines.
- B. Ensure that maximum pulling tensions of specified cables are not exceeded and cable bends maintain the proper radius during placement.
- C. Failure to follow appropriate guidelines for cabling installation will require the Contractor to provide, in a timely fashion, the additional material and labor necessary to rectify the situation. This shall apply to any and all damages sustained to the cables during installation.
- D. Field verify all cable measurements and install all backbone cables in such a manner as to avoid any and all mid-span splices. No mid-span splices are allowed except as specified and shown on project drawings.
- E. Pull and secure new muletape through all conduit while pulling new backbone cable.
- F. The Contractor shall be responsible for all damage to the cable during placement.
- G. Do not roll or store cable reels without an appropriate underlay.

- H. All new copper backbone cables shall be attached to the cable pathway systems or plywood backboards with cable ties for strain relief.
- I. Backbone telecommunications cabling shall be placed in dedicated pathways separate from horizontal and other cabling.
- J. Terminate cables so as not to pull tight on terminating equipment.
- K. Ensure that all splice closures are properly sealed for protection of the cable and splices.
- L. Neatly and permanently label all backbone cables with the cable number at both ends and at all splice locations.
- M. Firestop all sleeves and conduit openings after the cable installation is complete.
- N. Plug ends of conduit entering buildings with watertight conduit caulking compound after cable installation is complete to ensure foreign matter does not enter the buildings.
- O. Test, label, and document the final backbone cable installation, including cable footages, on the as-built drawings.

3.3 COPPER UTP BUILDING ENTRANCE TIE & BACKBONE CABLE TERMINATIONS

- A. Install copper UTP backbone cabling through conduit or other pathways as shown on the drawings.
- B. Refer to project drawings for building specific pair count for backbone copper.
- C. Terminate cable pairs on S110 connecting blocks in each ER and TR following the industry standard color code sequence.

3.4 FIBER BACKBONE CABLING

- A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practices.
- B. Backbone cables shall be installed separately from horizontal distribution cables.
- C. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.
- D. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits.
- E. Exposed cables must be OFNP rated if installed in an air return plenum. Riser rated cables shall be installed in metallic conduit if installed in an air return plenum.
- F. Where backbone cables and distribution cables are installed in a cable tray, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.
- G. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.
- H. Vertical runs of cables shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.
- I. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.
- J. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
- K. Each optical fiber cable shall be individually attached to the respective enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
- L. Each optical fiber cable shall be clearly labeled at the entrance to the enclosure. Cables labeled within the bundle shall not be acceptable.

- M. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.
- N. A maximum of 12 strands of fiber shall be spliced in each tray.
- O. All spare fiber strands shall be installed into spare splice trays.
- P. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.
- Q. Perform fusion splicing of multimode fiber strands on SC APC factory polished pigtails with loss ≤ 0.02 dB at 850 nm.
- R. Perform fusion splicing of single-mode fiber strands on SC APC factory polished pigtails with loss ≤ 0.05 dB at 1310 nm.
- S. Terminate fiber strands on connectors and in termination equipment (shelves and panels) as specified in manufacturer's color code sequence.
- T. Place "Caution Fiber" tags every 5' along the fiber cable route within the ER/TR.

3.5 SAFETY

- A. The contractor must comply with VT regulations for asbestos, lead, and confined spaces.

3.6 AS-BUILT DRAWINGS

- A. Mark the project drawings with notations reflecting actual cable lengths and any variations from the base specifications and drawings including as-built cable routing.
- B. Comply with construction drawings as-built requirements as described in Section 27 01 00.

END OF SECTION 27 13 00

SECTION 27 15 00
HORIZONTAL CABLING REQUIREMENTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Forms, and Conditions of the Contract, including Construction Manager/General Contractor (CM/GC) Agreement including Exhibits and other Division 1 Specification Sections, apply to this section

1.2 SCOPE OF WORK

- A. Provide all services, labor, materials, tools, and equipment required for the complete and proper installation and termination of new horizontal “station” cabling as called for in these specifications and related drawings.
- B. The horizontal portion of the telecommunications cabling system extends from the work area telecommunications outlet to the termination in the Telecommunications Room (TR) or Equipment Room (ER).
- C. This section includes minimum requirements and installation methods for the following:
 - a. Copper Horizontal Cabling
 - b. Work Area Faceplates
 - c. Copper Modular Jacks
 - d. Coaxial Horizontal (Drop) Cabling

1.3 QUALITY ASSURANCE

- A. All horizontal “station” cable installation and termination shall be performed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated shall be subject to the control of UDC & NI&S.
- B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval of NI&S based on submittals provided.
- C. Materials and work specified herein shall comply with the applicable requirements of:
 - a. ANSI/NFPA 70 – National Electrical Code including, but not limited to, the following articles:
 - i. 300 – Wiring Methods
 - ii. 645 – Information Technology Equipment
 - iii. 725 – Class 1, Class 2, and Class 3 Remote Control, Signaling, and Power-Limited Circuits
 - iv. 770 – Optical Fiber Cables and Raceways
 - v. 800 – Communications Circuits
 - b. ANSI/TIA/EIA-568-C.0-2 – Generic Telecommunications Cabling for Customer Premises – Addendum 2, General Updates
 - c. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard
 - d. ANSI/TIA-568-B.2 – Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted-Pair Cabling Components, including applicable addendum
 - e. ANSI/TIA/EIA-568-C.3-1 -- Optical Fiber Cabling Components Standard
 - f. ANSI/TIA-569-C – Commercial Building Standard for Telecommunications Pathways and Spaces

- g. ANSI/TIA-604 Series – Fiber Optic Connector Intermateability Standard
- h. ANSI/ICEA S-83-596 – Fiber Optic Premises Distribution Cable
- i. BICSI Telecommunications Distribution Methods Manual

1.4 SUBMITTALS

- A. As-built drawings (as required per Section 27 01 00)

PART 2 – MATERIALS

2.1 COPPER HORIZONTAL CABLING

- A. Category 6, 4-Pair Unshielded Twisted Pair (UTP) Indoor Cabling
 - a. Siemon System 6 Riser Cable 9C6R4-E3-02-R(X)A, White Sheath Color. (X-Indicates Payout System – Contractor may use Reelex or Reel).
 - b. Siemon System 6 Plenum Cable 9C6P4-E3-06-R(X)A, Blue Sheath Color. (X-Indicates Payout System – Contractor may use Reelex or Reel).
 - c. Riser and Plenum rated cable characteristics and specification are as follows:
 - i. Jacket features reverse sequential numbering.
 - ii. Round jacket.
 - iii. Center isolation member reduces NEXT loss by limiting pair-to-pair contact.
 - iv. Be available in both 1000’ reelex boxes and 1000’ reels.
 - v. ISO/IEC 11801:2002 (Category 6), ANSI/TIA 568-C.2 – 2009, UL CMR/CMP and CSA FT4/FT6 standards compliant.
 - vi. Transmission performance verified by UL.
 - vii. RoHS compliant.
 - viii. Meet the following electrical specifications:

DC Resistance	<9.38 Ω/100m
DC Resistance Unbalanced	5%
Mutual Capacitance	5.6 nF/100m
Capacitance Unbalanced	<330 pF/100m
Characteristic Impedance (ohms)	1-100 MHz: 100± 15% 100-520 MHz: 100 ± 22%
NVP	CMP – 70% CMR – 65%
LCL	30-10Log(f/100)dB
Delay Skew	≤ 35ns/100m

- B. Category 6A, 4-Pair Foil over Unshielded Twisted Pair (F/UTP) Indoor Cabling
 - a. Siemon System 6A Riser Cable 9A6R4-A5-05-R1A, Yellow Sheath Color. (Available Payout System – Reel).
 - b. Siemon System 6A Plenum Cable 9A6P4-A5-06-R1A, Blue Sheath Color. (Available Payout System – Reel).

- c. Riser and Plenum rated cable characteristics and specification are as follows:
 - i. Round cable jacket available in both CMR and CMP options with a nominal cable O.D. of less than or equal to 7.37mm (0.290 in.).
 - ii. Have a construction comprised of 4-pairs of 23AWG solid bare copper conductors utilizing a center isolation member to maintain pair geometry for optimal NEXT performance.
 - iii. Have a Mylar tape surrounding the cable pairs with a drain wire with an aluminum foil tape surrounding the drain wire.
 - iv. Have a rip cord installed under the jacket for jacket removal.
 - v. Be available in both 1000' and 3000' reels.
 - vi. ISO/IEC 11801Ed 2.2, IEC 61156-5 Ed 2.0, ANSI/TIA 568-C.2, UL CMR/CMP and CSA FT4/FT6 standards compliant.
 - vii. Transmission performance verified by UL.
 - viii. RoHS compliant.
 - ix. Meet the following electrical specifications:

DC Resistance	<17.0 Ω /100m
DC Resistance Unbalanced	5%
Mutual Capacitance	5.6 nF/100m
Capacitance Unbalanced	<330 pF/100m
Characteristic Impedance (ohms)	1 \leq f \leq 100: 100 \pm 15% 100 \leq f \leq 750: 100 \pm 22%
NVP	CMP - 72% CMR - 68%
LCL	30-10Log(f/100)dB
Delay Skew (ns)	\leq 45

2.3 COAXIAL HORIZONTAL CABLING AND CONNECTORS

- A. Coaxial RG-6, Quad Shield capable of certification up to 1GHZ.
 - a. Inside Rated (CM or CATV), White Sheath Color.
 - i. General Cable C5889.41.02
 - b. Plenum Rated (CMP or CATVP), White Sheath Color.
 - i. General Cable C3525.41.86
 - c. Connectors used for terminations shall be: Thomas and Betts Snap-N-Seal 360-degree true radial compression connectors. Hex-crimp connectors will not be accepted. Cable and connectors shall be capable of certification up to 1GHZ.

2.4 WORK AREA FACEPLATES

- A. Double Gang, Stainless Steel CT-Style Faceplate for Category 6 Option
 - a. Siemon CT-8-FP-SS-L
 - i. Allow couplers to be removed from the front of the faceplate.
 - ii. Allow UTP couplers to pass through faceplates even after termination.

- iii. Have write-on designation labels for circuit identification together with a clear plastic cover.
 - iv. Easily removable designation label covers which can be removed without use of tools.
 - v. Have optional modular furniture adapters available.
 - vi. Must be Communications Circuit Accessory Listed per Underwriters Laboratories Standard UL 1863.
- B. Double Gang, Stainless Steel MAX-Style Faceplate for Category 6A Option
- a. Siemon MX-FP-S-06-SS-L
 - i. Outlet to be 6-port double-gang configuration.
 - ii. Allow modules to be removed from the front of the faceplate.
 - iii. Allow UTP modules to pass through faceplates even after termination.
 - iv. Have write on designation labels for circuit identification together with a clear plastic cover.
 - v. Feature easily removable designation label covers which can be removed without use of tools.
 - vi. Have optional modular furniture adapters available.
 - vii. Faceplate to be stainless steel versions with designation label option.
 - viii. Must be certified by Underwriters Laboratories to United States Standards.

2.5 COPPER MODULAR JACKS

- A. Category 6, 8-Position, 8-Conductor UTP Outlet
- a. Siemon CT6 Coupler CT-C6-XX (XX-Indicates outlet Color Coordinate with Architect and UDC prior to ordering for project)
 - i. Be available in black, white, red, gray, yellow, blue, green, orange, ivory, bright white, light ivory and alpine white.
 - ii. Have available a gravity-feed (45 degree angled) design with angled shroud to protect connection and help control patch cord bend radius.
 - iii. Utilizes TRI-BALANCE™ technology with optimized pair balance design and linear crosstalk response to address applications up to 250 MHz.
 - iv. Have 310 style insulation displacement connectors with quadrant pair isolation and a Pyramid™ wire entry system.
 - v. Allow termination with a single conductor impact tool.
 - vi. Modules should feature category markings on front and rear of outlet.
 - vii. Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity.
 - viii. Have rear protective strain relief caps with side or rear entry, which can be installed onto cable before or after termination.
 - ix. Support industry standards for T568A or T568B wiring options on each individual outlet.
 - x. Be removable from the front with the faceplate mounted in place.
 - xi. Must have a hinged door option on angled version for areas having excessive airborne contaminants.

- xii. Provide color-coded snap-in icons available for circuit identification.
 - xiii. Be constructed of high impact, flame-retardant thermoplastic.
 - xiv. Allow for a minimum of 200 terminations without signal degradation below standards compliance limits.
 - xv. Must be certified by Underwriters Laboratories to United States Standards.
- B. Category 6A, 8-Position, 8-Conductor F/UTP Outlet
- a. Siemon Z-Max Shielded Outlet Z6A-S(XX) (XX-Indicates Outlet Color – Coordinate with Architect and UDC prior to ordering for project).
 - i. Exceed category 6A component compliance through the frequency range of 1 to 250MHz with usable bandwidth to 500MHz.
 - ii. Provide full integration of cable shielding through the termination process of the outlet.
 - iii. Be available in black, white, red, gray, yellow, blue, green, orange, ivory, bright white, light ivory and alpine white.
 - iv. Universal design allows the same outlet to be mounted in flat or angled orientation.
 - v. Terminate with a Siemon Z-tool to ensure fast and simple terminations.
 - vi. Have an available spring door allowing one handed operation.
 - vii. Have a lacing module that offers linear lacing and zero-cross termination, which eliminates pair crossing.
 - viii. Have available termination tool included with each box of 20 outlets
 - ix. Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity.
 - x. Support industry standards for T568A or T568B wiring options on each individual outlet.
 - xi. Allow installation from the front or rear of the faceplate, and allow for the jack to pass through the faceplate without re-termination.
 - xii. Provide color-coded, snap-in icons available for circuit identification.
 - xiii. Allow for a minimum of 5 terminations without signal degradation below standards compliance limits.
 - xiv. Have a bezel constructed of high impact, glass reinforced nylon.
 - xv. Have, as an option, an outlet, which can be mounted into an IEC 60603-7 compliant opening (keystone).
 - xvi. Must be certified by Underwriters Laboratories to United States Standards.

2.6 INSTALLATION MATERIALS, EQUIPMENT, AND TOOLS

- A. Furnish all required materials, equipment, and tools necessary to properly complete the horizontal copper and CATV coaxial cabling system installation including, but not limited to: tools for pulling and terminating the cables, mounting hardware, Velcro cable ties (plastic tie wraps will not be accepted), bolts, anchors, clamps, hangers, kits of consumables, lubricants, communication devices, stands for cable reels, cable wenchers, etc.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which horizontal cable is to be installed. Provide notification, in writing, of conditions detrimental to proper completion of the work.
- B. Verify cable routing and termination conditions are as shown on drawings. Provide notification, in writing, of conditions deviating from drawings.
- C. Beginning of horizontal cable installation indicates Contractor acceptance of existing conditions.

3.2 HORIZONTAL CABLING INSTALLATION

- A. Install faceplates and copper jacks at each work area outlet location as indicated on the project drawings. Place the jacks in the faceplates beginning with position A and placing the copper jacks before the CATV coaxial adapter jacks. Place blank covers in the unused openings on each faceplate. Faceplates shall be secured with mechanical fasteners. Adhesive fasteners shall not be allowed.
- B. Unless otherwise noted on project drawings, each portal (station location) will be fed with one Cat 6 or Cat 6A cable as directed per project design.
- C. Each Wireless Access Point will be fed with two Cat 6 or Cat 6A cables as directed per project design.
- D. Each Message Board will be fed with one Cat 6 or Cat 6A cable as directed per project design.
- E. Each Indoor Emergency Phone will be fed with one Cat 6 or Cat 6A cable as directed per project design.
- F. Copper cabling to Outdoor Emergency Phone locations will be provided by NI&S.
- G. Install copper cable from each work area outlet location indicated on the drawings to the nearest TR or ER as indicated on the project drawings.
- H. Perform all horizontal cable installation in conformance with manufacturer's installation guidelines.
- I. Ensure that maximum pulling tensions of specified cables are not exceeded and cable bends maintain the proper radius during placement.
- J. For outlet locations in walls, floor, and overhead, the horizontal cable distribution design uses conduit or surface raceway to the outlet location with conduit, surface raceway, and/or cable tray in the ceiling space to the TR or ER. Coordinate as necessary with electrical contractor for placement of horizontal cable pathways and outlet boxes.
- K. Horizontal telecommunications cabling shall be placed in dedicated pathways separate from backbone and other cabling.
- L. All horizontal cabling terminating within a single faceplate must be routed to and terminated in the same ER or TR.
- M. Install new Poly line in all conduits while pulling in new horizontal cables.
- N. Ceiling tile shall be removed as necessary for the cable installation and put back in place without damaging or dirtying any of the tiles or supporting framework. Ceiling tile shall be handled with clean hands so that no fingerprints or marks are left on the tiles. The contractor is responsible for the cost of repair or replacement of any damaged or dirtied tiles or ceiling hardware.
- O. For cable penetration of ceiling tiles, the holes must be placed along the ceiling tile edge.
- P. All cables in the ceiling space:
 - a. Shall be supported in conduit or in the cable tray and shall not droop or hang outside of cable tray.
 - b. Shall not be run "wild" (unsupported by conduit or cable tray) for distances greater than six inches.
 - c. Shall not be attached to the suspended ceiling structure or laid directly on the ceiling grid as a means of support.

- d. Shall not be supported by or attached by any means to fire sprinkler heads or delivery systems, any environmental sensor, or the exterior of any conduit or raceway.
- e. Shall be routed at right angles to the electrical power circuits where the cable is not enclosed in conduit or in cable tray.
- Q. The total length of any horizontal station cable from the jack location to the equipment room termination panel shall not exceed 90 meters.
- R. Maintain the following clearances from EMI sources:
 - a. Unshielded power lines or equipment less than or equal to 5 kVA near cable in open or non-metal pathway: 12”.
 - b. Unshielded power lines or equipment greater than 5 kVA near cable in open or non-metal pathway: 24”.
 - c. Unshielded power lines or equipment less than or equal to 5 kVA near cable in grounded metal pathway: 6”.
 - d. Unshielded power lines or equipment greater than 5 kVA near cable in grounded metal pathway: 12”.
 - e. Power lines enclosed in grounded metal conduit less than or equal to 5 kVA near cable in grounded metal pathway: 3”.
 - f. Power lines enclosed in grounded metal conduit greater than 5 kVA near cable in grounded metal pathway: 6”.
 - g. Fluorescent fixtures near cable in open or non-metal pathway: 12”.
 - h. Fluorescent fixtures near cable in grounded metal conduit: 6”.
 - i. Motors or transformers near cable in non-metal pathway: 48”.
 - j. Motors or transformers near cable in grounded metal pathway: 36”.
- S. Manage slack to avoid excess cable or kinking.
- T. Do not splice or bridge tap the cable.
- U. All cables shall be tied and dressed neatly with a minimum bend radius of 10 times the cable diameter. Provide necessary hardware to maintain proper bend radius at corners.
- V. All cables shall be firmly held in place. Fastenings and supports shall be adequate to support loads with ample safety factors.
- W. Where cable ties or other fastening devices are utilized, the Contractor shall ensure that the cables are not deformed by over tightening. Mechanical cable tie installation tools are not allowed. The use of Velcro-type cable ties is required. Plastic ties will not be accepted.
- X. Failure to follow appropriate guidelines for cable installation will require the Contractor to provide, in a timely fashion, the additional material and labor necessary to rectify the situation. This shall apply to any and all damages sustained to the cables during installation.
- Y. The Contractor shall be responsible for all damage to the cable during placement.
- Z. Cables with jackets that are chaffed or burned exposing internal conductor insulation or have any bare copper (shiners) shall be replaced.
- AA. Do not roll or store cable reels without an appropriate underlay.
- BB. Neatly and permanently label all horizontal cables with the cable number at both ends.
- CC. Firestop all sleeves and conduit openings after the cable installation is complete.
- DD. Test, label, and document final horizontal cable installation including outlet numbering on as-built drawings.
- EE. Remove existing cable and terminations that will no longer be used as specified and shown on project drawings. Coordinate as necessary with electrical contractor for removal of existing horizontal cable pathways and outlet boxes.

3.3 COPPER CABLE TERMINATION

- A. At the work area outlet and the jack panel in the ER/TR, terminate all pairs of the each copper horizontal cable on the jack with TIA T568B pin-pair assignments.
- B. All un-used Category 6 or Category 6A jack inserts packaged with the jack panels in the ER/TR are to be left in the manufacturer's original packaging and attached to the rack or wire manager for future cabling installations.
- C. Terminate all pairs of each copper horizontal cable.
- D. All cables shall be terminated so as not to pull tight on the terminating equipment.
- E. Do not untwist cable pairs more than 0.5 inches when terminating.

3.4 COAXIAL HORIZONTAL CABLING

- A. All drops are to be home-run from the nearest TR/ER to the face plate with no drop splitters or amplifiers to be used.
- B. Drop connectors shall be compression type as listed in the previous section "Part 2 - Products" above. "Hex-crimp" connectors are not allowed.
- C. Connector type is to be determined by the jacket material of the cable being terminated.

3.6 AS-BUILT DRAWINGS

- A. Mark the project drawings with notations reflecting actual cable outlet numbering and any variations from the base specifications and drawings.
- B. Comply with Construction Drawings AS-BUILT Requirements in Section 27 01 00.

END OF SECTION 27 15 00

SECTION 27 17 00
TESTING, IDENTIFICATION AND ADMINISTRATION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Forms, and Conditions of the Contract, including Construction Manager/General Contractor (CM/GC) Agreement including Exhibits and other Division 1 Specification Sections, apply to this section

1.2 SCOPE OF WORK

- A. Provide all services, labor, materials, tools, and equipment required for complete and proper testing, certification, identification, and administration of the installed telecommunications cabling as called for in these specifications and related drawings.
- B. This section includes minimum requirements and installation methods for the following:
 - a. Copper Cable Testing and Testers
 - b. Fiber Optic Cable Testing and Testers
 - c. Labels and Labeling
 - d. Documentation
- C. NI&S will provide the outlet numbers (H-Links) to the Contractor upon request. The Contractor must request this information at least four weeks prior to installing horizontal cabling. Requests for H-Links should be made through the UDC Project Manager.

1.3 QUALITY ASSURANCE

- A. All testing procedures and testers shall comply with applicable requirements of:
 - a. ANSI/TIA-568-C.0-2 – Generic Telecommunications Cabling for Customer Premises – Addendum 2, General Updates
 - b. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard
 - c. ANSI/TIA-568-B.2 – Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted-Pair Cabling Components, including applicable addendum
 - d. ANSI/TIA/EIA-568-C.3-1 -- Optical Fiber Cabling Components Standard
 - e. TIA-455 Series – Fiber Optic Test Procedures
 - f. TIA-526 Series – Optic Fiber Systems Test Procedures
 - g. TSB 140-04 – Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems
- B. Identification and administration work shall comply with applicable requirements of:
 - a. ANSI/TIA-568-C.0-2 – Generic Telecommunications Cabling for Customer Premises – Addendum 2, General Updates
 - b. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard
 - c. ANSI/TIA-568-B.2 – Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted-Pair Cabling Components, including applicable addendum
 - d. ANSI/TIA-568-C.3-1 – Optical Fiber Cabling Components Standard
 - e. ANSI/TIA-569-A – Commercial Building Standard for Telecommunications Pathways and Spaces
 - f. ANSI/TIA-598-A – Optical Fiber Cable Color Coding
 - g. ANSI/TIA-606 – Administration Standard for Telecommunications Infrastructure of Commercial Buildings

h. BICSI Telecommunications Distribution Methods Manual

1.4 SUBMITTALS

- A. Test reports
- B. As-built drawings (as required per Section 270100)

PART 2 – MATERIALS

2.1 MULTI-PAIR BACKBONE CABLING AND CATEGORY 6 TESTING

- A. All category 6 field-testing shall be performed by The Contractor with an approved level III balanced twisted-pair field test device.
- B. All multi-pair UTP backbone cables shall be 100% tested by The Contractor for continuity.
- C. Category 6 balanced twisted-pair horizontal cables shall be 100 percent tested according to ANSI/TIA/EIA-568-B.1. Test parameters include wire map plus ScTP shield continuity (when present), length, NEXT loss (pair-to-pair), NEXT loss (power sum), ELFEXT loss (pair-to-pair), ELFEXT loss (power sum), return loss, insertion loss, propagation delay, and delay skew.
 - a. Test Equipment Criteria
 - i. All balanced twisted-pair field testers shall be factory calibrated each calendar year by the field test equipment manufacturer as stipulated by the manuals provided with the field test unit. The calibration certificate shall be provided for review prior to the start of testing.
 - ii. Autotest settings provided in the field tester for testing the installed cabling shall be set to the default parameters.
 - iii. Test settings selected from options provided in the field testers shall be compatible with the installed cable under test.
 - b. Provide the following 4-connector guaranteed channel performance:

Parameter	UTP Cat 6 Cable System Performance				
	100 MHz	200 MHz	250 MHz	350 MHz	550 MHz
Insertion Loss (dB)	19.6	28.7	32.6	36.1	51.3
NEXT Loss (dB)	47.3	42.8	41.3	40.1	36.2
PSNEXT Loss (dB)	45.3	40.8	39.3	38.1	34.2
ACR (dB)	27.7	14.1	8.8	4.0	-15.1
PSACR (dB)	25.7	12.1	6.8	2.0	-17.1
ACR-F (dB)	30.8	24.8	22.8	21.3	16.0
PS ACR-F (dB)	28.8	22.8	20.8	19.3	14.0
Return Loss (dB)	22.5	21.0	20.5	20.1	18.8
Propagation Delay (ns)	517.6	516.5	516.3	516.1	515.5

Delay Skew (ns)	≤ 35	≤ 35	≤ 35	≤ 35	≤ 35
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2.2 CATEGORY 6A TESTING

- A. All 500 MHz category 6A field-testing shall be performed by The Contractor with an approved level 111e balanced twisted-pair field test device.
- B. All multi-pair UTP backbone cables shall be 100% tested by The Contractor for continuity.
- C. 500 MHz Category 6A balanced twisted-pair horizontal and backbone cables shall be 100 percent tested according to ANSI/TIA/EIA-568-C.1. Test parameters include wire map plus F/UTP (ScTP) shield continuity (when present), length, NEXT loss (pair-to-pair), NEXT loss (power sum), ELFEXT loss (pair-to-pair), ELFEXT loss (power sum), return loss, insertion loss, propagation delay, and delay skew.
 - a. Test Equipment Criteria
 - i. All balanced twisted-pair field testers shall be factory calibrated each calendar year by the field test equipment manufacturer as stipulated by the manuals provided with the field test unit. The calibration certificate shall be provided for review prior to the start of testing.
 - ii. Autotest settings provided in the field tester for testing the installed cabling shall be set to the default parameters.
 - iii. Test settings selected from options provided in the field testers shall be compatible with the installed cable under test.
 - b. Provide the following 4-connector guaranteed channel performance:

Parameter	UTP Cat 6A Cable System Performance								
	100 MHz	200 MHz	250 MHz	300 MHz	400 MHz	500 MHz	550 MHz	625 MHz	700 MHz
Insertion Loss (dB)	19.8	29.0	32.8	36.4	43.0	48.9	51.8	55.8	62.3
NEXT Loss (dB)	44.3	39.8	38.3	37.1	35.3	33.8	33.2	32.4	31.2
PSNEXT Loss (dB)	42.3	37.8	36.3	35.1	33.3	31.8	31.2	30.4	29.2
ACR (dB)	24.5	10.8	5.5	.07	-7.8	-15.1	-18.6	-23.5	-31.1
PSACR (dB)	22.5	8.8	3.5	-1.3	-9.7	-17.1	-20.6	-25.5	-33.1
ACR-F (dB)	27.8	21.8	19.8	18.3	15.8	13.8	13.0	11.9	10.3
PS ACR-F (dB)	24.8	18.8	16.8	15.3	12.8	10.8	10.0	8.9	7.3
Return Loss (dB)	20.1	18	17.3	16.8	15.9	15.2	14.9	14.5	14.0
Propagation Delay (ns)	538.0	537.0	536.0	536.0	536.0	536.0	536.0	535.0	535.0

Delay Skew (ns)	≤ 45	≤ 45	≤ 45	≤ 45	≤ 45	≤ 45	≤ 45	≤ 45	≤ 45
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2.2 OPTICAL FIBER CABLE TESTERS

- A. Field test instruments for multimode fiber cabling shall meet the requirements of ANSI/TIA/EIAA-526-14-A.
- B. Field test instruments for single-mode fiber cabling shall meet the requirements of ANSI/TIA/EIAA-526-7.
- C. Multimode Light Source
 - a. Meet the launch requirements of ANSI/TIA-455-78B achieved within the field test equipment or by use of an external mandrel wrap (as described in clause 6.4 of ANSI/TIA-568-C.0) with a Category 1 light source.
 - b. Provide stabilized 850 nm and 1300 nm +/- 20 nm wavelength LED light source.
 - c. Spectral width of sources shall be ≤ 50 nm of 850 nm wavelengths and ≤ 140 nm for 1300 nm wavelengths.
 - d. Output of light source shall be 8 MW for 62.5 or 50 μm core optical fiber as appropriate.
 - e. Output stability +/- 0.40 dB from 0 to 50 degrees C.
 - f. Long term output stability +/- 0.10 dB at 25 degrees C.
 - g. Connector types shall include: SC.
- D. Single-mode Light Source
 - a. Provide stabilized 1310 nm and 1500 nm +/- 20 nm wavelength Laser light source.
 - b. Output stability +/- 0.40 dB from 0 to 50 degrees C.
 - c. Long term output stability +/- 0.10 dB at 25 degrees C.
 - d. Connector types shall be SC APC.
- E. Optical Power Meter
 - a. Calibrated against National Institute of Standards and Technology (NIST) standard.
 - b. Provide 850 nm, and 1300 nm +/- 20 nm selectable wavelength test capability.
 - c. Measurement range from 10 to -60 dBm.
 - d. Accuracy +/- 5% at 0 to 50 dBm.
 - e. Accuracy +/- 10% 10 to 0 dBm and -50 to -60 dBm.
 - f. Resolution 0.01 dB.
 - g. Connector types shall include: SC .
- F. Optical Time Domain Reflectometer (OTDR)
 - a. Dual selectable wavelength: 850/1300 nm for multimode.
 - b. Dual selectable wavelength: 1310/1550 nm for single-mode.
 - c. Selectable Cable Index of Refraction.
 - d. Visual fault locator for continuity checks and dead zone fault location.
 - e. Front display and printer connection for hard-copy documentation.
 - f. Equipped with launch jumper cable of sufficient length to offset entry "dead zone".
 - g. Connector types shall include: SC and SC APC.

2.3 LABELS

- A. Faceplate labels shall be printed and supplied by the Contractor with a Dymo Electronic Labelmaker 5000 or equivalent with prior approval from NI&S.

- C. Labels for cable marking: vinyl substrate with a white printing area and a clear “tail” that self laminates the printed area when wrapped around the cable. If cable jacket is white, provide cable label with printing area that is any other color than white, so that the labels are easily distinguishable.
- D. Pre-printed labels shall meet legibility, defacement, exposure and adhesion requirements of UL 969.
- E. Hand written labels are not allowed.

PART 3 - EXECUTION

3.1 COPPER CABLE TESTING

- A. Test 100% of installed backbone copper cabling for:
 - a. Wire Map
 - b. Length
- B. Perform the following Permanent Link tests for 100% of installed Category 6 and Category 6A horizontal cabling as described in ANSI/TIA-568-C.1, Section 6.3 and ANSI/TIA-568-B.2, Annex E:
 - a. Wire Map
 - b. Length
 - c. Insertion Loss
 - d. Pair-To-Pair NEXT Loss
 - e. Propagation Delay
 - f. Delay Skew
- C. Perform the following Permanent Link tests for 100% of installed Category 6 and Category 6A horizontal copper cabling as described in ANSI/TIA-568-C.0, Section 6.3 and ANSI/TIA-568-B.2 Annex E:
 - a. PSNEXT Loss
 - b. Pair-To-Pair ELFEXT
 - c. PSELFEXT
 - d. Return Loss
- D. Cross-connects from horizontal to backbone cabling will not be in place for these tests.
- E. The wire map test shall verify pair to pin termination at each end and check for connectivity errors. The wire map shall indicate the following for each of the eight conductors:
 - a. Continuity to the remote end
 - b. Shorts between any two or more conductors
 - c. Reversed pairs
 - d. Split pairs
 - e. Transposed pairs
 - f. Any other miswiring
- F. The maximum length of the permanent link for horizontal cable shall be 90 meters. Shorten any cable runs as required at no additional cost to the project.
- G. Replace and or repair cable and terminations as necessary to assure 100% passing performance specifications.
- H. Final testing shall be scheduled and conducted in the presence of the NI&S & cable manufacturer’s representative as specified in Section 270100.
- I. Submit electronic and printed test results reports for each multi-pair backbone copper cable to NI&S (through the UDC PM).

- J. Submit electronic and printed test results reports for each copper cabling permanent link to both NI&S (through the UDC PM) and horizontal copper system manufacturer per Siemon Structured Cabling System warranty requirements.

3.2 OPTICAL FIBER CABLE TESTING

- A. Test all installed fiber optic strands after splicing and termination with an OTDR (Optical Time-Domain Reflectometer) per TIA-455-61 and TSB-140:
 - a. End-to-end bi-directional signature trace with fault finding, connection point reflections, fiber bend, pressure point locations, etc.
 - b. One wavelength, 1300 nm for multimode strands.
 - c. One wavelength, 1550 nm for single-mode strands.
 - d. Multimode fiber connector losses ≤ 0.5 dB at 850 nm.
 - e. Single-mode fiber connector losses ≤ 0.2 dB at 1310 nm.
 - f. Multimode fiber splice losses ≤ 0.3 dB at 850 nm.
 - g. Single-mode fiber splice losses ≤ 0.2 dB at 1310 nm.
 - h. Localized attenuation shall not exceed 0.5 dB at any point.
- B. Test link attenuation of all installed fiber optic strands after splicing and termination in accordance with ANSI/TIA-568-C.0, Section 6.4 and Annex E, and TSB-140.
 - a. One direction with an optical light source and an optical power meter.
 - b. Test at two wavelengths to account for attenuation differences due to wavelength:
 - i. 850 nm and 1300 nm for multimode strands
 - ii. 1310 nm and 1550 nm for single-mode strands
 - c. Test multimode strands in accordance with TIA-526-14-A, Method B, One Reference Jumper.
 - d. For multimode strands, wrap reference jumper around mandrel to remove high-order mode transient losses as specified in ANSI/TIA-568-C.0, Section 6.4, Table 3.
 - e. Test Single-mode strands in accordance with TIA-526-7, Method A.1, One Reference Jumper.
 - f. The total attenuation budget for each fiber cable length (end-to-end) shall equal the allowed attenuation for the fiber (0.2 dB per km times the length in km) plus the attenuation for each splice and connector. For example, a cable length of 3 km with 1 splice and 2 connectors would have an attenuation budget of $(3 \text{ km} \times 0.2 \text{ dB/km}) + (1 \times 0.2 \text{ dB}) + (2 \times 0.2 \text{ dB}) = 1.2 \text{ dB}$.
- D. Fibers that are broken or damaged shall be replaced at no cost to VT and replaced fiber optic cables shall be re-tested.
- E. Final testing shall be scheduled and conducted in the presence of the NI&S and cable manufacturer's representative as specified in Section 27 01 00.
- F. Submit electronic and printed OTDR test results reports for each fiber optic cable strand to both NI&S (through the UDC PM) and fiber system manufacturer per OCC fiber warranty requirements.

3.3 HORIZONTAL CABLE IDENTIFICATION AND LABELING:

- A. Neatly and permanently label all copper and fiber optic cables with the cable number at both ends within 2" of termination end.
- B. NI&S provided standard outlet numbers (H-Links) are to be used for labeling faceplates, 110-blocks, patch panels, and fiber terminations.

3.4 AS-BUILT DRAWINGS

- A. Mark the project drawings with notations reflecting any variations from the base specifications and drawings including as-built numbering for the outlets on the floorplans.
- B. As-built drawings must include the NI&S provided H-Link outlet information as described in this Section.
- C. Comply with Construction Drawings AS-BUILT Requirements as described in Section 27 01 00.

END OF SECTION 27 17 00

SECTION 10 17 16
EMERGENCY TELEPHONE ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

- A. A number of “push-to-talk” emergency phones may be located within the project limits. The number and location of the phones is determined by the Office of Emergency Management and the VT Police Department. The physical requirements for the infrastructure to support the phones are found on the attached drawings and in the following specifications.
- B. Equipment and materials used shall be standard components that are manufactured and available for purchase as standard replacement parts as long as the product is commercially available from the manufacturer.

1.2 QUALITY ASSURANCE

- A. All tower installation, configurations, setup, program and related work shall be performed by electronic technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.
- B. The tower shall be warrantied against any defects in material and workmanship under normal use for a period of five (5) years from date of installation, provided that manufacturer receives a completed "Installation Certification" certifying the date on which the system has been installed. An "Installation Certification" card shall be enclosed with every unit. In the event that no "Installation Certification" is received by manufacturer, the five (5) years will commence on the date of shipment by the manufacturer.
- C. The blue light and faceplate light shall be warrantied against any defects in material and workmanship under normal use for a period of twenty-four (24) months from date of installation, provided that manufacturer receives a completed "Installation Certification" certifying the date on which the system has been installed. An "Installation Certification" card shall be enclosed with every unit. In the event that no "Installation Certification" is received by manufacturer, the twenty four (24) months will commence on the date of shipment by the manufacturer.

1.3 CERTIFICATIONS AND STANDARDS

- A. The tower (Talk-A-Phone model: ETP-MT) as an assembly shall be certified to:
 - a. UL Std 60950-1
- B. The included LED blue light (Talk-A-Phone model: ETP-EL or ETP-EL12/24) shall be certified to:
 - a. UL Std 1598
 - b. CSA Std C22.2 No. 250.0

PART - 2 PRODUCTS

2.1 GENERAL

- A. The tower shall:
 - a. Consist of a highly vandal-resistant free-standing steel emergency phone tower mount with an integrated flashing LED blue light. Have an integrated LED faceplate light, mounted directly above the phone faceplate.

2.2 HARDWARE

- A. The tower shall:

- a. Be constructed of 0.25" thick steel and weigh approximately 300 lbs.
- b. Measure:
 - i. Tower only: 10" W x 8" D x 108" H, with a 0.5" radius on each corner.
 - ii. Tower and Blue Light: 10" W x 8" D x 114" H.
- c. Utilize a high-gloss, multi-coat, corrosion-inhibitive coating that shall be applied to withstand prolonged exposure to hard environments.
 - i. Tower shall be sandblasted to SSPC-6 standards before a 2-3 mil layer of rust-inhibitive primer is applied.
 - ii. Tower shall be hand sanded for smoothness before a second 2-3 mil layer of primer is applied.
 - iii. Tower shall have a 2-3 mil layer of dark bronze color coat applied.
 - iv. Tower shall have a 1-2 mil layer of clear coat applied.
- B. The tower base plate shall:
 - a. Be 2.0" above the tower base.
 - b. Be constructed of 0.75" thick A-36 Structural Steel.
 - c. Have a 4" diameter center hole for wiring access.
 - d. Have four 1" holes for anchor bolt attachment.
- C. The tower wiring access opening shall:
 - a. Measure 9"H x 6.75" W.
 - b. Be located 15" above the base of the tower.
 - c. Have a flush cover plate that shall:
 - i. Be constructed of 0.25" thick steel.
 - ii. Be held in place by two 1/4"-20 countersunk, tamper-resistant spanner screws.
- D. The tower shall have an opening in the front to accommodate flush mounting an emergency phone. The phone opening shall:
 - a. Measure 10" H x 6.75" W.
 - b. Have six self-clinching #10-24 stainless steel threaded nuts to mount the emergency phone.
- E. Directly below the tower phone opening, the tower shall have a section with a 30° downward slope from rear to front, spanning the depth of the phone opening to the full tower depth.
- F. The tower shall have the word "EMERGENCY" emblazoned on all four sides in 3.25" high reflective white letters. Custom lettering, sizes and colors are available.
- G. The tower blue light shall:
 - a. Be mounted at the top of the tower with three #10-24 tamper-resistant spanner screws.
 - b. Have a polycarbonate refractor lens assembly with a prismatic pattern to increase visibility at greater distances.

2.3 FUNCTIONALITY

- A. Blue Light
 - a. The LED blue light shall remain lit at all times.
 - b. The blue light shall automatically flash 78 times per minute when triggered by the emergency phone.
 - c. The blue light shall have an illumination rating of 209 lumens (peak).
 - d. The blue light shall retain 70% of its initial output intensity after 50,000 hours of operation.
- B. Faceplate Light
 - a. The faceplate light shall remain lit at all times.

- b. The faceplate light shall have a concealed, ultra-bright LED design.
- c. The faceplate light LEDs shall have no less than 50,000 hour lifetime.

2.4 POWER REQUIREMENTS

- A. The tower shall be powered by one of the following power sources:
 - a. 12VDC – Nominal: 9 Watts
 - b. 24VDC – Nominal: 9 Watts
 - c. 24VAC – Nominal: 9 Watts
 - e. 120VAC – Nominal: 9 Watts

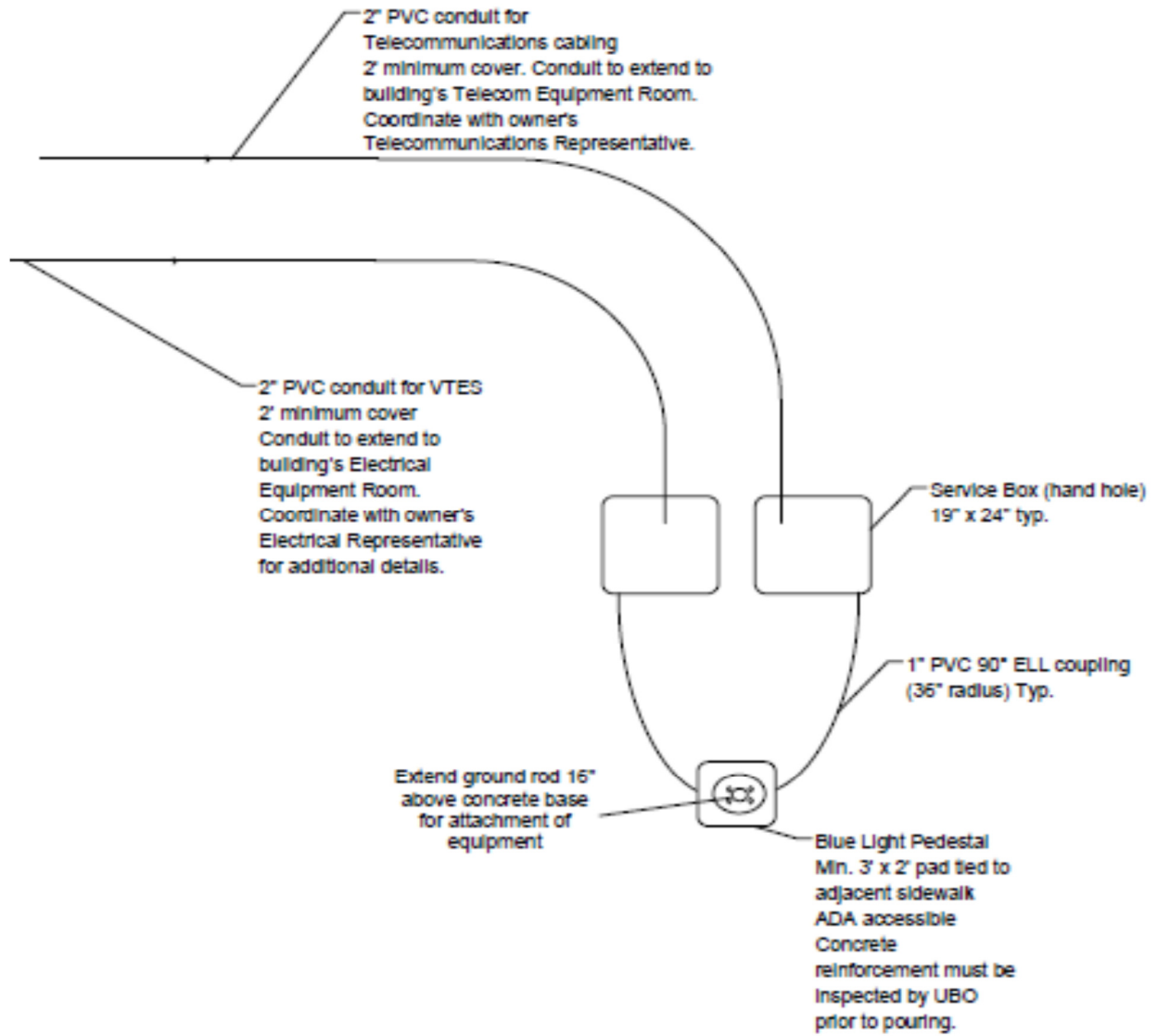
2.5 MANUFACTURED UNITS

- A. The tower shall be a Talkaphone ETP-MT Emergency Telephone Tower to match existing equipment specified by VTPD & The Office of University Planning

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall carefully follow instructions in documentation provided by the manufacturer to ensure all steps have been taken to provide a reliable, easy-to-operate system.
- B. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
- C. The tower shall include 24-inch long J-bolts for mounting into a minimum 36” wide by 24” long by 36” deep reinforced concrete foundation.
- D. The J-bolts shall protrude approximately 5 inches from the surface of the foundation.
- E. Provide and install all necessary conduit pathway and infrastructure as noted in the drawing attached.
- F. Telecommunications cabling to be installed by NI&S under separate contract.
- F. Power to the telephone tower is to be provided by the EC / GC under separate contract.
 - a. EC / GC to consult tower manufacturer’s recommendations for power requirements.
- G. Conduit pathways including service / pull boxes locations are to be designed by EC / GC during site plan coordination.
 - a. Conduit pathway installation detail (next page):



END OF SECTION 10 17 00