UTAH VALLEY UNIVERSITY™

TELECOMMUNICATIONS & A/V CONSTRUCTION GUIDE SPECIFICATION

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Approved by: Eddie Sorensen 5-1-13
IT Infrastructure Services — Date
Eddie Sorensen, Sr. Director

Approved by: Frank Young 5/1/13
Facilities / Engineering — Date
Frank Young, Sr. Director

Prepared by:

Utah Valley University
Information Technology Services

and

SUMMIT
Engineering & Consulting P.S.

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1 Preface

1.1 Introduction

A. The Construction Guide Specification (CGS) is written to communicate the requirements of Utah Valley University (UVU) for the installation of technology infrastructure and systems at UVU facilities.

B. The CGS is written for an audience of Architects, Engineers and Designers who are responsible for the design of new or remodeled facilities for UVU where telecommunications distribution systems currently exist or will be installed. It is intended to assist in developing specifications for a particular project.

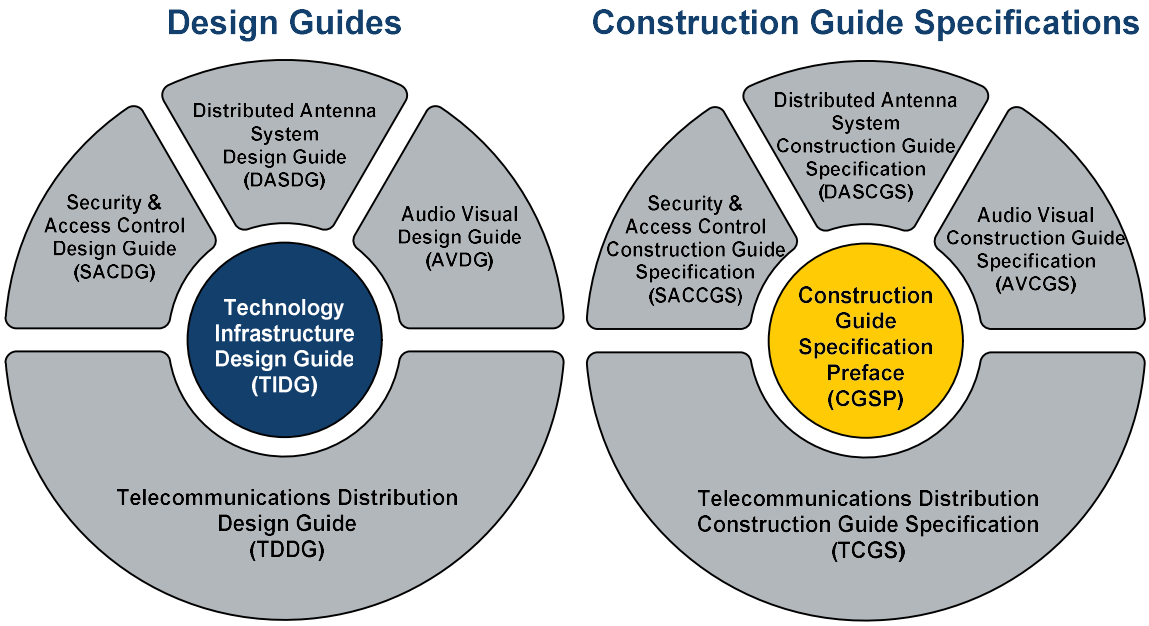
C. It is also intended for other low voltage telecommunications Contractors and Subcontractors installing telecommunications distribution systems at UVU facilities. It is intended to communicate UVU's requirements for the appropriate construction and installation of telecommunications distribution systems at UVU-owned and leased facilities.

D. This document also applies to infrastructure designed and installed by UVU staff, when a formal design is not developed.

E. The CGS consists of several sections written based on the 2004 Construction Specifications Institute (CSI) format (www.csinet.org), using Master Format, Section Format, and Page Format structuring guidelines. The CGS reflects UVU and industry standards in effect as of the date of this publication.

F. The Construction Guide Specification and this Preface (CGSP) belong to a set of documents (depicted below) that comprise the standard design and installation practices for all facets of technology systems and infrastructure at UVU's facilities. This document forms the core of the Construction Guide Specification document set.

Technology Infrastructure Standards Document Set



G. The Construction Guide Specification Preface (CGSP) is a key companion to the Design Guides.

- Designers shall adapt the various Construction Guide Specification sections “as written” for creating specifications for a particular project according to the instructions in the Design Guides. In other words, Designers shall use the electronic specification section documents (provided by UVU in MSWord format) and then shall make any project-specific edits to the specifications in those documents.

- Rewriting sections in the Construction Guide Specification or modifying the format structure or requirements will not be accepted.

H. It is the responsibility of the Designer of technology infrastructure for UVU to coordinate with the other designers on a project (architectural, electrical, mechanical, etc.) to determine that other systems are both compatible with and complementary to the technology infrastructure. It is critical to coordinate between disciplines during the design phase of a project, rather than making adjustments in the field during construction.

I. This document was prepared by the Information Technology Services department at Utah Valley University and by Summit Engineering & Consulting, P.S. As technology and needs evolve, the document will be periodically updated.

- May 1, 2013 – Originally published
- January 4, 2016 – First Revision

1.2 Document Intent

The CGS has been developed with the intent that UVU standards and practices are followed during the design and construction of telecommunications distribution systems.

Each CGS specification section has references, products, procedures, processes, and work descriptions/summaries that are common to many UVU projects. This information is provided in specification format to serve as a guide to the Engineer/Designer in producing a CSI-compliant specification that will meet the unique requirements of UVU projects. For UVU staff performing telecommunications work, this information shall be followed to fulfill the requirements of a fully compliant installation.

Each CGS section includes products upon which UVU has standardized and which were current at the time the specification section was written. When newer products become available, or when a different product appears to be better suited for a particular project, the Designer, Contractor or Installer shall bring this recommendation to the attention of the UVU ITPM for review and final approval before making changes to the CGS section or installing the newer or different product.

The CGS is intended to be a “Guide Specification” rather than a “Master Specification”. The products listed and other information included in each section are not intended to be all-inclusive for any given project. Instead, each specification section is meant to serve as a starting point for developing the specification section for a given project, with content to be added or removed as required. However, all additions and changes must be pre-approved as indicated above.

In addition to implementing UVU standards and practices, the intent of the CGS is to reduce the time required for UVU staff to review project specifications. UVU has determined that following these instructions will reduce the review time required for each project.

Unless otherwise stated, the information in the CGS applies to both new construction and remodel projects and (as appropriate) to leased facilities.

1.3 How to Use this Document

The CGS shall be used in conjunction with the corresponding Design Guide (xDG) to produce Construction Documents for bidding or to assist UVU-selected personnel in the design and administration of small telecommunications construction projects.

UVU will provide the CGS specification sections to the Designer electronically as Microsoft Word documents. The Designer shall then edit the Microsoft Word document for each specification section using the latest version of Microsoft Word, adding or removing content as required to meet the unique needs of a given project.

It is not acceptable to create new specification sections based on the Designer's interpretation of the "intent" of the TCGS, or to cut and paste content from TCGS sections into other existing specification sections.

All edits made by the Designer to the original CGS electronic documents shall be made using Microsoft Word's Tracking Changes feature. The specification sections shall be submitted in hardcopy format when required by UVU during the design review process with the "Final Showing Markup" option selected so that the revision marks are visible in the printed documents to be reviewed. Just prior to bid, when the specifications have been reviewed by the ITPM and approved as final/100% Construction Documents, the "tracking changes" items can be "accepted" and the specifications can be published without any revision markings.

Red text in gray-shaded boxes in each CGS section is formatted in Microsoft Word as "hidden text" and can be made to appear/disappear on screen and in the printed document using the check boxes on the File / Options / Display dialog box. This hidden text is included to add clarity behind UVU's decisions for certain features of the specifications. It is also intended to prompt the Designer about items that may require modification for a particular project. Although this text is generally written in declarative form, the Designer shall consider it guidance only.

The Designer shall not assume that the content of each CGS specification section in its native form is suitable or sufficient for any given project. The Designer shall be responsible for adding and/or removing content as required to develop a thorough and complete specification section that meets the requirements of the project being designed. The Designer shall be professionally liable for the documents produced for a project, including content from these specifications.

1.4 Copyright

Summit Engineering & Consulting retains the copyright for this document, including the associated specifications. Utah Valley University is authorized to edit and adapt the document and specifications. Designers working for UVU on UVU's projects are authorized to edit and adapt the specifications for use on UVU's projects. All other rights are reserved.

Summit Engineering & Consulting has authored similar documents for many other organizations. The document is intended (in part) to describe best practices that are found in some segments of the industry. As a result, portions of this document are similar to comparable content in documents previously prepared by Summit Engineering & Consulting for other organizations. This document does not contain any information that is proprietary or confidential to other organizations.

1.5 Guide Specification Sections

1.5.1 TELECOMMUNICATIONS CONSTRUCTION GUIDE SPECIFICATION SECTIONS

The Telecommunications Construction Guide Specification (TCGS) contains the following specification sections:

Division 27

27 05 00	Common Work Results for Communications
27 05 26	Grounding and Bonding for Communications Systems
27 05 29	Hangers and Supports for Communications Systems
27 05 33	Conduits and Backboxes for Communications Systems
27 05 36	Cable Trays for Communications Systems
27 11 00	Communications Equipment Room Fittings
27 13 00	Communications Backbone Cabling
27 15 00	Communications Horizontal Cabling
27 16 00	Communications Connecting Cords, Devices, and Adapters
27 32 00	Voice Communications Telephone Sets

Division 33

33 81 26	Communications Underground Ducts, Manholes, and Handholes
33 82 00	Communications Distribution
33 82 43	Grounding and Bonding for Communications Distribution

1.5.2 AUDIO/VISUAL CONSTRUCTION GUIDE SPECIFICATION SECTIONS

The Audio/Visual Construction Guide Specification (AVCGS) contains the following specification sections:

Division 27

27 05 00	Common Work Results for Communications
27 41 00	Audio-Video Systems
27 41 16.61	Integrated Audio-Video Systems and Equipment for Theaters

1.5.3 SECURITY AND ACCESS CONTROL CONSTRUCTION GUIDE SPECIFICATION SECTIONS

In the future, UVU might prepare a Security and Access Control Construction Guide Specification (SACCGS). If this were to be done, it would contain the following specification sections:

Division 28

28 05 00	Common Work Results for Electronic Safety and Security
28 13 00	Access Control
28 13 00	Intrusion Detection
28 20 00	Video Surveillance

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials and labor for the installation of an inside plant telecommunication system. All materials shall be new, free from defects, of current manufacture, of the quality specified or shown. Each type of material shall be of the same manufacturer throughout the work. This section includes Inside Plant Communications cabling, termination, and administration equipment and installation requirements for the specified Structured Cabling System and Audio Visual System Systems.

1.2 SYSTEM DESCRIPTION

A. Furnish, install, test and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete ANSI/TIA/EIA, NECA/NEIS and ISO/IEC compliant communications system as hereinafter specified and/or shown on the Contract Documents. The system is intended to be capable of integrating voice, data, and video signals onto a common media.
   1. The Structured Cabling System shall be tested for and be capable of 10 Gigabit Ethernet operation as specified in IEEE 802.3z.

B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant SCS.

1.3 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the work of this section and to all Division 27 Specification Sections.

1.4 STANDARDS AND CODES

A. Incorporate by reference the applicable portions of the following specifications, standards, codes into this specification section.
   1. General:
      a. National Fire Protection Association (NFPA) – NFPA 70: National Electrical Code (NEC)
      b. National Fire Protection Association (NFPA) – NFPA 101: Life Safety Code
      c. National Electrical Safety Code (NESC)
      d. Utah Occupational Safety and Health (Utah OSHA)
      e. Occupational Safety and Health Act (OSHA)
      f. Utah Administrative Code (UAC)
   2. Communications:
      a. ANSI/TIA - 455: Fiber Optic Test Standards
      b. ANSI/TIA - 526: Optical Fiber Systems Test Procedures
      c. ANSI/TIA - 568-C.0: Generic Telecommunications Cabling for Customer Premises
      d. ANSI/TIA - 568-C.1: Commercial Building Telecommunications Cabling Standard
      e. ANSI/TIA – 569-B: Commercial Building Standard for Telecommunication Pathways and Spaces
      f. ANSI/TIA – 606-A: Administration Standard for Commercial Telecommunications Infrastructure
      g. ANSI/TIA – 607-B: Commercial Grounding (Earthing) and Bonding for Customer Premises
      h. ANSI/TIA – 862: Building Automation Systems Cabling Standard for Commercial Buildings

i. ANSI/TIA -TSB67: Transmission Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems
j. ANSI/TIA -TSB75: Additional Horizontal Cabling Practices for Open Offices
k. ANSI/TIA-1152: Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
l. ISO/IEC 61935-1: Specification for the Testing of Balanced and Coaxial Information Technology Cabling
m. ISO/IEC IS 11801: Generic Cabling for Customer Premises
n. NECA/FOA 301-1997: Standard for Installing and Testing Fiber Optic Cables
o. NECA/BICSI 568-2001: Standard for Installing Commercial Building Telecommunications Systems
p. IEEE 802.3 (series): Local Area Network Ethernet Standard, including the IEEE 802.3z Gigabit Ethernet Standard
q. BICSI: BICSI Telecommunications Cabling Installation Manual (TCIM)
r. BICSI: BICSI Telecommunications Distribution Methods Manual (TDMM)
s. BICSI: BICSI Outside Plant Design Reference Manual (OSPDRM)
t. BICSI: BICSI Network Design Reference Manual (NDRM)

3. Audio Visual Systems:
   a. InfoComm/BICSI: AV Design Reference Manual
   b. InfoComm: Audiovisual Best Practices: The Design and Integration Process for the AV and Construction Industries
   c. InfoComm: Basics of Audio and Visual Systems Design
   d. ANSI S12.60-2002: Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools
   e. ANSI/INFOCOMM 2M-2010: Standard Guide for Audiovisual Systems Design and Coordination Processes
   f. ANSI/INFOCOMM 3M-2011: Projected Image System Contrast Ratio Standard
   g. ANSI/INFOCOMM 10-2013: AV Systems Performance Verification
   h. US Dept. of Justice: 2010 ADA Standards for Accessible Design
4. Firestopping:
   a. ASTM E 84, “Surface Burning Characteristics of Building Materials”
   b. ASTM E 119, “Fire Tests of Building Construction and Materials”
   c. ASTM E 814, “Fire Tests of Through Penetration Firestops”
   d. ANSI/UL263, “Fire Tests of Building Construction and Materials”
   e. ANSI/UL723, “Surface Burning Characteristics of Building Materials”
   f. ANSI/UL1479, “Fire Tests of Through Penetration Firestops”
   g. Underwriters Laboratories Inc. (UL) – Fire Resistance Directory

B. In case of differences between building codes, state laws, local ordinances, utility company regulations, and the Contract Documents, the most stringent shall govern; this shall not be construed as relieving the contractor from complying with any requirements of the plans or specifications which may be in excess of code requirements and not contrary to same.

1.5 DEFINITIONS

A. “SCS” shall mean *Structured Cabling System*. The SCS is defined as all required equipment and materials including (but not limited to) ANSI/TIA/EIA 568-B and ISO/IEC 11801 compliant copper station cable (Category 5E, Category 6, Category 6A, etc.) and fiber optic cable (multimode and singlemode), patch cables, stations and station connectors, termination blocks, patch panels, racks/enclosures (such as EIA standard equipment racks, enclosures, and vertical and horizontal cable management hardware), pathway/raceway materials (such as conduit, sleeves, D-rings, surface raceway, ladder rack, cable tray, etc.), and other incidental and miscellaneous equipment and materials as required for a fully operational, tested, certified, and warranted system, compliant with all applicable codes and standards.

B. TDS: shall mean *Television Distribution System.*

C. “UTP” shall mean *Unshielded Twisted Pair* cable.

D. “TMGB” shall mean *Telecommunications Main Grounding Busbar.* There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.

E. “TGB” shall mean *Telecommunications Grounding Busbar.* There is typically one TGB per telecommunications room. The TGB is connected both to the TMGB and to building structural steel or other permanent metallic systems.

F. “TBB” shall mean *Telecommunications Bonding Backbone.* The TBB is a conductor used to connect TMGBs to TGBs.

G. “EMT” shall mean Electrical Metallic Tubing.

H. “RMC” shall mean Rigid Metal Conduit.

I. “Raceway” shall mean any enclosed channel for routing wire, cable or busbars.

J. “Pullbox” shall mean a metallic box with a removable cover, used to facilitate pulling cable through conduit runs longer than 100’ or in which there are more than 180 degrees of bends.

K. “Junction box” shall mean a pullbox wherein a feeder conduit transitions to multiple distribution conduits.

L. “Wire gutter” shall mean a metallic raceway with a square cross-section used for routing wire or cabling.

1.6 REQUIREMENTS OF REGULATORY AGENCIES

A. The entire installation shall comply with the code requirements of all authorities having jurisdiction.

B. Contractor shall arrange for all inspections and shall correct non-complying installations.

1.7 PERMITS AND FEES

A. The Contractor, at its expense, shall obtain permits and inspections required for the electrical work on this project. Inspection certificates shall be included in the Operation and Maintenance Manuals. Deliver copies thereof to the Architect/Engineer prior to final acceptance of the work.

1.8 SUBMITTAL INFORMATION

A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Combine product submittals for all products and submit together as a single submittal.
   1. Submit a cover letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. State in the letter that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
   2. If (in the Contractor’s judgment) the system as designed will not meet the required performance specifications, submit a detailed written description of the reasons.
   3. Provide standard manufacturer’s cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.

4. For those items noted as allowing “or equal,” and which are not being provided as specifically named, submit a written description detailing the reason for the substitution, along with standard manufacturer's cut sheets or other descriptive information.
5. Submit a list of proposed test equipment for use in verifying the installation of the SCS. Proposed test equipment shall meet the criteria as stated in PART 3 – TESTING.
    a. Submit for each testing device:
        1) Manufacturer and product number.
        2) Documentation from the manufacturer showing date and outcome of last re-calibration. Testing device shall have been re-calibrated within the manufacturer’s recommended calibration period, encompassing the period of time when the testing device will be used on this project.
        3) Documentation from the manufacturer showing software revision. Software revision shall be most current revision available for the device and shall be based upon the most current ANSI/TIA/EIA testing guidelines.
    b. Submit proposed copper and fiber cable test forms (see PART 3 – TESTING for more detail).

B. Quality Control Submittals: Provide submittal information for review as follows:
1. Prior to bidding, in accordance with the QUALITY ASSURANCE requirements below, submit the following contractor-qualifications documentation:
    a. Documentation from the SCS manufacturers demonstrating that the Contractor is trained and certified by the Manufacturers to install, test, and maintain the SCS and is certified by the SCS Manufacturers to provide the SCS Manufacturer’s Warranty (see PART 1 - WARRANTY).
        1) For Copper:
            a) Siemon Certified Installer (CSI) Contractor
        2) For Fiber, one of the following:
            a) Corning Network of Preferred Installers (NPI) Contractor
            b) Siemon Certified Installer (CSI) Contractor
    b. Documentation indicating that the Contractor will have only manufacturer-trained and manufacturer-certified employees perform installation, testing, and firestopping work, as detailed below.
        1) A list of the personnel who will be assigned to the project, the type of work they will be performing, and copies of the manufacturers’ training certifications for each. If personnel changes are made during the project, submit the above information for any new personnel prior to their commencement of work on the project.
    c. Documentation demonstrating that the Contractor employs a minimum of one Registered Communications Distribution Designer (RCDD) certified by and in current good standing with BICSI. The document shall declare that the RCDD is a direct full-time employee of the Contractor, and also that the Contractor will continue to employ a minimum of one RCDD throughout the duration of the project.
    d. List of references for no less than five similar projects (in terms of size and construction cost) performed by the Contractor under the Contractor’s current business name within the past three years. Detail the following for each project:
        1) Project name and location
        2) Construction cost
        3) A brief description of the project, the components involved, and the SCS manufacturer used on the project.
        4) Number of station drops
        5) Customer contact names, phone numbers, and addresses

C. Closeout Submittals: Provide submittal information for review as follows:
1. O&M Manual for Communications - At the completion of the project, submit O&M information from product data submittals (above), updated to reflect any changes during the course of

construction, to the Engineer in the telecommunications-specific O&M Manual for Communications binder labeled with the project name and description. Provide three bound copies of the O&M Manual for Communications.

2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specifications, and Addenda. Record Drawings shall consist of redline markups of changes to Contract Documents such as drawings, specifications and spreadsheets, including maintenance hole/handhole butterfly drawings.
   a. At the beginning of the work, set aside one complete set of the drawings to be maintained as a complete Record Drawings set. Notations shall be done in a neat and legible manner as specified in Division 01 and in accordance with the Architect/Engineer's instructions.
   b. The Record Drawings shall be updated daily by the foreman to show every change from the original drawings, and the exact locations, sizes and kinds of equipment. Clearly identify system component labels and identifiers on Record Drawings. This set of drawings shall not be used for any other purpose and shall be maintained at the job site.
   c. The actual locations and elevations of all buried lines, boxes, monuments, stub-outs and other provisions for future connection shall be shown on the Record Drawings, and shall be referenced to the building lines or approved bench marks.
   d. Keep Record Drawings at the job site and make them available to the Owner and Engineer at any time.
   e. Keep Record Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction.)
   f. Show identifiers for major infrastructure components on Record Drawings.
   g. Upon completion of the job, deliver the marked-up Record Drawings to the Architect/Engineer.

1.9 QUALITY ASSURANCE

A. All Division 27 Contractors:
   1. Contractor's employees whose duties include the application of firestopping material shall be trained and certified by the specified firestopping manufacturer. Training and certifications by employee type are required as shown below:
      a. Supervisors/Project Foremen: All (100%) shall be trained/certified for installation.
      b. Firestopping Technician: All (100%) shall be trained/certified for installation.

B. Telecommunications Contractor Qualifications:
   1. Contractor shall be trained and certified by the Manufacturers to install, test, and maintain the SCS and be certified by the SCS Manufacturers to provide the SCS Manufacturers' Warranties (see PART 1 - WARRANTY).
      a. For Copper:
         1) Siemon Certified Installer (CSI) Contractor
      b. For Fiber, one of the following:
         1) Corning Network of Preferred Installers (NPI) Contractor
         2) Siemon Certified Installer (CSI) Contractor
   2. Contractor's employees directly involved with the supervision, installation, testing, and certification of the SCS shall be trained and certified by the selected SCS manufacturers. Training and certifications by employee type are required as shown below:
      a. Supervisors/Project Foremen: Shall be trained/certified by the manufacturer for installation and testing.
      b. Lead Technician: Shall be trained/certified by the manufacturer for installation and testing.
      c. Other Technicians: All other technicians shall be trained by a manufacturer-trained employee, at no cost to the Owner.
      d. Other personnel: Personnel not directly responsible for installation supervision, installation, testing or certifying the SCS (i.e. project managers, cleanup crew, etc.) are not

required to be manufacturer trained and certified. Otherwise, untrained personnel shall not be allowed on the job site.

3. Contractor shall employ a minimum of one Registered Communications Distribution Designer (RCDD) certified by and in current good standing with BICSI. The RCDD shall be a direct full-time employee of the Contractor (i.e. an RCDD consultant/sub-contractor to the Contractor is not acceptable). Contractor shall continue to employ a minimum of one RCDD throughout the duration of the project.
4. Contractor shall have successfully completed no less than five similar projects (in terms of size and construction cost) under the Contractor's current business name within the past three years.
5. Firms desiring to have their qualifications reviewed pursuant to a determination of their qualifications shall submit documentation of the above requirements not later than ten days prior to the bid opening. Firms that have not been evaluated for qualification shall not bid. The following firms have been pre-qualified:
   a. Americom Technology, Joseph Rose, 801-892-0546
   b. Cache Valley Electric, Brad Christensen, 801-908-4179
   c. IES Commercial, Mike Austin, 801-972-2262
   d. Team Linx, Mike Herd, 801-702-7083

C. Audio Visual Contractor Qualifications:
   1. Contractor's employees directly involved with the supervision, installation, testing, and certification of the A/V System shall be full-time employees of the contractor for a minimum of one year, and shall have the experience detailed in this section. Provide documentation indicating that the Contractor will have only manufacturer-trained and manufacturer-certified employees perform installation, testing, and firestopping work, as detailed below. Provide a list of the personnel who will be assigned to the project, the type of work they will be performing, and copies of the manufacturers' training certifications for each. If personnel changes are made during the project, submit the above information for any new personnel prior to their commencement of work on the project.
      a. Supervisors/Project Foremen: All (100%) shall be certified as InfoComm CTS-I.
      b. Technicians: All (100%) shall be certified as:
         1) Crestron CAPE Certified Programmer
         2) Crestron Digital Media Certified Designer (DMC-D)
      c. Technicians: A minimum of one shall be certified as:
         1) InfoComm CTS-I certified technician in current good standing with InfoComm. The CTS-I shall be a direct-full time employee of the Contractor (i.e. a consultant/sub-contractor to the Contractor is not acceptable). Contractor shall continue to employ a minimum of one CTS-I throughout the duration of the project.
   2. Contractor shall have successfully completed no less than three similar projects (in terms of size and construction cost) under the Contractor's current business name within the past four years. The Contractor's project history shall include installation of common audio/visual equipment such as speaker systems, video projection and audio/video routing in a campus-type environment.
      a. Provide a list of references with the following details for each project:
         1) Project name and location
         2) Construction cost
         3) A brief description of the project, the components involved, and the main audio/visual equipment manufacturers used on the project.
         4) Equipment used for the project
         5) Customer contact names, phone numbers, and addresses
   3. Firms desiring to have their qualifications reviewed pursuant to a determination of their qualifications shall submit documentation of the above requirements not later than ten days prior to the bid opening. Firms that have not been evaluated for qualification shall not bid. Bids from firms that have not been pre-qualified shall be discarded. The following firms have been pre-qualified:

a. none

1.10 COORDINATION

A. The Division 27 Contractor shall coordinate his work with that of the other contractors doing work in the building and shall examine all drawings, including the several divisions of mechanical, ventilating, structural and general, for construction details and necessary coordination.

B. Coordinate and schedule connecting electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

C. Coordinate the interruption of electrical systems to any part of the facility in use by the Owner at least 48 hours before interruption of the system.

D. Special attention is warranted concerning the following items. All conflicts shall be reported to the Architect/Engineer before installation for decision or correction:
1. Location of fixtures, pipes, ducts and other mechanical equipment such that telecommunications and audio/visual outlets, wall-mounted telephone devices, equipment racks and panels, and other electrical equipment are mounted in proper relationship to these items.
2. Location of cabinets and counters such that communications work is clear of and in proper relation to these items.
3. Penetrations of building structure for communications work.
4. Compliance to Section 110-26 of NEC.
5. Coordination and provisions for maintaining telephone service to areas in use during construction, especially elevator equipment, fire alarm systems, security systems and emergency systems (comply with General Division Provisions).
6. Communications equipment shall fit in the space provided on the plan drawings or as specified. Equipment heights shall not exceed those shown or specified. Larger equipment shall not be acceptable. Contractor shall be responsible for all clearances around the communications equipment.

E. When conduit, inserts or sleeves for outlet boxes and/or conduits are required, Contractor shall fully coordinate the installation thereof with other trades.

F. The communications contractor shall take full responsibility for furnishing, installing and troubleshooting all communications systems in the building. The communications contractor shall be responsible for overall coordination of all communications systems and ensuring correct and full operation of all systems and system interfaces. The communications contractor shall coordinate the interfaces between the communications systems and all other systems.

1.11 SEQUENCING

A. Provide coordination with the cabling manufacturers to ensure that manufacturers' inspectors are available to schedule site visits, inspections, and certification of the system. Provide and coordinate any manufacturer-required modifications and have manufacturer re-inspect and certify the system prior to the scheduled use of the system by the Owner.

B. The Contractor is solely responsible for all costs associated with scheduling the manufacturer inspection, the inspection itself and any manufacturer-required re-inspections, and for any modifications to the installation as required by the manufacturers.

1.12 WARRANTY

A. Contractor Warranty:
1. Provide a Contractor-endorsed one-year service warranty against defects in materials and workmanship.
a. Provide all labor attributable to the fulfillment of this warranty at no additional cost to the Owner.
1) The Contractor Warranty period shall commence upon Owner acceptance of the work.
b. This warranty shall not be voided by Owner's move, add and change activities. The resulting parts of any Owner-performed moves, adds and changes do not become part of the warranty. Nothing in this section shall be construed to terminate the warranty by performance of normal maintenance or service on the system or by expanding the system in any manner consistent with the original design and intent for the system.

B. SCS Manufacturer Warranties:
1. Provide SCS Manufacturer extended product, performance, application, and labor warranties that shall warrant all passive components used in the SCS. Additionally, these warranties shall cover components not manufactured by the SCS Manufacturers, but approved by the SCS Manufacturers for use in the SCS (i.e. "Approved Alternative Products"). The SCS Manufacturer warranties shall warrant:
a. That the products will be free from manufacturing defects in materials and workmanship.
b. That the cabling products of the installed system shall exceed the specification of ANSI/TIA/EIA 568-B and exceed ISO/IEC 11801 standards.
c. That the installation shall exceed the specification of ANSI/TIA/EIA 568-B and exceed ISO/IEC 11801 standards.
d. That the system shall be application-independent and shall support both current and future applications that use the ANSI/TIA/EIA 568-B and ISO/IEC 11801 component and link/channel specifications for cabling.
2. Provide materials and labor attributable to the fulfillment of this warranty at no cost to the Owner.
3. The SCS Manufacturer Warranties shall be provided by the selected SCS Manufacturers and shall be:
a. For Category 5e or Category 6 cabling work, provide the Commscope 20-year Warranty.
b. For Category 6A cabling work, provide the Commscope 20-year Warranty.
c. For fiber optic cabling work, provide the Corning 25-year System Warranty.
Provide a copy of the warranty registration documentation to the Owner at the time of submittal to the manufacturers.
4. The SCS Manufacturer Warranty period shall commence upon a Warranty Certificate being issued by the manufacturer. The Warranty Certificates shall be issued no later than three months after Owner acceptance of the work.

PART 2 - PRODUCTS

2.1 GENERAL

A. Products and materials shall be as specified in the pertinent Sections of Division 27. Provide materials as specified. Equivalent materials are not acceptable unless specifically stated as "or equal," "or approved equal," "or pre-approved equal." Substitutions for some materials require the Owner's approval prior to bidding.

B. Wherever possible, all materials and equipment used in the installation of this work shall be of the same Manufacturer throughout for each class of material or equipment. Materials shall be new and bear UL label. Comply with ANSI, IEEE and NEMA standards, where applicable.

C. Components shall be manufactured by the manufacturers listed in Division 27. Components shall not be intermixed between different manufacturers unless the manufacturer has listed (in writing) another manufacturer's component as an "Approved Alternative Product" and will warrant the "Approved Alternative Product" as part of the Manufacturer Warranty.
   1. Bid only the manufacturers for which the Contractor is certified.

D. All copper-related components shall be part of the copper SCS product line and all fiber optic-related components shall be part of the fiber optic SCS product line – components shall not be intermixed between manufacturers' SCS product lines. The SCS product lines shall be engineered "end-to-end" – the system and all of its components shall be engineered to function together as a single, continuous transmission path.

E. Physically verify existing site conditions prior to purchase and delivery of the materials, including but not limited to lengths of conduit and/or pathway to be used for routing backbone cabling. Pre-cut materials of insufficient length are the sole responsibility of the Contractor.

F. Provide materials, devices, equipment or supplies of materials that are inherently non-corrosive or are coated or covered in a manner, acceptable to the Engineer, which renders them non-corrosive. Material that may cause rusting or streaking on a building surface shall not be used.

G. Provide all incidental and/or miscellaneous hardware (including equipment cables and connectors) not explicitly specified or shown on the Contract Documents that is required for a fully operational, tested, certified and warranted system.

H. Provide cables of the same type or application in the same color throughout the project, unless otherwise indicated. Multiple colors of the same cable type are not acceptable.

2.2 TOUCH-UP PAINT

A. For Equipment: Provided by equipment manufacturer and selected to match equipment finish.

B. For Non-equipment Surfaces: Matching type and color of undamaged, existing adjacent finish.

C. For Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

2.3 FIRESTOPPING

A. Firestopping material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions. Manufactured by:
   1. Specified Tech. Inc., Hilti, or approved equal, regardless of the products or manufacturers specified in Division 7.

B. Fire-Rated Cable Pathways: Device modules shall be comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill:
   1. Specified Technologies Inc. (STI) EZ-PATH Fire Rated Pathway

C. Firestop Pillows: Pillows shall be re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame-retardant poly bag:
   1. Specified Technologies Inc. (STI) SpecSeal® Series SSB Pillows
   2. Hilti CP 657 Firestop Brick

2.4 GROUNDING AND BONDING

A. As specified under Division 27 Section — "Grounding and Bonding for Communications Systems."

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.

B. All work shall comply with applicable safety rules and regulations including OSHA and Utah OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.

C. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.

D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.

E. Equipment Dimensions and Clearances:
   1. Dimensions indicated for communications equipment and dimensions indicated for the installation of communications equipment are restrictive dimensions. Verify that equipment will fit within the indicated locations and spaces. Do not use equipment that impinges upon the required clearance, reduces actual clearance, or exceeds the indicated dimensions:
      a. Except as approved in writing by the Engineer.
   2. Do not use arrangements of equipment that impinge upon the required clearance, reduce actual clearances or exceed the space allocation.

F. Equipment Access:
   1. Install equipment so it is readily accessible for operation and maintenance.
   2. Access to equipment shall not be blocked or concealed by conduits, supporting devices, boxes, or other items.
   3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.

G. Equipment shall be installed plumb, square and true with the building construction and shall be securely fastened.

H. Do not provide materials which contain polychlorinated biphenyls, asbestos or other hazardous or detrimental materials. Do not install materials in a manner, location or construction that produces galvanic action or any other materials corroding or eroding action. Equipment fabricated from aluminum shall not be placed in direct contact with earth or concrete. Outdoor wall-mounted equipment and indoor equipment mounted walls in contact with earth or water shall be provided with corrosion-resistant spacers to maintain ¼ inch separation between the equipment and the wall. Screen or seal all raceways or other openings into equipment to prevent the entrance of moisture, rodents and insects.

I. Drawings indicate the approximate location and arrangement of electrical equipment and the approximate location of other equipment requiring electrical work. The general arrangement of

panelboards, outlets and other equipment is diagrammatic and approximate as to locations. To avoid interference with structural members and equipment of other trades, it may be necessary to adjust the intended location of electrical equipment. Where minor changes are required because of structural or finish conditions or for the convenience of the Owner, provide such changes without additional expense to the Owner. Unless specifically dimensioned or detailed, the Contractor may, at his discretion, make minor adjustments in equipment location without obtaining the Engineer's approval. Minor adjustments are defined as a distance not to exceed:

1. 1 ft at grade, floor and roof level in any direction in the horizontal plane.
2. 1 ft for equipment at ceiling level in any direction in the horizontal plane.
3. 1 ft on walls in a horizontal direction within the vertical plane.
4. Changes in equipment location exceeding those defined above require the Engineer's approval.
5. Particular attention shall be paid to door swings, piping, radiation, ductwork, and structural steel:
    a. In general, waste and vent lines and large pipe mains and ductwork shall be given priority for the locations and space shown.
    b. No additional compensation will be allowed for the moving of misplaced outlets, wiring, or equipment.

J. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.

K. Remove surplus material and debris from the job site and dispose of legally.

3.2 SCHEDULE

A. Provide a time-scaled construction schedule indicating construction phases and deadlines associated with this work. At a minimum, the following tasks shall be shown on the schedule:

1. Start of outside plant ductbank and maintenance hole construction
2. Dates of outside plant ductbank concealment (concrete and backfill)
3. Start of conduit and box rough-in
4. Start of main campus cable feed to building MDF
5. Start of MDF and IDF build out
6. Start of vertical riser cable installation
7. Start of horizontal cable installation
8. Start of horizontal cable termination
9. Date when elevator telephone service required
10. Date when building automation system (HVAC) will require network service
11. Start of outlet device termination and labeling
12. Start of installation testing – provide IT w/preliminary test results.
13. Start of final inspection process

3.3 INSTALLATION

A. Install the equipment and materials in a neat and workmanlike manner employing workmen skilled in the particular trade and in accordance with the manufacturer’s instructions and industry standards. Maintain adequate supervision of the work by a person in charge at the site during any time that work under this division is in process or when necessary for coordination with other work.

B. Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated. Mount enclosures for individual units at fifty-four inches above floors to centerline of controls.

C. Install items level, plumb, and parallel and perpendicular to other building systems and components, except where otherwise indicated. All items shall be securely fastened.

D. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

E. Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure. Attach enclosures with a minimum of three fasteners, and more if the manufacturer so recommends.
   1. Attach enclosures mounted on equipment with machine screws or clamps as required. Do not drill equipment frames or sheets without permission of supplier/manufacturer or the Engineer.
   2. Stand equipment off wall surfaces a minimum of one-quarter inch where enclosures are mounted on walls in wet areas (outdoors, below grades, etc.) with neoprene, fiberglass or plastic shim washers.
   3. Welding to steel structure may be used only for threaded studs - not for conduits, pipe straps, or any other items.

F. Select fasteners so the load applied to any fastener does not exceed 25 percent of the proof-test load.

G. Give right of way to raceways and piping systems installed at a required slope.

H. Make all penetrations of electrical work through walls and roofs water-tight and weather-tight.

I. Install concrete pads and bases according to requirements of Division 03 Section "Cast-in-Place Concrete."

3.4 DEMOLITION

A. Demolish existing telecommunications equipment, cable, materials, and incidentals no longer in use after installation of and cutover to the new SCS. Demolish all existing devices and cables which are noted for demolition. Demolition includes, but is not limited to:
   1. Remove all conduit, conductors, fittings, device boxes, hangers, panels, devices, etc., which are not concealed in the building structure or below grade/slab.
   2. Remove existing conductors from conduits, unless otherwise indicated, where existing work is to be abandoned in place. Cut and remove buried raceway indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap and patch surface to match existing finish.
   3. Do not remove or damage fireproofing materials. Repair or replace fireproofing that was removed or becomes damaged.

B. When demolishing existing surface plastic/metal raceway, patch and/or paint wall to match existing undisturbed wall finish after raceway is removed.

C. Locate, identify, and protect equipment and materials to remain. Where existing work to remain is damaged in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality at no additional cost to the Owner.

D. Remove demolished material from the Project site and dispose of legally.

E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation and/or reconnection.

F. Coordinate demolition activities with those pertaining to other Divisions.

3.5 SEISMIC REQUIREMENTS

A. General: Electrical equipment for emergency systems shall be braced to withstand lateral forces that result from earthquakes. The Electrical Contractor shall provide seismic calculations stamped and signed by a registered Structural Engineer confirming size, number and location of all required anchoring hardware. Electrical equipment vendors shall submit weights, dimensions and center of gravity locations for all emergency electrical equipment for this purpose.

3.6 CUTTING AND PATCHING

A. Cutting of Existing Structural Work: Holes in existing slabs and concrete walls shall be cored to the minimum size required. Contractor shall submit dimensioned drawings showing dimensioned sizes and locations for all holes to Architect/Engineer for approval before cutting. Where required for conduit installation, grade slabs shall be saw-cut to minimum required width. Approval drawings shall be submitted to Architect/Engineer before cutting.

B. Patching: All holes or chases shall be patched to match adjacent surfaces.

3.7 PAINTING

A. General: All finish painting of electrical equipment shall be as specified in Division 9, unless equipment is specified herein to be furnished with factory-applied finish coats. Equipment to be field-painted shall be supplied with factory-applied prime coat.

B. Touch Up: If factory finish on any equipment furnished under this Division is damaged in shipment or during construction of the building, equipment shall be refinished by Contractor to the satisfaction of the Architect/Engineer.

C. Concealed Equipment: All uncoated cast iron or steel that will be concealed or will not be accessible when installations are completed shall be given one heavy coat of black asphalt before installation.

3.8 CONCRETE WORK

A. All concrete required for communications work shall be provided under Division 33.

3.9 FIRESTOPPING

A. Only employees trained/certified by the firestopping manufacturer shall apply firestopping materials.

B. Maintain fire rating of penetrated fire barriers. Fire stop and seal penetrations made during construction.
   1. Provide firestopping material for through and membrane penetrations of fire-rated barriers.
   2. Install firestops in strict accordance with manufacturer’s detailed installation procedures.
   3. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer’s recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1 – REFERENCES. Apply sealing material in a manner acceptable to the local fire and building authorities.
   4. For demolition work, apply firestopping to open penetrations in fire-rated barriers where cable is removed. Apply firestopping regardless of whether or not the penetrations are used for new cable, or left empty after construction is complete.
   5. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/re-enterable.

C. Fire and smoke stopping sleeve devices shall be provided for all sleeve penetrations through fire-rated walls and wherever cables (not in conduit) pass through fire-rated walls. Devices shall be arranged singly or in gangs, and installed in strict accordance with the manufacturer's recommendations. Apply the factory-supplied gasketing material prior to the installation of the wall plates. Secure wall plates to devices per the equipment manufacturer's recommendations. Putty-type firestopping products are not acceptable.

D. Fire and smoke stopping sleeve devices shall be provided for all floor-to-floor firestopping applications. Firestopping putty and firestopping pillow products shall not be used for vertically oriented applications.

3.10 GROUNDING AND BONDING

A. Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, Utah Administrative Code (UAC), National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 – REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.

B. Provide grounding and bonding as required under Division 27 Section — "Grounding and Bonding for Communications Systems" and as required under other Division 27 sections.

3.11 PROTECTION, CARE AND CLEANING

A. Protection: Provide adequate protection for all finished parts of the materials and equipment against physical damage from any cause during the progress of work and until final completion. Sensitive electrical equipment shall not be installed until major construction is completed.

B. Care: During construction, properly cap all lines and equipment to prevent the entrance of sand and dirt. Protect equipment against moisture, plaster, cement, paint or work of other trades by covering with polyethylene sheets.

C. Cleaning: After installation has been completed, clean all systems as follows:
1. Field Painted Items: Clean exterior of conduits, raceways, piping and equipment exposed in completed structure, removing rust, plaster, cement and dirt by wire brushing. Remove grease, oil and similar materials by wiping with clean rags and suitable solvents.
2. Factory Finished Items: Remove grease, oil and dust on factory finished items such as cabinets, racks, and rack-mounted equipment, and leave surfaces clean and polished. Vacuum inside all electrical equipment and remove dust and debris.

D. Connections: Prior to energizing, check all electrical connection hardware.

3.12 DAMAGE AND REPAIRS

A. Emergency Repairs: Owner reserves the right to make temporary repairs as necessary to keep equipment in operating condition without voiding the Contractor's warranty or relieving the Contractor of his responsibility during the warranty period.

B. Responsibility for Damage: Contractor shall be responsible for damage to the grounds, buildings, or equipment due to work furnished or installed under this Division.

3.13 SERVICE OUTAGES

A. Any telephone, data or television service outage required to perform work under this Contract shall be performed at a time that is coordinated with and convenient to the Owner. Submit to the Owner (in writing) for Owner's approval, a schedule showing the dates and times the Contractor desires to perform

outage-causing work. This schedule shall be submitted no less than five days prior to commencing work. It may be necessary to perform this work at night, on holidays or during maintenance shutdowns. The Contractor shall include in his bid all premium time labor costs for this work.

3.14 IDENTIFICATION AND LABELING

A. General: Labeling and administration shall comply with ANSI/TIA/EIA 606 and standard industry practices.

B. Labels shall be arranged such that they are readable after cabling has been dressed and secured.

C. Labeling shall be affixed to all communications equipment, conduits, cabling and grounding/bonding systems as required in Division 27.

3.15 TESTING

A. Test each cable in accordance with Contract requirements, manufacturer requirements, industry standards, and warranty requirements and as required in Division 27.

B. Provide test records on a form approved by the Owner's IT Representative and Engineer. Submit the test results for each cable. The records shall include the unique cable identifier, outcome of test, indication of errors found, cable length, retest results, and name and signature of technician completing the tests. Provide test results to the Owner's IT Representative and Engineer for review and acceptance within two weeks of Substantial Completion.
   1. Prepare and submit the test results in the native file type from the cable test device and also in Adobe Acrobat PDF electronic form (on a CDROM) to the Owner's IT Representative and Engineer for review. Handwritten test results will not be accepted.

C. Costs of test shall be borne by Contractor. Contractor shall provide all instruments, equipment, labor and materials to complete testing. Should tests detect any defective materials, poor workmanship or variance with requirements of Specifications, Contractor shall make any changes necessary and remedy any defects at his expense.

3.16 PRELIMINARY OPERATION

A. The Owner reserves the right to operate portions of the communications system on a preliminary basis without voiding the warranty or relieving the Contractor of his responsibilities.

3.17 CLEAN-UP

A. Upon completion and at other times during the progress of the work, when required, remove all surplus materials, rubbish and debris resulting from the work.

3.18 DEMONSTRATION

A. Demonstrate equipment in accordance with Division 01.

B. Provide assistance to the Engineer during the demonstration or observation of equipment by operating devices and equipment, opening enclosures for inspection, checking record drawing information, and similar tasks, as necessary in the Engineer's judgment, to verify all work performed.

C. Acceptance is contingent on:
   1. Completion of final review and correction of all deficiencies.

2. Satisfactory completion of acceptance tests which demonstrate compliance with all performance and technical requirements of Contract Documents.
3. Satisfactory completion of training program and submission of all manuals and drawings required by Contract Documents.

3.19 OWNER-PROVIDED SERVICES

A. The Owner will provide the following services:
1. Install station patch cords and/or cross-connect “jumpers” for voice and data.
2. Connections to the Local Exchange Carrier, and Inter-exchange Carrier.
3. Connections to the campus voice, video and data network.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials and labor for the installation of a grounding and bonding system for inside plant telecommunications infrastructure. This section includes requirements for providing a permanent grounding and bonding infrastructure for horizontal and backbone communications circuits, equipment racking, raceways, and cable trays. These requirements are in addition to any that may exist in Section 26 – "Grounding."

1.2 SYSTEM DESCRIPTION

A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete, permanent Grounding and Bonding infrastructure for communications circuits, raceways, and cable trays as hereinafter specified and/or shown on the Contract Documents. The Grounding and Bonding system shall support an ANSI/TIA/EIA and ISO/IEC compliant communications Structured Cabling System (SCS) as specified in 271100 – "Communications Equipment Room Fittings" and 338200 – "Communications Distribution."

B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working Grounding and Bonding system that is compliant with ANSI/TIA/EIA 607.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials shall consist of busbars, supports, bonding conductors and other incidentals and accessories as required.

2.2 GROUNDING/BONDING:

A. Telecommunications Main Grounding Busbar (TMGB):
   1. Large (20" x 4" x ¼"), Pre-drilled:
      a. CPI 10622-020
      b. Panduit GB2B0312TPI-1
      c. or approved equal
   2. Small (10" x 4" x ¼"), Pre-drilled:
      a. CPI 10622-010
      b. or approved equal

B. Telecommunications Grounding Busbar (TGB):
   1. Large (20" x 4" x ¼"), Pre-drilled:
      a. CPI 10622-020
      b. Panduit GB2B0312TPI-1
      c. or approved equal
   2. Small (10" x 4" x ¼"), Pre-drilled:
      a. CPI 10622-010
      b. or approved equal
   3. Narrow (13" x 2" x ¼"), Pre-drilled (for exterior wireless access point application):
      a. Erico ERITECH TGB-A12L06PT
      b. or approved equal

C. Telecommunications Bonding Backbone: #6 AWG insulated (green in color) copper conductor.

D. Grounding Conductor: #6 AWG insulated (green in color) copper conductor.

E. Grounding Conductor: #6 AWG bare copper conductor.

2.3 LABELS:

A. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
   1. Labels:
      a. Panduit Marker Tie (or approved equal)
      b. Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)
   2. Hand-carried label maker:
      a. Brady: ID Pro Plus (or approved equal).

PART 3 - EXECUTION

3.1 GENERAL

A. Install the grounding and bonding system in a manner ensuring that communications circuits, when installed, are able to fully comply with the ANSI/TIA/EIA standards.

3.2 INSTALLATION

A. The grounding and bonding infrastructure system shall not make use of the building plumbing system, unless required to do so by the NEC.
   1. Coordinate the installation of the grounding and bonding system with the electrical power distribution system grounding infrastructure.

3.3 GROUND/BONDING:

A. TMGB: Provide a minimum of one TMGB per telecommunications room for each building and as shown on the Contract Documents. Install TMGB(s) and directly bond TMGB(s) to electrical service ground and to associated TBB(s). Group protector, busbar bonding, and approved building grounding conductors toward the left end and leave space for equipment grounding conductors to the right end.

B. TGB: Provide TGB as shown on the Contract Documents and as required. Directly bond each TGB to its associated TBB and to the nearest building structural steel or other permanent metallic system. Group protector, busbar bonding, and approved building grounding conductors toward the left end and leave space for equipment grounding conductors to the right end.

C. TBB(s) and Grounding Conductors: Provide TBB(s) and grounding conductors as shown on the Contract Documents and as required to bond all non-current carrying metal telecommunications equipment and materials to the nearest TGB. Use TBB(s) to connect the TMGB to each TGB. Route along the shortest and straightest path possible with minimal bends. Bends shall be sweeping. Insulate TBB(s) and conductors from their support. TBB(s) and grounding conductors shall be continuous (without splices).
   1. Bare conductors shall be provided for cable trays, wire mesh trays and wire gutter.
   2. Insulated conductors shall be provided in telecommunications rooms.
   3. Ensure that bonding breaks through paint to the bare metallic surface of all painted metallic hardware.

D. Special Applications:
   1. Exterior Wireless Access Point Panels: Provide a Narrow grounding busbar as shown on the Contract Documents. Install busbars and bond busbars to associated TBB(s).

3.4 LABELS:

A. Label TMGB(s) with “TMGB”. If the TMGBs are existing and unlabeled, provide labels for each.

B. Label TGB(s) with “TGB”. If the TGBs are existing and unlabeled, provide labels for each.

C. Label TBB(s) and bonding conductors “WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!”

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials and labor for the installation of hangers and supports for an inside plant telecommunication system.

1.2 SYSTEM DESCRIPTION

A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete system of hangers and supports for an inside plant telecommunications system as hereinafter specified and/or shown on the Contract Documents. The system shall support an ANSI/TIA/EIA and ISO/IEC compliant communications Structured Cabling System (SCS) as specified in section 271500 - Communications Horizontal Cabling.

B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the Contract Documents but which are necessary to make a complete working Raceway system.

1.3 QUALITY ASSURANCE

A. Listing and Labeling: Provide devices specified in this Section that are listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in NEC, Article 100.
   2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

B. Comply with NECA's "Standard of Installation" and with NEC.

1.4 COORDINATION

A. Coordinate layout and installation of devices with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 GENERAL

A. Installation and materials for the raceway and boxes for the SCS shall be as specified under section 270528.33 – “Conduits and Backboxes for Communications Systems” except where noted below.

2.2 SLEEVES

A. EMT conduit, with insulated throat bushings for each end.

2.3 CABLE SUPPORTS

A. Cable Supports (J-Hooks, Straps) complete with incidental materials and assemblies required for mounting. CADDY and BLine products or approved equal:
   1. CADDY CableCat Wide Base Cable Supports (J-Hooks):
      a. CAT12 (up to 16 4-pair/2-strand UTP/fiber cables)
      b. CAT21 (up to 50 4-pair/2-strand UTP/fiber cables)
      c. CAT32 (up to 80 4-pair/2-strand UTP/fiber cables)
   2. CADDY CableCat Adjustable Cable Supports (Straps):

a. CAT425 (up to 425 4-pair/2-strand UTP/fiber cables)

PART 3 - EXECUTION

3.1 SLEEVES

A. Provide sleeves where required for cable pass-thru through building structures and/or fire rated barriers. Provide roto-hammering or core drilling where required for sleeve installation. Seal (and if a fire rated barrier, firestop) between sleeve and building structure and/or barrier.

B. Size sleeves:
1. As noted in the Contract Documents.
2. Where not noted, size sleeves a minimum of 2 inches in diameter or by the type and quantity of cable to be routed through the sleeve per ANSI/TIA/EIA 569 cable capacity standards plus an additional 100% for future expansion - whichever is greater.

3.2 CABLE SUPPORTS

A. Provide cable supports (J-Hooks, Straps) for routing cable in non-exposed open access environments as shown in the Contract Documents. Cable supports may be affixed to wall/ceiling structures or other supports, but shall not be attached to a ceiling support system.

B. Size supports according to the type and quantity of cable to be routed through the ring per ANSI/TIA/EIA 569 cable capacity standards, plus an additional 50% for future expansion.

C. Mount cable supports at 4 foot intervals unless otherwise specified in the Contract Documents. Do not use cable supports for more cables than they were designed to support. Provide multiple cable supports where the total cable count exceeds the maximum cable count for which the support was designed.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials and labor for the installation of a pathway system for inside plant communications circuits. This section includes requirements for horizontal and building backbone raceways, fittings, and boxes specific to communications circuits (cabling) for voice and data.

1.2 SYSTEM DESCRIPTION

A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete Raceway system as hereinafter specified and/or shown on the Contract Documents. The Raceway system shall support an ANSI/TIA/EIA and ISO/IEC compliant communications Structured Cabling System (SCS) as specified in 271500 - Communications Horizontal Cabling.

B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the Contract Documents but which are necessary to make a complete working Raceway system, compliant with ANSI/TIA/EIA 572.

1.3 QUALITY ASSURANCE

A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in NEC, Article 100.
   2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

B. Comply with NECA's "Standard of Installation" and with NEC Quality assurance.

1.4 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials shall consist of conduit, surface metal raceway, outlet boxes, fittings, enclosures, pull boxes, and other raceway incidentals and accessories as required for inside plant communications circuits.

2.2 MATERIALS

A. Conduit:
   1. EMT: 1¼” trade size minimum, however 1” trade size may be permitted for some specifically-designated, limited applications. Flexible metal conduit (FMC) is not acceptable.
      a. Conduit: Galvanized steel tubing meeting ANSI C80.3.
      b. Couplings: Steel couplings or malleable iron compression-type couplings employing a split, corrugated ring and tightening nut, with integral bushings and locknuts. Set-screw couplings are acceptable.
         1) Die-cast couplings are not permitted.
         2) Indent-type couplings are not permitted.

c. Insulated throat bushings: Arlington EMTxxx or approved equal.
d. Ground Wire Clamp: Penn-Union Zinc Die Cast Ground Clamp or approved equal.

2. RMC: 1¼" trade size minimum.
   a. Conduit: Hot dipped galvanized steel with threaded ends meeting ANSI C80.1.
   b. Couplings: Unsplit, NPT threaded steel cylinders with galvanizing equal to the conduit.
   c. Nipples: Same as conduit, factory-made up to 8 inches in diameter, no running threads.
   d. Insulated throat bushings: Arlington RGDxxx or approved equal.
   e. Ground Wire Clamp: Penn-Union Zinc Die Cast Ground Clamp or approved equal.

B. Sleeves: EMT conduit, with insulated throat bushings for each end and ground wire clamp on one end.

C. Outlet boxes: Minimum 5"x5" size, 2 7/8" minimum depth, with extension rings (if needed) and double gang covers (i.e. mud rings), unless otherwise noted on the Contract Documents. Combined interior depth of outlet box, extension ring and cover shall be a minimum 3 3/8". Welded steel, galvanized, with knockouts for 1¼" trade size conduit or connector entrance, meeting NEMA OS 1, with 4 cable management inserts.
   1. Acceptable manufacturers for indoor applications:
      a. RANDL Industries, Inc., T-series with cable management. www.randl-inc.com (509) 340-0050. Also available from Siemon.
   2. Acceptable manufacturers for outdoor weatherproof applications:
      a. Box: 4"x4" Taymac DB5100 with plugs for unused holes.
      b. Cover: Taymac MX6200 with GFCI device configuration.

D. Outlet Box Support Brackets: Rough in brackets for mounting multiple device boxes in a single stud space.
   1. Acceptable manufacturers:
      a. RANDL Industries, Inc. www.randl-inc.com (509) 340-0050
         1) 16" Stud Spacing: RANDL 5BSB-16
         2) 24" Stud Spacing: RANDL 5BSB-24

E. Floor Boxes:
   1. FSR:
      a. Box: FL-500P-x (where x = 6, 8 or 10 inches deep)
      b. Cover: FI-500P-xxx-C
      c. Slab-on-grade Pour Pan: FL-GRD2/4
      d. Fire-rated Slab Pour Pan: FL-FRK-500P
   2. FSR:
      a. Box: FL-600P-x (where x = 6, 8 or 10 inches deep)
      b. Cover: FI-600P-xxx-C
      c. Slab-on-grade Pour Pan: FL-GRD2/4
      d. Fire-rated Slab Pour Pan: FL-FRK-605P
   3. Hubbell:
      a. Recessed Multi-Service Concrete Floor Box: CFB7Gx (where x = 4 or 6 inch minimum depth of pour)
      b. Cover: Aluminum, CFB7CVRALU

F. Poke-thru Devices:
   1. Legrand:
      a. Device: Evolution xATC series (where x = 6 or 8 inches in diameter) with surface-style cover.
      b. Cover: Matching architectural finish (black, gray, nickel, brass or bronze)
      c. Device Plates: as required for audio visual connectors, data connectors and power receptacles
         1) Center-mount device plates

2) Side-mount device plates
3) Bottom-feed center-mount device plates
4) Bottom-feed side-mount device plates

G. Junction Boxes and Pull Boxes: Stamped steel, deep drawn one piece (without welds or tab connections), galvanized, with knockouts for conduit or connector entrance. Boxes 6”x6”x4” or larger may be code gauge fabricated steel continuously welded at seams and painted after fabrication.
1. Dry locations: meeting NEMA OS 1
2. Wet locations: NEMA OS 3R

H. Miscellaneous Fittings:
1. Die-cast fittings are prohibited.
2. Locknuts and conduit bushings: Malleable iron
a. Appleton, Crouse Hinds, OZ Gedney, or equal
3. Through wall seals and floor seals shall be:
a. OZ Gedney FS and WS series

I. Pull Strings: Plastic or nylon with a minimum test rating of 200 lb.

2.3 LABELING AND ADMINISTRATION

A. Labels: As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, typed, and created by a hand-carried label maker or an approved equivalent software-based label making system. Handwritten labels are not acceptable.
1. Labels:
a. Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)
b. Hand-carried label maker: Brady: ID Pro Plus (or approved equal)

PART 3 - EXECUTION

3.1 GENERAL

A. Install the raceway system in a manner ensuring that communications circuits, when installed, are able to fully comply with ANSI/TIA/EIA Standards.

3.2 EXAMINATION

A. Examine surfaces and spaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Notify the Engineer and the Owner’s IT Representative of conditions that may adversely affect the installation or subsequent use to not comply with ANSI/TIA/EIA standards.

3.3 INSTALLATION

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions. Provide a raceway for each circuit indicated. Do not gang raceway into wireways, pullboxes, junction boxes, etc., without specific approval from the Engineer. Do not group home runs or circuits without approval from the Engineer.

B. Conduit:

1. Provide EMT unless other conduit shown on the Contract Documents is required by Code, or is permitted under these specifications.
2. Provide RMC for outdoor applications and as shown on the Contract Documents, and where RMC is required by Code.
3. Install conduit as a complete, continuous system without wires, mechanically secured and electrically connected to metal boxes, fittings and equipment. Blank off unused openings using factory-made knockout seals.
4. Run conduit in the most direct route possible, parallel to building lines. Do not route conduit through areas in which flammable material may be stored.
5. Keep conduit at least 6 inches away from parallel runs of flues and steam or hot water pipes or other heat sources operating at temperatures above one hundred degrees Fahrenheit. Install horizontal conduit runs above water piping.
6. Keep conduit away from sources of electromagnetic interference as follows:
   a. 5 inches from fluorescent lighting
   b. 12 inches from conduit and cables used for electrical power distribution
   c. 48 inches from motors or transformers
7. Do not exceed 90 meters total length for a given conduit run to be used for distribution cabling (from outlet box to telecommunications room), including intermediate conduits and junction boxes.
8. Install conduit exposed, except in finished areas or unless shown otherwise on the drawings. Do not install conduit below grade/slab unless specifically shown on the Contract Documents as being installed below grade/slab.
9. Install exposed conduit in lines parallel or perpendicular to building lines or structural members except where the structure is not level. Follow the surface contours as much as practical. Do not install crossovers or offsets that can be avoided by installing the conduit in a different sequence or a uniform line.
   a. Run parallel or banked conduits together, on common supports where practical.
   b. Make bends in parallel or banked runs from same centerline to make bends parallel.
10. Conduits concealed above ceilings, furred spaces, etc., which are normally inaccessible may be run at angles not parallel to the building lines.
11. Wherever practical, route conduit with adjacent ductwork or piping and support on common racks. Base required strength of racks, hangers, and anchors on combined weights of conduit and piping.
12. Where conduits cross building expansion joints, use suitable sliding or offsetting expansion fittings. Unless specifically approved for bonding, use a suitable bonding jumper.
13. Support conduits as specified in Section 270500 "Common Work Results for Communications."
    a. Provide anchors, hangers, supports, clamps, etc. to support the conduits from the structures in or on which they are installed. Do not space supports farther than five feet apart.
    b. Provide sufficient clearance to allow conduit to be added to racks, hangers, etc. in the future.
    c. Support conduit within three feet of each outlet box, junction box, gutter, panel, fitting, etc.
14. Ream conduits to eliminate sharp edges and terminate with metallic insulated grounded throat bushings. Seal each conduit after installation (until cable is installed) with a removable mechanical-type seal to keep conduits clean, dry and prevent foreign matter from entering conduits.
15. Install a pull string in each conduit.
16. For conduits entering through the floor of a telecommunications room, terminate conduits 4 inches above the finished floor.
17. Do not install communications conduits in wet, hazardous or corrosive locations.
18. Where conduit is shown embedded in masonry, embed conduit in the hollow core of the masonry. Horizontal runs in the joint between masonry units are not permitted.
19. Where conduit is shown embedded in concrete, embed conduit a minimum of two inches from the exterior of the concrete. Do not place conduit in concrete less than five inches thick.

a. 1¼" trade size conduit shall be used. Conduits sized larger or smaller than 1¼" trade size conduit are not permitted embedded in concrete.
b. Run conduit parallel to main reinforcement.
c. Conduit crossovers in concrete are not permitted.

20. Where conduit exits from grade or concrete, provide a rigid steel elbow and adapter.
21. Where conduit enters a space through the floor and terminates in that space, terminate the conduit at 4" above the finished floor.
22. Where conduits terminate at a cable tray, the conduits shall be consistently terminated no more than 8" from the cable tray, and have a visually uniform appearance.
23. Where several circuits follow a common route, stagger pullboxes or fittings.
24. Where several circuits are shown grouped in one box, individually fireproof each conduit.
25. Bend and offset metal conduit with standard factory sweeps or conduit fittings. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
    a. Conduit sweeps:
        1) Sweeps shall not exceed 90 degrees.
        2) Do not exceed 180 degrees for the sum total of conduit sweeps for a section of conduit (between conduit termination points).
        3) Sweep radius shall be at least 10 times the internal diameter of the conduit.
        4) 90-degree condulets (LBs) and electrical elbows are not acceptable.
    b. Factory-manufactured sweeps are required for bends in conduit larger than 1¼" trade size.
    c. For bends in 1¼" trade size conduit, field-manufactured bends (using a hydraulic bender with a 1¼" boot) are permitted only when factory-manufactured sweeps are not suitable for the conditions. In all other cases, factory-manufactured sweeps are required. "Hickey-bender" use is prohibited.
26. Connect conduit to hubless enclosures, cabinets and boxes with double locknuts and with insulating bushings. Use grounding bushings where connecting to concentric or eccentric knockouts. Connect conduits to enclosures at the nearest practicable point of entry to the enclosure area where the circuits contained in the conduit will terminate.
27. Penetrations for raceways:
    a. Do not bore holes in floor and ceiling joists outside center third of member depth or within two feet of bearing points. Holes shall be 1½" diameter maximum.
    b. Penetrate finished walls and finished surfaces with a PVC or sheet metal sleeve with an interior diameter (ID) at least ¼" greater than the outer diameter (OD) of the conduit, set flush with walls, pack with fiberglass, seal with silicone sealant and cover with escutcheon plate.
    c. Penetrate poured-in-place walls and free slabs with a cast iron sleeve (or Schedule 40 PVC black pipe sleeve for above-grade only) with retaining ring or washer. Set sleeves flush with forms or edges of slab. Pack around conduit with fiberglass and seal with silicone sealant.
28. Raceway terminations and connections:
    a. Join conduits with fittings designed and approved for the purpose and make joints tight. Do not use set indent-type or die-cast couplings.
    b. Make threaded connections waterproof and rustproof by applying a watertight, conductive thread compound. Clean threads of cutting oil before applying thread compound.
    c. Make conduit terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
    d. Cut ends of conduit square using a hand saw, power saw or pipe cutter. Ream cut ends to remove burrs and sharp ends. Where conduit threads are cut in the field, cut threads to have same effective length, thread dimensions, and taper (pitch) as specified for factory-cut threads.
    e. Provide double locknuts and insulating bushings at conduit connections to boxes and cabinets. Align raceways to enter squarely, and install locknuts with dished part against the box. Use grounding type bushings where connecting to concentric or eccentric knockouts.

f. Where conduits are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

29. Install conduit sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed conduits, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
    a. Where conduits pass from warm to cold locations, such as the boundaries of air-conditioned or refrigerated spaces and where conduits enter or exit buildings from outdoor areas, including underground ducts or conduit runs.
    b. Where otherwise required by the NEC.
30. Conduit shall be clean and dry.

C. Sleeves:
1. Provide sleeves where required, sized as noted on the Contract Documents. Where not noted, sleeve sizing shall be determined by the type and quantity of cable to be routed through the sleeve per TIA/EIA 569A cable capacity standards, plus an additional 100% for future expansion.
2. Provide roto-hammering or core drilling where required for installation.
3. Seal between sleeve and wall or floor in which the sleeve is installed. Firestop penetration to restore wall or floor to pre-penetration fire rating.

D. Wire Gutter:
1. Provide wire gutter as shown on Contract Documents.
2. Wire gutter shall be routed parallel to and perpendicular to surfaces or exposed structural members, and follow surface contours. Wire gutter shall not be warped during installation such that hinged cover operation is impaired.
3. Wire gutter color shall be painted according to Architectural requirements.
4. Wire gutter systems shall be completely installed, including insulating bushings and inserts as required by manufacturer’s installation requirements. Unused openings in the surface raceway shall be closed using manufactured fittings.
5. Wire gutter covers shall open and close without obstruction and shall swing freely on hinges. Closure mechanisms shall securely retain the covers in their closed position.
6. Wire gutter shall be securely supported by screws or other anchor-type devices at intervals not exceeding 4 feet and with no less than six supports per straight section. Wire gutter shall be securely supported in accordance with the manufacturer’s requirements. Tape and glue are not acceptable support methods.
7. Provide a continuous grounding conductor running the length of the wire gutter. Bond each section of wire gutter to the grounding conductor. Ensure that the grounding/bonding hardware breaks through painted surfaces and contacts bare metal.
8. For wire gutter installed in outdoor environments, seal all penetrations against moisture intrusion.

E. Outlet Boxes:
1. Provide outlet boxes and covers as shown on the Contract Documents and as needed. Verify that the appropriate cover type and depth is provided for each type of wall and finish. Provide extension rings as needed.
2. Coordinate box locations with building surfaces and finishes to avoid bridging wainscots, joints, finish changes, etc.
3. Install boxes in dry locations (not wet, corrosive, or hazardous).
4. Attach boxes securely to building structure with a minimum of two fasteners. Provide attachments to withstand a force of 50 pounds minimum, applied vertically or horizontally.
5. Install boxes at the following heights to the bottom of the box, except where noted otherwise:
    a. Wall mounted telephones: 48 inches above finished floor to center line.

b. Workstation outlets: 18 inches above finished floor to center line.
c. Place boxes for outlets on cabinets, countertops, shelves, and similar boxes located above countertops two inches above the finished surface or two inches above the back splash. Verify size, style, and location with the supplier or installer of these items prior to outlet box installation.

6. Recessed mounted outlet boxes:
   a. Recess boxes in the wall, floor, and ceiling surfaces in finished areas. Set boxes plumb, level, square and flush with finished building surfaces within one-sixteenth inch for each condition. Set boxes so that box openings in building surfaces are within one-eighth inch of edge of material cut-out and fill tight to box with building materials. Single gang opening shall extend at least to the finished wall surface and extend not more than 1/8 inch beyond the finished wall surface. Provide backing for boxes using structural material to prevent rotation on studs or joists.
   b. Install floor boxes level and adjust to finished floor surface.
7. Surface-mounted outlet boxes:
   a. For boxes surface-mounted on finished walls, provide Wiremold outlet box. Cut box as necessary to accept conduit.
   b. For boxes surface-mounted on unfinished walls (i.e. electrical rooms, mechanical rooms), provide 4”x4” (minimum) outlet box with single gang cover.
8. Outdoor outlet boxes:
   a. For boxes mounted outdoors, provide weatherproof boxes and covers.

F. Floor Boxes: See Division 26.
1. For floor boxes with combined power and telecommunications circuits, provide metal dividers to separate power from telecommunications circuits.

G. Poke-thru Devices:
1. Provide poke-thru devices with mounting plates as required for each application.
2. Coordinate with Division 26 requirements.

H. Junction Boxes:
1. Provide junction boxes as shown on the Contract Documents and as required.
   a. Where sizing is not shown on the Contract Documents, size junction box length and depth according to the size of the feeder conduit in the following table:

Feeder Conduit Size	Box Length	Box Depth
1”	12”	4”
1-¼”	12”	4”
1-½”	12”	4”
2”	24”	4”
2-½”	24”	6”
3	36”	6”
3-½”	48”	6”
4”	60”	6”

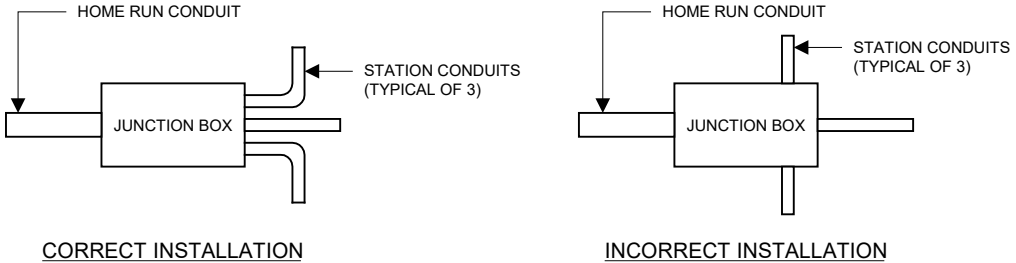
   b. Where sizing is not shown on the Contract Documents, size junction box width according to the following formula:
      1) From the table below, select the width associated with the largest conduit on the distribution side of the box. For each additional distribution conduit, add the “Increase Width” value associated with the size of that distribution conduit to the box width for the largest distribution conduit.

a) For example, if the distribution side of the junction box has three 1-¼" distribution conduits and one 1" distribution conduit, the total distribution-side width would be 6"+3"+3"+2"=14".

2) Repeat the above process for the feeder side of the junction box. Junction boxes are typically fed by a single conduit, therefore unless the box has more than one feeder conduit, the "Increase Width" part of the formula is unnecessary.
   a) For example, if the feeder side of the junction box has two 2" feeder conduits the total feeder-side width would be 8"+5"=13".
3) The larger of the two width calculations (distribution side vs. feeder side) shall be the width of the junction box to be provided.
   a) For example, if the distribution-side width were 10" and the feeder-side width were 13", provide a 13" wide junction box.

Conduit Size	Box Width	For each additional conduit Increase Width
1"	4"	2"
1-¼"	6"	3"
1-½"	8"	4"
2"	8"	5"
2-½"	10"	6"
3	12"	6"
3-½"	12"	6"
4"	15"	8"

2. A junction box may not be substituted for a 90-degree bend. *90 degree condulets (LBs) are not acceptable.*
3. Install junction boxes in an accessible location, readily accessible both at time of construction and after building occupation. Do not install junction boxes in inaccessible interstitial building spaces.
4. Where junction boxes are to be mounted on ceiling structure above ceiling grid, do not mount higher than 4' above grid (mount on wall instead).
5. Install hinged-cover enclosures and cabinets plumb, and supported at each corner.
6. Install junction boxes so that the access door opens from the side where the cable installer will normally work – typically from the bottom (floor side) of the box.
   a. Where a junction box is installed in a ceiling space, provide full access to the junction box door and adequate working room for both the installation personnel and for proper looping of cable during installation.
   b. Provide a lockable access cover (or junction box door if junction box is exposed) in hard lid ceilings.
7. Install junction boxes such that conduits enter and exit at opposite ends of the box as follows:



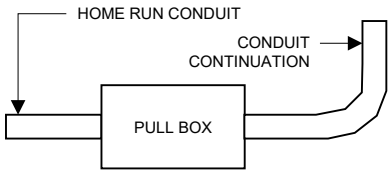
CORRECT INSTALLATION INCORRECT INSTALLATION

I. Pull Boxes:

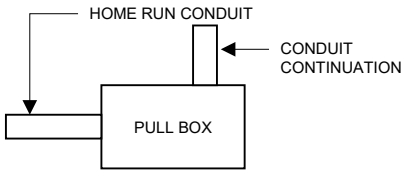
1. Provide pull boxes as shown on the Contract Documents and as required.
   a. Where sizing is not shown on the Contract Documents, size pull boxes as follows:

Size of Largest Conduit	Box Width	Box Length	Box Depth
1”	4”	12”	4”
1-¼”	6”	12”	4”
1-½”	8”	12”	4”
2”	8”	24”	4”
2-½”	10”	24”	6”
3	12”	36”	6”
3-½”	12”	48”	6”
4”	15”	60”	6”

   b. Where a pull box is required with conduits 1” trade size or smaller, an outlet box may be used as a pull box. Where outlet boxes are used as pull boxes, the outlet boxes shall be dedicated for use as a pull box and shall not host cable termination hardware.
2. A pull box may not be substituted for a 90-degree bend. *90 degree condulets (LBs) are not acceptable.*
3. Install pull boxes in an accessible location, readily accessible both at time of construction and after building occupation. Do not install pull boxes in inaccessible interstitial building space.
4. Where pull boxes are to be mounted on ceiling structure above ceiling grid, do not mount higher than 4’ above grid (mount on wall instead).
5. Install hinged-cover enclosures and cabinets plumb, and supported at each corner.
6. Install pull boxes so that the access door opens from the side where the cable installer will normally work (typically from the bottom, or floor side, of the box).
   a. Where a pull box is installed in a ceiling space, provide full access to the junction box door and adequate working room for both the installation personnel and for proper looping of cable during installation.
   b. Provide a lockable access cover (or pull box door if pull box is exposed) in hard lid ceilings.
7. Install pull boxes such that conduits enter and exit at opposite ends of the box as follows:



CORRECT INSTALLATION



INCORRECT INSTALLATION

3.4 GROUNDING/BONDING:

A. Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, UAC, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 – REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.
   1. Bond metallic raceway together and to the nearest TGB (as provided under Division 27 Section — “Grounding and Bonding for Communications Systems”). Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.

3.5 LABELS:

A. Conduits: Label each conduit end in a clear manner by designating the location of the other end of the conduit (i.e. room name, telecommunications room name, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.). Indicate conduit length on the label.
   1. Where a conduit is intended for future cabling use outside of the Contract, the conduit shall be labeled in a clear manner by designating the location of the other end of the conduit (i.e. room name, telecommunications room name, pull box identifier, etc.) along with a sequential number for each spare conduit terminated into a single room. Indicate conduit length on the label.
      a. Suggestion: The second spare conduit (whether spare or in use) between Room 100 and telecommunications room 205 might be labeled in the telecommunications room as “Room 100 - #2, __ feet.” In Room 100 the same conduit might be labeled “205 - #2, __ feet.”

B. Pull Boxes: Label each pullbox with a unique identifier. Identifiers shall be of the form “RN-Y” where “RN” is the room name of the room closest to (or containing) the pull box, and “Y” is the sequential number of the pull box for each “RN”.
   1. Example: The second pull box in the vicinity of room “100” would have the label “100-2”.

3.6 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and in accordance with accepted industry practice, to ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING
   1. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials and labor for the installation of a cable tray system for communications infrastructure. This section includes requirements for providing a cable tray system for communications circuits. These requirements are in addition to any that may exist in Division 26 – “Cable Tray.”

1.2 SYSTEM DESCRIPTION

A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete, permanent Cable Tray infrastructure for communications circuits as hereinafter specified and/or shown on the Contract Documents. The Cable Tray system shall support an ANSI/TIA/EIA and ISO/IEC compliant communications Structured Cabling System (SCS) as specified in Division 27 Section — "Communications Horizontal Cabling."

B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant Cable Tray system.

1.3 REFERENCES

A. The applicable portions of the following specifications, standards, codes and regulations shall be incorporated by reference into this section:
1. ASTM A123 – Specification for Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
2. ASTM A653 – Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process, Structural (Physical) Quality.
3. ASTM A1011 – Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low-Alloy with Improved Formability.
4. ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low-Alloy with Improved Formability.
5. ASTM B633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel
6. NEMA VE 1 – Metallic Cable Tray Systems
7. NEMA VE 2 – Cable Tray Installation Guidelines

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials shall consist of tray sections, tray fittings, connectors, supports, expansion joints, blind end plates, barrier strips, radius drops, bonding conductors and other incidentals and accessories as required. Provide all incidental and/or miscellaneous hardware not explicitly specified or shown on the Contract Documents that is required for a fully operational and warranted system.

B. Physically verify existing site conditions prior to purchase and delivery of the materials.

C. Except for the use of ladder rack and wire basket tray where indicated, open bottom type cable trays, where cable and wiring are exposed to view are not acceptable.

D. Structure of trays shall be suitable to support a continuous loading of cables weighing 75 lbs. per linear foot, when supported on 12' centers, without any deflection exceeding 1/100 of the span, with a safety factor of 1.50.

E. Interior surfaces shall be smooth and free of offset edges, projections or misalignment. Assembly bolts for end-to-end connections shall have a pattern which does not cause damage to cable sheaths or jackets. All edges shall be smooth, rounded and de-burred.

F. Manufacturer's factory-fabricated accessories and special transitions shall be provided for all changes in direction, elevation and offsets. Use manufacturer's standard fittings including bolting assemblies for all end-to-end connections.
   1. Field-fabricated transitions shall not be accepted.

2.2 LADDER-STYLE CABLE TRAY

A. Ladder-style cable tray components shall be manufactured by a single manufacturer. Components shall not be intermixed between different manufacturers.
   1. The cable tray manufacturer shall be the following:
      a. BLine, Thomas & Betts (T&B), PW, Cablofil, GS Metals or pre-approved equal
   2. Substitution is not acceptable unless the cable tray manufacturer has been pre-approved prior to bidding. Contractors, in order to obtain approval for cable tray manufacturer substitution, shall submit their request for substitution to the Engineer at least two weeks prior to the bid date. Approval or denial of a substitution request will be based upon the judgment of the Engineer and the Owner’s IT Representative.

B. Cable tray shall be comprised of “C” channel sides and a bottom comprised of ladder rungs (with a rung interval between 6” and 8”, and a fill depth of 4”).
   1. The cable tray product line shall be the following:
      a. For 12” BLine: 166 P 06-12-144 (pre-galvanized steel).
      b. For 18” BLine: 166 P 06-18-144 (pre-galvanized steel).
      c. For 12” T&B: (PG3-5)-12-L06-288 (pre-galvanized steel).
      d. For 18” T&B: (PG3-5)-12-L06-288 (pre-galvanized steel).
      e. For 12” PW: 06-B518-0020-12 (mill-galvanized steel).
      f. For 18” PW: 06-B518-0020-18 (mill-galvanized steel).
   2. Aluminum tray is not permitted.
   3. Width: Widths shall be as shown on the Contract Documents. Where cable tray width is not shown on the Contract Documents, it shall be sized according to the amount of cable to be placed in the trays (as shown on the Contract Documents) plus an additional 100% for future expansion capability.
   4. Depth: Depths shall be as shown on the Contract Documents. Where cable tray fill/load depth is not shown on the Contract Documents, it shall be 4”.
   5. Fittings: Fittings shall be factory manufactured.
   6. Lids: Lids shall be provided where shown on the Contract Documents.

C. Cable tray shall be factory-galvanized and remain unpainted as indicated in the Contract Documents. Do not paint cable tray or cabling.

2.3 WIRE BASKET (MESH) TRAY

A. Wire mesh tray components shall be manufactured by a single manufacturer. Components shall not be intermixed between different manufacturers.
   1. The cable tray manufacturer shall be one of the following:
      a. Cablofil
      b. GS Metals

c. PW
d. or pre-approved equal

2. Substitution is not acceptable unless the cable tray manufacturer has been pre-approved prior to bidding. Contractors, in order to obtain approval for cable tray manufacturer substitution, shall submit their request for substitution to the Engineer at least two weeks prior to the bid date. Approval or denial of a substitution request will be based upon the judgment of the Engineer and the Owner's IT Representative.

B. For a given manufacturer, all components shall be part of a single cable tray product line – components shall not be intermixed between a manufacturer's cable tray product lines.
1. The cable tray product one shall be one of the following Electroplated Zinc galvanized product lines, 2" deep and 4" deep as the application requires:
a. For Cablofil, Inc.: EZ Tray CF54/xxx and CF105/xxx Series
b. For GS Metals: EG Flextray FT2 and FT4 Series
c. For PW: Wire Mesh Cable Trays 8020 and 8040 Series

C. Wire mesh tray shall be constructed of welded wire mesh (high strength steel wires) with a continuous safety edge wire lip. Tray shall be complete with all supports, materials, and incidental and miscellaneous hardware required for a complete cable tray system.
1. Finish: Carbon steel with electro-plated zinc galvanized finish.
2. Width: Widths shall be as shown on the Contract Documents. Where cable tray width is not shown on the Contract Documents, it shall be sized according to the amount of cable to be placed in the trays (as shown on the Contract Documents) plus an additional 100% for future expansion capability.
3. Depth: Depths shall be as shown on the Contract Documents. Where cable tray depth is not shown on the Contract Documents, it shall be 4".
4. Mesh: 2 x 4 inches.
5. Fittings: Fittings shall be field-fabricated from straight sections using manufacturer-approved tools and in accordance with manufacturer's instructions.

2.4 SUPPORTS

A. Cable tray supports shall be as shown on Contract Documents.

B. Wall bracket supports, per manufacturer's requirements:
1. Cable tray shall be attached to bracket.
2. Brackets shall provide for open side access cable lay-in capability.
3. Coordinate bracket installation with General Contractor for blocking and backing support for cable tray installation.

C. Center hanger supports, per manufacturer's requirements:
1. Cable tray shall be attached to bracket.
2. Center support hangers shall provide for open side access cable lay-in capability.
3. Coordinate center hanger installation with General Contractor for blocking and backing support for installation of angled sway-prevention member.

D. Trapeze-style hanger supports, per manufacturer's requirements:
1. Cable tray shall be attached to bracket.
2. Coordinate center hanger installation with General Contractor for blocking.

E. Single channel supports shall be formed finished steel shapes.

2.5 GROUNDING AND BONDING

A. Continuous Grounding Conductor: 6 AWG bare copper conductor. Using the cable tray or wire mesh tray as a grounding conductor, with bolted splicing hardware and bonding jumpers, is not acceptable.

B. Grounding Lugs:
   1. Ladder-style Tray
      a. For BLine: 9A-2130 with attachment clamp 9ZN-2351
      b. For T&B: 10105
      c. For PW: 9992-A840-01 with attachment clamp 9999-1873-03
   2. Wire Mesh Tray
      a. For GS Metals: GROUNDBOLT with Ground Support Clip GROUNDSUPT GL
      b. For Cablofil: GNDCL Grounding Lug with GS Metals Ground Support Clip GROUNDSUPT GL
      c. For PW: 9992-A840-01 with attachment clamp 9999-1873-03

2.6 FIRESTOPPING MATERIAL

A. Firestopping material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions. Manufactured by:
   1. Specified Tech. Inc.

2.7 LABELING AND ADMINISTRATION

A. Labels: As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
   1. Labels: Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)
   2. Label Clips: Cablofil, Inc. (regardless of wire mesh tray manufacturer)
   3. Hand-carried label maker: Brady: ID Pro Plus (or approved equal).

PART 3 - EXECUTION

3.1 GENERAL

A. Install the cable tray system in a manner ensuring that communications circuits, when installed, are able to fully comply with the ANSI/TIA/EIA Standards.

3.2 EXAMINATION

A. Examine surfaces and spaces to receive cable tray for compliance with installation tolerances and other conditions affecting performance of cable tray installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Notify the Engineer/Owner of conditions that may adversely affect the installation, subsequent use, or cause the tray (or circuits to be subsequently installed in the tray) to not comply with ANSI/TIA/EIA standards.

3.3 INSTALLATION

A. Provide cable tray, in the locations and widths shown on the Contract Documents and in accordance with manufacturer's requirements and industry practices (NEMA VE 2). Ensure that the cable tray

equipment complies with the requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.

1. Cable tray shall be installed plumb, level and square with finished building surfaces.
2. Cable tray shall be protected from damage prior to and during installation. Visible warping, dents, and other damage are prohibited. Remove and replace any damaged tray segments.
3. Provide factory-manufactured connection hardware between each cable tray segment. Cable tray segments shall be mutually aligned. Connection hardware shall be installed according to the manufacturer's requirements.
4. Cable tray elevation changes shall be gradual or as shown on the Contract Documents.

B. Wall Penetrations:
   1. Provide wall penetrations where required and as shown on the Contract Documents. Provide roto-hammering, core drilling and saw cutting where required for installation. Seal (and firestop if fire-rated barrier) between slot/sleeve and cable tray.
   2. Provide fire-rated cable pathway hardware.

C. Cable Tray Routing:
   1. Route cable tray as shown on the Contract Documents. Where not shown on the Contract Documents, route cable tray in the most direct route possible, parallel to building lines.
   2. Do not route cable tray through areas in which flammable material may be stored or through wet, hazardous or corrosive areas.

D. Cable Tray Clearance Requirements:
   1. Clearance requirements for cable tray accessibility:
      a. Maintain a clearance of 10" between top of cable tray and ceiling structure or other equipment or raceway.
      b. Maintain a clearance of 12" between at least one side of cable tray and nearby objects.
      c. Maintain a clearance of 2" between bottom of cable tray support brackets and ceiling grid or other equipment or raceway.
   2. Clearance requirements from sources of electromagnetic interference (EMI):
      a. Maintain a clearance of 5" or more from fluorescent lighting.
      b. Maintain a clearance of 12" or more from conduit and cables used for electrical power distribution.
      c. Maintain a clearance of 48" or more from motors or transformers.
      d. Pathways shall cross perpendicularly to electrical power cables or conduits.
   3. Maintain a clearance of at least 6 inches from parallel runs of flues and steam or hot water pipes or other heat sources operating at temperatures above one hundred degrees Fahrenheit.

E. Cable tray supports shall be provided where shown on the Contract Documents. Where not shown on the Contract Documents, supports shall be provided according to the manufacturer's recommendations.
   1. Load span criteria: Install tray supports in accordance with the load criteria of L/240, and as shown on the Contract Documents.
   2. Supports shall be attached to structural ceiling or walls with hardware or other installation and support aids specifically designed for the cable tray and designed to support the cable tray's weight and required cable weight and volume.
   3. Where cable trays abut walls, provide wall-mounted supports.
   4. Do not attach cable tray supports to ceiling support system or other mechanical support systems.

F. Cable tray shall be installed free of burrs, sharp edges, or projections which may damage cable insulation or cause cuts to cable installation technicians. Cable tray shall be free of denting and other bending damage in surfaces that are intended to be straight and true.
   1. Where burrs, sharp edges, or projections occur, remove sharp surfaces and repair coating.

G. Wire mesh-type cable tray shall be cut with a manufacturer-approved cutter with “offset cutting blade” jaws and a minimum 24 inch handle.
   1. The position of the jaws at the point where the cut is to be made shall allow shearing as close as possible to the intersection of the steel wires.
   2. Cuts shall ensure the integrity of the galvanic protective layer.
   3. Do not use saws to cut tray.

H. Wire Mesh Tray Fittings: Provide field-fabricated fittings from straight sections of cable tray using manufacturer-approved tools and in accordance with manufacturer’s instructions. Bends shall be long radius. Short radius bends and T-sections shall not be used unless specifically shown on the Contract Documents.

I. Cable Tray Fittings: Provide factory-fabricated fittings in accordance with manufacturer’s instructions. Bends shall be long radius. Short radius bends and T-sections shall not be used unless specifically shown on the Contract Documents.

J. Expansion Joints: Provide cable tray sliding or offsetting expansion joints/fittings where shown on the Contract Documents and where cable tray crosses building expansion joints. Provide bonding jumper except where expansion joints are specifically approved for bonding.

K. Thermal contraction and expansion: Install cable tray sections with gap settings between cable tray sections that are appropriate for the range of thermal expansion and contraction expected for the space during construction and also during normal occupancy and operation.

L. Blind End Plates: Close unused openings using factory-made blind end plates.

M. Barrier Strips: Provide barrier strips as shown on the Contract Documents

N. Radius Drops: Provide cable tray radius drops where shown on the Contract Documents and where cable trays cross other telecommunications cable trays or ladder rack. Provide radius drops where corridor trays enter telecommunications rooms and where cabling transitions to ladder rack.

3.4 GROUNDING AND BONDING

A. Install bonding prior to priming and painting.

B. Bond metallic raceway (including cable tray) together and to the nearest TGB (as provided under Division 27 Section — "Grounding and Bonding for Communications Systems”).

C. Provide a continuous grounding conductor running the length of the cable tray.
   1. Bond each tray segment to the conductor using listed hardware.
   2. Cable tray bonding jumpers/splices are not permitted as a substitute for a continuous grounding conductor.

D. Bonding conductors:
   1. Bond distribution conduits and raceways to cable tray.
   2. Provide bonding jumpers at expansion joints, sleeves and any other locations where electrical continuity is interrupted.
   3. Provide bonding conductor between cable tray and the electrical power distribution system grounding infrastructure.

3.5 CLEANING AND PROTECTION

A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris. Repair damaged finishes, including chips, scratches, and abrasions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and in accordance with accepted industry practice, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

3.6 TESTING

A. Test cable trays to ensure electrical continuity of bonding and grounding connections. Demonstrate compliance with maximum grounding resistance per NFPA 70B, Chapter 18.

3.7 LABELING AND ADMINISTRATION

A. Provide the following label every 10 feet along the entire length of the cable tray:
   1. Label shall read “TELECOMMUNICATIONS / LOW VOLTAGE CABLING ONLY”.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials and labor for the installation of telecommunications cabinets, racks, frames, enclosures, cable management, and power hardware. This section includes hardware that supports the specified Structured Cabling System (SCS - See Definition Below).

B. Products installed (but not furnished) under this section:
   1. Grounding Conductor

1.2 SYSTEM DESCRIPTION

A. Furnish, install, test and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances associated with telecommunications cabinets, racks, frames, enclosures, cable management, and power hardware to support an ANSI/TIA/EIA, NECA/NEIS and ISO/IEC compliant communications Structured Cabling System (SCS) as shown on the Contract Documents.

B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant SCS.

PART 2 - PRODUCTS

2.1 GENERAL

A. Racks, rack cable distribution hardware, ladder rack, and other rack and distribution components shall be manufactured by a single manufacturer unless stated otherwise in this Specification or in the Contract Documents. Do not intermix equipment and components between different manufacturers.
   1. Rack/Distribution Equipment: The Siemon Company (Siemon)
   2. Ladder Racking Equipment: Chatsworth Products, Inc. (CPI), Ortronics/Legrand (OR) or approved equal.

2.2 CABLE SUPPORTS

A. Backboards:
   1. ¾ inch A-C fire-retardant plywood backboards, void free, 2440-mm (8 ft) high, unless otherwise noted.
   2. Primer
   3. Light-colored non-conductive paint
   4. White-colored semi-gloss paint

B. D-Rings:
   1. Metallic (CPI or equal):
      a. Small (5 square inch Capacity): CPI 10941
      b. Medium (10 square inch Capacity): CPI 10942
      c. Large (16 square inch Capacity): CPI 10943

C. Ladder Rack: Complete with fittings including (but not limited to) splice kits, cable radius drop, radius bends, protective end caps, retaining posts, support brackets, foot kits, vertical wall brackets, wall angles, grounding hardware and other incidental and miscellaneous hardware required for a complete

ladder rack system. Ladder rack components shall be manufactured by the selected Rack/Distribution Equipment manufacturer.

1. Unless otherwise indicated, all ladder rack and incidental equipment color shall be black.
2. Ladder rack:
   a. For CPI: Universal Cable Runway 10250-7xx (xx = width)
   b. For Ortronics: Tubular Runway OR-TR10-xxB (xx = width)
3. Horizontal radius bends:
   a. For CPI: Cable Runway E-Bend 10822-7xx (xx = width)
   b. For Ortronics: Horizontal Radius Runway TRT style OR-TRTHR-xxB (xx = width)
4. Cable Retaining Posts:
   a. For CPI: (8 inch high) 10596-708
   b. For Ortronics: (12 inch high) OR-CF-12B
5. Radius Drops:
   a. For CPI:
      1) Stringer CPI 12101-701
      2) Radius Drop: CPI 12100-7xx (xx = width)
   b. For Ortronics: Transition Pan OR-TRPxx-CM (xx = width, use 1” narrower than ladder rack width)
6. Triangle Support Wall-bracket for Cable runway:
   a. For CPI: 11312-71x
   b. For Ortronics: OR-P139340HB (12” width)
7. Wall Angle Support bracket for Cable runway:
   a. For CPI: 11421-7xx (xx = width)
   b. For Ortronics: OR-P128240HB (12” width)
8. Vertical Wall Support bracket for Cable runway:
   a. For CPI: 10608-701
   b. For Ortronics: OR-P982078HB
9. Ladder rack/cable runway Grounding kits:
   a. For CPI: 40164-0xx
10. Ladder rack/cable runway Elevation kits:
    a. For CPI: 10506-706
11. Ladder rack/cable runway end kits:
    a. End Closing Kit:
       1) For CPI: 11700-7xx (xx = width)
       2) For Ortronics: OR-RECBK-xxB (xx = width)
    b. End Caps:
       1) For CPI: 10642-001
       2) For Ortronics: 2-E1-25C-A
12. Other factory-manufactured appurtenances as necessary.

2.3 EQUIPMENT RACKS/ENCLOSURES

A. Unless otherwise indicated, equipment racks/enclosures and incidental equipment color shall be black.

B. Unless otherwise indicated, equipment rack/enclosure/wall-mounted brackets and incidental materials and equipment shall be provided by the selected Rack/Distribution Equipment manufacturer. Do not intermix products from different manufacturers.

C. Free Standing Equipment Racks: EIA-standard 7-foot high x 19-inch wide steel racks with universal alternating-hole pattern, complete with top angles, self-supporting bases, and mounting holes on both sides of the rails.
   1. Racks:
      a. CPI: 55053-703
   2. Vertical Cable Management:

a. CPI: 35571-703 (6” wide)
b. CPI: 35574-703 (12” wide)

D. Wall-mounted Equipment Cabinets: EIA-standard 19-inch wide racks (36-inch high, 27-inch deep) with universal alternating-hole pattern, complete with top angles, and mounting holes on both sides of the rails. Cabinets shall be double-hinged (front and rear) with extra-strong hinges. Doors shall be lockable with smoked plexiglass windows.
1. Cabinets:
a. CPI: CUBE-iT Wall-Mounted Cabinet 12419-736
b. Hubbell: QuadCab Wall-Mount Cabinet HSQ3636
c. or pre-approved equal

E. Grounding kit and #6 AWG (insulated or bare) copper conductor grounded to the nearest TGB.
1. For CPI: 40164-0xx or field-manufactured jumpers

F. Incidental materials required for proper construction, mounting and securing.

2.4 GROUNDING AND BONDING

A. As specified under Division 27 Section – “Grounding and Bonding for Communications Systems.”

2.5 LABELING AND ADMINISTRATION

A. Labels:
1. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
a. For Station Cable:
1) Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)
b. For Backbone Cable:
1) Panduit Marker Tie (or approved equal)

B. Hand-carried label maker:
1. Brady: ID Pro Plus (or approved equal).

PART 3 - EXECUTION

3.1 CABLE SUPPORTS

A. Backboards: Provide backboards as shown on Contract Documents. Backboards shall be capable of supporting attached equipment. Mount A-C plywood backboards with the “A” side exposed. Paint backboards with a minimum of two coats (over primer) of non-conductive paint, and one coat of white semi-gloss top coat paint.

B. D-Rings: Provide D-Rings as necessary to route exposed cables in telecommunications rooms and on backboards and for raceway for routing cable in non-exposed open access environments, and as shown in the Contract Documents. D-Rings may be affixed to wall/ceiling structures or other supports, but not attached to a ceiling support system. In telecommunications rooms, mount D-Rings at 12 inch intervals and as shown in the Contract Documents.
1. Size D-Rings as noted in the Contract Documents.
2. Where not noted, size D-Rings according to the type and quantity of cable to be routed through the ring per TIA/EIA 569 cable capacity standards, plus an additional 100% for future expansion, but not less than a minimum of 2 inches in diameter.

3. D-Rings are not permitted outside of telecommunications rooms unless otherwise indicated in the Contract Documents.

C. Ladder Rack: Provide ladder racking, sized and in locations as shown on the Contract Documents, installed per manufacturer's instructions with flat (rung) side up. Install ladder rack affixed to top of equipment racks to serve as equipment rack bracing.
1. Cut ends of ladder rack square. Ream cut ends to remove burrs and sharp edges. Cap cut ends with manufacturer's recommended caps.
2. Provide 90-degree horizontal radius bends for each 90-degree change in direction of ladder rack angle.
3. Provide cable runway grounding kits across ladder rack splices and where ladder racks are connected to equipment racks/cabinets.
4. Provide cable retaining posts at each corner and junction, and wherever needed to manage cabling and innerduct, as follows:
   a. The inside of ladder rack (away from wall), where rack is mounted adjacent to a wall.
   b. Both sides of ladder rack where rack is not mounted adjacent to a wall.
5. Where ladder rack is shown vertically mounted on telecommunications room walls, provide wall-mount brackets. Vertical ladder rack shall be routed from within 6-inches above the riser pathway in the floor up to within 6-inches of the riser pathway in the ceiling. Cap cut ends of ladder rails with end caps.

3.2 EQUIPMENT RACKS/ENCLOSURES

A. Provide EIA racks/cabinets and all associated hardware according to locations, elevations, and plan views as shown in the Contract Documents.

B. Free-standing Equipment Racks:
1. Bolt cabinets to structurally suitable flooring. Ensure that designated power outlets are installed in the rack as designed.
2. Attach top of rack to overhead ladder racking per manufacturer's recommendations.

C. For Wall-mounted Racks/Cabinets:
1. Bolt cabinets to structurally suitable members in the wall. Ensure that designated power outlets are installed inside the cabinet on the rear wall of the cabinet.
2. Mounting height shall be such that the bottom of the cabinet is not lower than 80" above the finished floor.

3.3 GROUNDING AND BONDING

A. Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, UAC, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 – REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.
1. Provide a minimum of one wall-mountable telecommunications ground bus bar per telecommunications room and as shown on the Contract Documents.
2. Grounding conductor shall be installed to bond all non-current carrying metal telecommunications equipment and materials to the nearest TMGB or TGB (as provided under Division 27 Section — "Grounding and Bonding for Communications Systems").
   a. Ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware.
   b. Provide ladder rack grounding kits to bond each section of ladder rack and bond ladder rack to racks/cabinets where ladder racks are connected.

3.4 LABELING AND ADMINISTRATION

A. Telecommunications Rooms: Affix a permanent label with the telecommunications room number on the wall above the light switch inside each telecommunications room. Where telecommunications room names are required in other labels, use the room number assigned to the telecommunications room and as shown on the room signage as-constructed.

B. Racks: Label racks in the form of the form “R#” where “R” stands for “Rack” and “#” is the sequential rack number within a given telecommunications room, numbered left to right while facing the front of the racks. Affix label centered across top cross-member of rack.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials and labor for the installation of an inside plant telecommunication system. This section includes Inside Plant Communications Backbone cabling, termination, and administration equipment and installation requirements for the specified Structured Cabling System (SCS - See Definition Below).

1.2 SYSTEM DESCRIPTION

A. Furnish, install, test and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete ANSI/TIA/EIA, NECA/NEIS and ISO/IEC compliant communications Structured Cabling System (SCS) as hereinafter specified and/or shown on the Contract Documents. The system is intended to be capable of integrating voice, data, and video signals onto a common media, and shall be tested for and be capable of 10 Gigabit Ethernet operation as specified in TIA/EIA 568-B.2-10 and ISO/IEC 11801:2002/Amd 1:2008.

B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant SCS.

PART 2 - PRODUCTS

2.1 GENERAL

A. SCS components shall be manufactured by the manufacturers listed below. Components shall not be intermixed between different manufacturers unless the manufacturer of the SCS has listed (in writing) another manufacturer's component as an "Approved Alternative Product" and will warrant the "Approved Alternative Product" as part of the SCS Manufacturer Warranty (see PART 1 - WARRANTY).
   1. Bid only the following SCS Manufacturers, and only bid manufacturers for which the Contractor is certified. The SCS Manufacturers shall be the following. Substitution is not acceptable:
      a. Commscope for copper-related products
      b. Corning for fiber optic-related products

2.2 PATCH PANELS

A. Fiber Patch Panels: Pre-assembled enclosures with cassettes, blank panels (for unused cassette slots), and strain relief, complete with fiber connectors and fiber optic receptacle adapters (see CONNECTORS below), and with incidental materials necessary for mounting. Fiber patch panels shall be manufactured by the selected SCS Manufacturer:
   1. Backbone Distribution:
      a. Corning:
         1) Rack mounted patch panels:
            a) Corning CCH-01U (1U, 12/24 port) (black)
            b) Corning CCH-02U (2U, 24/48 port) (black)
            c) Corning CCH-03U (3U, 36/72 port) (black)
            d) Corning CCH-04U (4U, 72/144 port) (black)
         2) Connector Panels:
            a) Singlemode: Corning (12-strand/6-connector) duplex SC, CCH-CP12-59

2.3 COPPER TERMINATION BLOCKS

A. Copper Termination Blocks: UL-listed and exceed ANSI/TIA/EIA 568-B Category 5e specifications for performance. Include connecting blocks, designation strips, and labels for each 25-pair strip. Label colors per ANSI/TIA/EIA standards. Termination blocks shall be manufactured by the selected SCS Manufacturer:
   1. For Backbone Cable:
      a. 110 Block kits (Siemon S110AA2-300FT) containing:
         1) Blocks: 110Connect XC 100-Pair with legs S110AW2-300
         2) IDC Connecting Blocks (5-pair markings): S110C-5
         3) Designation Strips: S110-HDLR
         4) Labels (white): S110-LBL-2
      b. Cable Managers with Legs: Siemon S110A2RMS

2.4 INNERDUCT

A. Innerduct shall be plenum-rated microduct, with a white colored MDPE oversheath, individually colored microducts, with internal ribs and low friction internal surface, and with sequential footage markers.
   1. Duraline Futurepath 7-Way, with 18/14 (14mm ID) microduct for MDF to MDF applications
   2. Duraline Futurepath 4-Way, with 18/14 (14mm ID) microduct for MDF to IDF applications
   3. or pre-approved equal.

2.5 CABLE

A. General: Cables shall be manufactured by the selected SCS Manufacturer.

B. Copper Cable:
   1. Copper backbone cable shall be non-shielded 24-AWG solid copper conductors insulated with color-coded PVC, and UL Verified to TIA/EIA 568-B for Category 3 performance. Cable shall be manufactured by the selected SCS Manufacturer:
      a. Commscope (or approved equal)
      b. Plenum-rated or riser-rated as required
   2. For Termination Block Connections (back-side): Unshielded, non-plenum multi-pair copper cable.
   3. Multi-pair Copper Cable: 24-AWG, solid copper conductor, and insulated with color coded PVC, UL Verified to ANSI/TIA/EIA 568-B for Category 3 performance. Cable shall be plenum-rated or riser-rated as required. Cable shall be manufactured by the selected SCS Manufacturer:
      a. Commscope
      b. or approved equal

C. Fiber Cable:
   1. For Singlemode: Riser-rated, tight-buffered with a maximum attenuation of 0.4 dB/km @ 1300 nm and 0.3 dB/km @ 1550 nm. Cable shall be manufactured by the selected SCS Manufacturer and shall be:
      a. For Corning:
         1) MIC 12-strand: 012E81-3313124
         2) MIC 24-strand: 024E81-3313124
         3) Unitized MIC 48-strand: 048E81-6113124
         4) Unitized MIC 144-strand: 144E81-T313124
         5) MiniXtend – this isn’t plenum rated
      b. or pre-approved equal

2.6 CONNECTORS

A. Fiber Pigtail Cassettes (fusion spliceable):

1. Singlemode: 12-strand, UPC, Duplex SC:
   a. Corning: CCH-CS12-59-P00RE

B. Fiber Pigtails (fusion spliceable):
1. Singlemode: UPC, SC:
   a. Corning: 0058-01-R4131-001-M with SC Duplex Clip (95-400-03-BP)

2.7 LABELING AND ADMINISTRATION

A. Labels:
1. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
   a. For Backbone Cable:
      1) Panduit Marker Tie (or approved equal)

B. Hand-carried label maker:
1. Brady: ID Pro Plus (or approved equal).

PART 3 - EXECUTION

3.1 PATCH PANELS

A. Provide patch panels and horizontal wire management according to locations, elevations, and plan views as shown on the Contract Documents.
1. Fiber: Size and install rack-mountable patch panels as shown on the Contract Documents. Use fiber patch panels to terminate backbone and horizontal fiber optic cables.
   a. Terminate all fiber optic cabling SC-Duplex, with one cable per patch panel.

3.2 COPPER TERMINATION BLOCKS

A. Provide termination blocks, jumper troughs, and distribution rings with legs and as shown on the Contract Documents. Install termination block wall field according to the elevations shown in the Contract Documents.
1. Use jumper troughs above each column for OSP, Riser and Horizontal cabling, and below each termination block for OSP and Riser (not Horizontal).

B. Route cable horizontally along ladder rack until it reaches the termination block column on which it is to terminate and then route vertically to the termination block.

C. If questions arise regarding the proper sequence for punching down cable, the Contractor shall obtain clarification from the Engineer and Owner's IT Representative prior to punching down cable. The Contractor shall be responsible, at no additional expense to the Owner, for re-terminating and re-installing (if necessary) all cable not punched down in the proper sequence.

D. Install termination block punch downs for riser cable as follows:
1. Punch down riser cable sequentially across the termination strips.

E. Punch down cable using only the selected SCS Manufacturer-approved impact tool.

3.3 INNERDUCT

A. Provide plenum-rated microduct for all indoor fiber optic cabling applications, sized as indicated in the Contract Documents. Where not indicated, provide 7-way microduct.

B. Route microduct unspliced between designated endpoints. Maintain proper bend radius of microduct and prevent duct kinking. Attach microduct to the inside side wall of cable trays at 4-foot intervals using zip ties, with the head of the zip tie positioned at the bottom inside to avoid accidental hand/arm injury.

C. Terminate microduct in telecommunications rooms by routing as follows: Route up wall from riser pathway (supported by vertical wall-attached ladder rack) then sweeping (bend-radius compliant) up through the horizontal ladder rack such that that cables transition cleanly from microduct to the top side of the ladder rack.

3.4 CABLE

A. General (applicable to all cable types): Provide non-plenum (CM/CMR, OFNR) rated cable for locations where cable is to be installed in conduit. For cable not installed in conduit, provide plenum (CMP, OFNP) rated cable if cable is installed in a plenum air space environment, otherwise install non-plenum rated cabling. Cabling shall bear plenum or non-plenum markings for the environment in which it is installed.
   1. Provide intra-building backbone cable in types, sizes, and quantities as shown on the Contract Documents. Install intrabuilding backbone cables between telecommunications rooms within the same building. Provide cables of the same type in the same color – multiple colors of the same cable type are not acceptable.
   2. Install cable in compliance with ANSI/TIA/EIA and ISO/IEC 11801 requirements and BICSI TCIM practices.
   3. Adhere to the bending radius and pull strength requirements as detailed in the ANSI/TIA/EIA standards and the manufacturer's installation recommendations during cable handling and installation.
      a. Pull all cables simultaneously where more than one cable is being installed in the same raceway.
      b. Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation (Polywater, or approved equal).
      c. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage media or raceway. Repair or replace conduit bushings that become damaged during cabling installation.
   4. Install cable in a continuous (non-spliced) manner unless otherwise indicated.
   5. Install exposed cable parallel and perpendicular to surfaces on exposed structural members and follow surface contours where possible.
   6. Tie or clamp cabling. Attaching cables to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system (grids, hanger wires, etc. – with the exception of ceiling support anchors) is not acceptable. Install tie-wraps in conformance with the SCS manufacturer's installation recommendations. Do not over-tighten tie wraps or cause cross-sectional deformation of cabling.
   7. Cable at the backboards:
      a. Lay and dress cables to allow other cables to enter raceway (conduit or otherwise) without difficulty at a later time by maintaining a working distance from these openings.
      b. Route cable as close as possible to the ceiling, floor, sides, or corners to insure that adequate wall or backboard space is available for current and future equipment and for cable terminations.
      c. Lay cables via the shortest route directly to the nearest edge of the backboard from mounted equipment or blocks. Support cables so as not to create a load on the equipment upon which the cables are terminated. Tie-wrap similarly routed and similar cables

together and attach to D-rings vertically and/or horizontally, then route over a path that will offer minimum obstruction to future installations of equipment, backboards or other cables.

d. See COPPER TERMINATION BLOCKS above for details on routing copper cabling to termination blocks.

8. Cable in the telecommunications rooms:
   a. For telecommunications rooms with ladder rack, lay cable neatly in ladder rack in even bundles and loosely secure cabling to the ladder rack at regular intervals with tie-wraps or hook-and-loop straps.
9. Cable terminating on patch panels located on racks:
   a. Route cables in telecommunications rooms to patch panels on racks by routing across ladder rack across top of rack and then down vertical ladder rack to patch panel.

B. Copper Cable: Terminate all pairs within a cable. Un-terminated cable pairs are not acceptable.
1. Install intrabuilding backbone cable in the locations shown on the Contract Documents. Provide a service loop long enough in the telecommunications room to reach termination equipment if moved to the farthest side of the room in the future, but no less than a minimum length of 10 feet at each end.
   a. Use unshielded, non-plenum multi-pair copper cable for connecting the back side of termination blocks to entrance protectors, telephone systems, and voice grade active electronics.
   b. For shielded cable, bond both ends of the metallic shield (or metallic strength) member to the nearest TGB (as furnished under Division 27 Section — “Grounding and Bonding for Communications Systems”).

C. Fiber Cable: Terminate all fiber strands within a fiber cable. The installation of “dark fiber” is not acceptable.
1. Test fiber optic cable on the reel upon delivery to the job site, and again prior to installation. Permanently affix the test results to the reel and submit a copy to the Owner prior to installation. Do not install cables that fail the on-reel test. Replace any cables that fail the on-reel test at no additional expense to the Owner.
   a. Test shall conform to the procedures as outlined in the paragraph entitled TESTING at the end of this specification section.
   b. Demonstrate that the test results agree with the factory test results as shipped with the reel.
2. For shielded cable, bond both ends of the metallic shield (or metallic strength) member to the nearest TGB (as furnished under Division 27 Section — “Grounding and Bonding for Communications Systems”).
3. Provide a service loop long enough in the ER/TRs to reach termination equipment if moved to the farthest side of the room in the future, but no less than a minimum of 10 feet at each end.
4. The service slack stored inside the fiber patch panel cabinets shall be 1 meter length.

3.5 CONNECTORS

A. Fiber Pigtail Cassettes: Provide Cassettes per manufacturer recommendations and install into Patch Panels. Fusion-splice all pigtails to all cable strands.

B. Fiber Pigtails: Provide Connector Panels and Fiber Pigtails per manufacturer recommendations and install into Patch Panels. Fusion-splice all pigtails to all cable strands

C. Fiber Connectors: Provide Connector Panels, Connectors and Adapters per manufacturer recommendations and install into Connector Panels. Terminate all cable strands with Fiber Connectors.

3.6 LABELING AND ADMINISTRATION

A. Cables:
1. Label Location: Affix at each end of the cable, within 6 feet of telecommunications room entrance and again within 12" of termination point.
2. Fiber Optic Cables shall be labeled in the form of "##SM to BB rm#" where "##" is the number of strands, "SM" is the fiber type, "BB" is the building abbreviation and "rm#" is the telecommunications room or lab where the far end of the cable is terminated.
   a. For example: A 48-strand singlemode cable whose far end terminates in building "LA" in telecommunications room 005 would be labeled on the near end "48SM to LA 005".
3. Copper Backbone Cables shall be labeled in the form of "###PR to BB rm#" where "###PR" is the number of copper pairs, "BB" is the building abbreviation and "rm#" is the telecommunications room where the far end of the cable is terminated.
   a. For example: A 200PR copper backbone cable whose far end terminates in building "LA" in telecommunications room 005 would be labeled on the near end "200PR to LA 005".

B. Innerduct:
1. Label Location: Affix at each end of the innerduct, within 6 feet of telecommunications room entrance and again within 12" of the end of the innerduct.
2. Innerduct shall be labeled in the form of "BB rm#", where "BB" is the building abbreviation and "rm#" is the telecommunications room.
   a. For example: An innerduct whose far end terminates in building "LA" in telecommunications room 005 would be labeled on the near end "LA 005".

C. Termination Blocks:
1. Desi-strips for termination blocks used for copper backbone distribution shall be laser printed with the following information:
   a. The identifier for the cable terminated on the blocks.
   b. The pair numbers, with the first and last pairs and a pair number for each interval of 5 pairs, with the pair numbers spaced to match the termination location for each pair.
      1) For example: A 50-pair backbone cable whose far end terminates in building "LA" in telecommunications room 005 would be labeled on the near end:

01	05	10	15	20	25
		50PR to LA 005			
26	30	35	40	45	50

2. Color Coding: Apply industry standard color coding to cable termination fields. Always apply the same color at both ends of any given cable. Cross-connections are generally made between termination fields of different colors. The color may be applied to the backboard behind the termination equipment, may be the color of a cover on the termination equipment, or may be the actual color of the insert label on the termination equipment. Use the following color code:
   a. Green: Identification of network connections on the customer side of the demarcation point.
   b. White: Identification of first-level backbone in the building containing the main cross-connect, or may be used to identify the second-level backbone in buildings not containing the main cross-connect.
   c. Brown: Identification of inter-building backbone cables.
   d. Yellow: Identification of auxiliary circuits, alarms, maintenance, security, and other miscellaneous circuits.

D. Fiber Optic Patch Panels:
1. Fiber optic patch panels shall be labeled on the face of the patch panel with the same identifier as the cable that terminates in the patch panel. See paragraph A above.

E. Before applying the cable numbering scheme described above, verify that the room numbers shown on the drawings match the actual room numbers that appear on building signage. The room numbering scheme may change between design and construction. All labeling and numbering schemes that incorporate room numbers shall reflect the finished, as-built room numbering, which may be different than the numbering shown in the construction documents.

3.7 TESTING

A. Test the SCS after installation for compliance with all applicable standards as follows:
   1. Intrabuilding Backbone Copper: Test all cable pairs for length, shorts, opens, continuity, polarity reversals, transposition (wire map), and the presence of AC voltage. All pairs shall demonstrate compliance to TIA/EIA 568-B Category 3 standards.
      a. Test copper cable after installation, from termination block to termination block.
      b. Use a TIA/EIA Level III testing instrument, re-calibrated within the manufacturer's recommended calibration period, with the most current software revision based upon the most current TIA/EIA testing guidelines, capable of storing and printing test records for each cable within the system.
         1) Fluke DSP-4000, or approved equal.
   2. Fiber: Test fiber optic cable after installation.
      a. Prior to testing, calculate the cable loss budget for each fiber optic cable and clearly show the result on the test documentation. Calculate maximum loss using the following formula, assuming no splices:
         1) For Horizontal Distribution:
            a) Max Loss = 2.0db (per ANSI/TIA/EIA 568-B)
         2) For Backbone Distribution:
            a) Max Loss = [(allowable loss/km) * (km of fiber)] + [(.3db) * (# of connectors)]
            b) A mated connector-to-connector interface is defined as a single connector for the purposes of the above formula.
            c) A given fiber strand shall not exceed its calculated maximum loss (per the above formula).
      b. Test all strands using a bi-directional end-to-end optical transmission loss test instrument (such as an OTDR) trace performed per ANSI/TIA/EIA 455-61 or a bi-directional end-to-end power meter test performed per ANSI/TIA/EIA 455-53A, and ANSI/TIA/EIA 568-B.
         1) Calculate loss numbers by taking the sum of the two bi-directional measurements and dividing that sum by two.
         2) Provide test measurements as follows:
            a) Test singlemode cables at both 1310 and 1550nm.
      c. Test results shall conform to:
         1) The criteria specified in ANSI/TIA/EIA-568B.
         2) The Contractor's calculated loss budget above.
         3) The criteria specified in IEEE 802.3z (10GBase-X 10 Gigabit Ethernet).
            a) In addition to the above, perform tests both recommended and mandated by the manufacturer. Tests shall confirm/guarantee compliance with the manufacturer's performance standards and also IEEE 802.3ae-2002 for a maximum end-to-end dB loss of 2.5 dB.
         4) The criteria specified in IEEE 802.3ae-2002 (10GBase-X 10 Gigabit Ethernet).

B. Cables and equipment that do not pass tests shall be identified and discussed with the Owner and Engineer. Determine the source of the non-compliance and replace or correct the cable or the connection materials, and retest the cable or connection materials at no additional expense to the Owner. Provide new test results to the Owner and Engineer in the same manner as above.

1. In addition to the above, if it is determined that the cable is at fault, remove the damaged cable and replace it with a new cable. Cable “repairs” are not acceptable. The procedure for removing the cable shall be as follows:
    a. Prior to removal of damaged cable and installation of new cable:
        1) Inform the Owner and Engineer of the schedule for the removal and installation.
        2) Test the new cable on the reel per paragraph B, above.
        3) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable per paragraph B, above, regardless of whether or not they are new cables installed as part of this project or existing cables installed prior to this project.
        4) Provide test results to the Owner and Engineer for approval by the Owner and Engineer.
    b. Remove the damaged cable and provide new cable.
    c. After the removal of the damaged cable and installation of the new cable:
        1) Test the new cable per the paragraph titled TESTING.
        2) Test cables that occupy the same innerduct or conduit as the damaged cable per paragraph B, above, regardless of whether they are new cables installed as part of this project or existing cables installed prior to this project.
        3) If any of the cables requiring testing are in use, coordinate with the Owner to schedule an outage opportunity during which the testing can be performed.
        4) Provide test results to the Owner and Engineer for approval by the Owner and Engineer.
    d. If a cable which occupies the same innerduct or conduit as a damaged cable is damaged by the extraction and reinstallation process, replace the cable at no additional expense to the Owner.
        1) Damaged cables which are replaced shall be subject to the testing procedures of the paragraph titled TESTING.

C. Provide test records on a form approved by the Owner and Engineer. Include the test results for each cable in the system. Submit the test results for each cable tested, with identification as discussed under LABELING AND ADMINISTRATION above. Include the cable identifier, outcome of test, indication of errors found, cable length, retest results, and name and signature of technician completing the tests. Provide test results to the Owner and Engineer for review and acceptance within two weeks of Substantial Completion.
    1. Print test records in Adobe PDF format for each cable directly from the test software and submit in electronic form (in Adobe PDF and native Fluke test files) on CDROM to the Owner and Engineer for review. Handwritten test results will not be accepted.
    2. Any cabling discovered to have unsatisfactory test results shall be reterminated or replaced and retested.
    3. After all performance and testing issues have been addressed, resubmit the complete set of corrected test reports to the Owner and Engineer on CDROM.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials and labor for the installation of an inside plant telecommunication system. This section includes Inside Plant Communications cabling, termination, and administration equipment and installation requirements for the specified Structured Cabling System (SCS - See Definition Below).

1.2 SYSTEM DESCRIPTION

A. Furnish, install, test and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete ANSI/TIA/EIA, NECA/NEIS and ISO/IEC compliant communications Structured Cabling System (SCS) as hereinafter specified and/or shown on the Contract Documents. The system is intended to be capable of integrating voice, data, and video signals onto a common media, and shall be tested for and be capable of 10 Gigabit Ethernet operation as specified in TIA/EIA 568-B.2-10 and ISO/IEC 11801:2002/Amd 1:2008.

B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant SCS.

1.3 SEQUENCING

A. Provide coordination with the cabling manufacturers to ensure that manufacturers' inspectors are available to schedule site visits, inspections, and certification of the system. Provide and coordinate any manufacturer-required modifications and have manufacturer re-inspect and certify the system prior to the scheduled use of the system by the Owner.

B. The Contractor is solely responsible for all costs associated with scheduling the manufacturer inspection, the inspection itself and any manufacturer-required re-inspections, and for any modifications to the installation as required by the manufacturers.

PART 2 - PRODUCTS

2.1 GENERAL

A. SCS components shall be manufactured by the manufacturers listed below. Components shall not be intermixed between different manufacturers unless the manufacturer of the SCS has listed (in writing) another manufacturer's component as an "Approved Alternative Product" and will warrant the "Approved Alternative Product" as part of the SCS Manufacturer Warranty (see PART 1 - WARRANTY).
   1. Bid only the following SCS Manufacturers and only bid manufacturers for which the Contractor is certified. The SCS Manufacturers shall be the following. Substitution is not acceptable:
      a. Siemon, for copper-related products

B. All copper-related components shall be part of the copper SCS product line – components shall not be intermixed between manufacturers' SCS product lines. The SCS product lines shall be engineered "end-to-end" – the system and all of its components shall be engineered to function together as a single, continuous transmission path.
   1. The SCS Product Line shall be the following, per manufacturer. Substitution is not acceptable:
      a. For Category 6A Copper Distribution: Siemon connectivity materials with cabling materials from Commscope.

2.2 PATCH PANELS

A. Copper Patch Panels: Complete with pre-manufactured cable management for supporting station cable behind the patch panel, and with incidental materials necessary for mounting. Unless otherwise indicated, copper patch panels shall be manufactured by the selected SCS Manufacturer:
   1. Horizontal Distribution Patch Panels (Workstation Patch Panels): Shall exceed Category 6A transmission requirements for connecting hardware, as specified in TIA/EIA 568-B.2-10 and ISO/IEC 11801:2002/Amd 1:2008. Wired for T568B.
      a. For Siemon:
         1) Category 6A, 24 Port: Siemon Z6A-PNL-24K
         2) Category 6A, 48 Port: Siemon Z6A-PNL-U48K

B. Fiber Patch Panels: Pre-assembled enclosures with cassettes, blank panels (for unused cassette slots), and strain relief, complete with fiber connectors and fiber optic receptacle adapters (see CONNECTORS below), and with incidental materials necessary for mounting. Fiber patch panels shall be manufactured by the selected SCS Manufacturer:
   1. For Horizontal Distribution:
      a. For Corning:
         1) Rack mounted patch panels:
            a) Corning CCH-01U (1U, 12/24 port) (black)
            b) Corning CCH-02U (2U, 24/48 port) (black)
            c) Corning CCH-03U (3U, 36/72 port) (black)
            d) Corning CCH-04U (4U, 72/144 port) (black)
         2) Connector Panels:
            a) Singlemode: Corning (12-strand/6-connector) duplex SC, CCH-CP12-59

2.3 COPPER TERMINATION BLOCKS

A. Copper Termination Blocks: UL-listed and exceed ANSI/TIA/EIA 568-B Category 5e specifications for performance. Include connecting blocks, designation strips, and labels for each 25-pair strip. Label colors per ANSI/TIA/EIA standards. Termination blocks shall be manufactured by the selected SCS Manufacturer:
   1. For Horizontal Cable:
      a. 110 Block kits (Siemon S110AB2-300FT) containing:
         1) Blocks: 110Connect XC 100-Pair with legs S110AW2-300
         2) IDC Connecting Blocks (4-pair markings): S110C-4
         3) Designation Strips: S110-HDLR
         4) Labels (white): S110-LBL-2
      b. Cable Managers with Legs: Siemon S110A2RMS

2.4 CONNECTORS

A. Voice Copper Connectors (modular jacks): 6-position/6-conductor, insulation displacement connection (IDC), non-keyed, and shall accept modular 6-position/6-conductor plugs, complete with multicolored identification labels/icons for identification, and with a universally color-coded wiring pattern for both T568A and T568B. Copper connectors shall be manufactured by the selected SCS Manufacturer.
   1. Horizontal Distribution: Shall meet or exceed Category 5e transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA 568-B and ISO/IEC 11801:
      a. Siemon MX3-U3-01

B. Data Copper Connectors (modular jacks): 8-position/8-conductor, insulation displacement connection (IDC), non-keyed, and shall accept modular 8-position/8-conductor plugs, complete with multicolored identification labels/icons for identification, and with a universally color-coded wiring pattern for both T568A and T568B. Copper connectors shall be manufactured by the selected SCS Manufacturer.

1. Horizontal Distribution: Shall meet or exceed Category 6A transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA 568-B.2-10 and ISO/IEC 11801:2002/Amd 1:2008:
   a. Siemon Z6A-02

C. Data Copper Plugs (RJ45 plugs): Category 6A rated, 8-position/8-conductor, insulation displacement connection (IDC), non-keyed, and for mating with modular 8-position/8-conductor jacks, with a universally color-coded wiring pattern for T568B.
1. Straight:
   a. Plug interface and strain relief: Telegärtner J00026A3xxx (where xxx=001, 003, 111 or 113 and is selected to match wire size)
   b. Wire manager: Telegärtner F00020A313x (where x=1 or 3 and is selected to match wire size)
2. 90-degree:
   a. Telegärtner MFP8-4x90 product set

D. Fiber Connectors:
1. Fiber Pigtail Cassettes (fusion spliceable):
   a. For Singlemode: 12-strand, UPC, Duplex SC:
      1) For Corning: CCH-CS12-59-P00RE
2. Fiber Pigtails (fusion spliceable):
   a. For Singlemode: UPC, SC:
      1) For Corning: 0058-01-R4131-001-M with SC Duplex Clip (95-400-03-BP)

2.5 STATIONS

A. Faceplates: Complete with port identification labels and blank inserts/fillers for covering unused connector openings:
1. Stations to be used for analog wall-mount telephones: Brushed stainless steel with stainless steel mounting lugs suitable for supporting wall-mount telephones:
   a. SUTTLE SE-630AD4
   b. or approved equal
2. All other stations shall be double-gang standard 6-port faceplates:
   a. For Siemon: MX-FP-D-06-02 with blank inserts as required MX-BL-02.

B. Faceplate Mounting Brackets: Suitable for mounting faceplates over wall cutouts (i.e. flush-mount faceplates with no in-wall outlet box).
1. For CADDY:
   a. Single gang faceplates: CADDY MP1P
   b. Double gang faceplates: CADDY MPAL2

C. Surface Device Boxes: Surface mount device boxes shall be:
1. Single gang: Siemon CT4-BOX-02
2. Double gang: Siemon CT8-BOX-02
3. or approved equal.

2.6 CABLE

A. General: Cables shall be manufactured by the selected SCS Manufacturer.

B. Data Copper Cable: 4-pair UTP, 23 AWG, NEC/NFPA CMP or CMR rated, with solid copper conductors and shall be part of the UL LAN Certification and Follow-up Program.
1. Category 6A: Shall meet or exceed channel specifications of ANSI/TIA/EIA-568-C Category 6a and ISO/IEC 11801:2002/Amd 1:2008 Class EA up to 500 MHz when used as a component in a

properly installed Siemon F/UTP channel. Cabling shall comply with all of the performance requirements for current and proposed applications such as 10 Gigabit Ethernet (10000BASE-Tx), 10/100/1000BASE-Tx, analog and digital video, analog and digital voice, VoIP, and shall exceed all requirements for IEEE 802.3an for 10 Gigabit Ethernet on all parameters.

a. Commscope: 10G4
    1) Non-plenum: 8441704/10 (WHITE)
    2) Plenum: 8765504/10 (WHITE)
b. Commscope: GigaSPEED X10D
    1) Non-plenum: 760081406 (WHITE)
    2) Plenum: 760234860 (WHITE)

2. Category 6 Outdoor Rated: Shall meet or exceed channel specifications of ANSI/TIA/EIA-568-C Category 6 when used as a component in a properly installed channel. Cabling shall comply with all of the performance requirements for current and proposed applications such as Gigabit Ethernet (1000BASE-Tx), 10/100BASE-Tx, analog and digital video, analog and digital voice (VoIP) on all parameters.
    a. For General Cable: Outdoor Genspeed 6, 7136100

C. Voice Copper Cable: 4-pair, 24 AWG, NEC/NFPA CMP or CMR rated, with solid copper conductors and shall be part of the UL LAN Certification and Follow-up Program.
1. Category 5e: Shall meet or exceed channel specifications of ANSI/TIA/EIA-568-C Category 6a up to 100 MHz when used as a component in a properly installed Siemon F/UTP channel. Cabling shall comply with all of the performance requirements for current and proposed applications such as Gigabit Ethernet (1000BASE-Tx), 10/100BASE-Tx, analog and digital video, analog and digital voice, VoIP, and shall exceed all requirements for IEEE 802.3ab Gigabit Ethernet on all parameters.
    a. Commscope: PowerSUM
        1) Non-plenum: 760004671 (BLUE)
        2) Plenum: 760041913 (BLUE)

D. Hook and Loop Cable Managers: Reusable hook and loop (similar to Velcro) style, adjustable tension, roll or spool dispensed:
1. Panduit HLS-15R0
2. AMP 5/8” wide: 1375255-X
3. Or equal

2.7 LABELING AND ADMINISTRATION

A. Labels:
1. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
    a. For Station Cable:
        1) Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)

B. Hand-carried label maker:
1. Brady: ID Pro Plus (or approved equal).

PART 3 - EXECUTION

3.1 PATCH PANELS

A. Provide patch panels and horizontal wire management according to locations, elevations, and plan views as shown on the Contract Documents.
   1. Copper: Size and install rack-mountable patch panels as shown on the Contract Documents. Use patch panels to terminate copper horizontal cables.
   2. Fiber: Size and install rack-mountable patch panels as shown on the Contract Documents. Use fiber patch panels to terminate backbone and horizontal fiber optic cables.
      a. Terminate all fiber optic cabling SC-Duplex, with one cable per patch panel.
   3. Horizontal Wire Management: Provide horizontal wire management as shown on the Drawings.

3.2 COPPER TERMINATION BLOCKS

A. Provide termination blocks, jumper troughs, and distribution rings with legs and as shown on the Contract Documents. Install termination block wall field according to the elevations shown in the Contract Documents.
   1. Use jumper troughs above each column (for OSP, Riser and Horizontal cabling) and below each termination block for OSP and Riser (not Horizontal).

B. Route cable horizontally along ladder rack until it reaches the termination block column on which it is to terminate and then route vertically to the termination block.

C. If questions arise regarding the proper sequence for punching down cable, the Contractor shall obtain clarification from the Engineer and Owner's IT Representative prior to punching down cable. The Contractor shall be responsible, at no additional expense to the Owner, for re-terminating and re-installing (if necessary) all cable not punched down in the proper sequence.

D. Install termination block punch downs for riser cable as follows:
   1. Punch down riser cable sequentially across the termination strips.

E. Punch down cable using only the selected SCS Manufacturer approved impact tool.

3.3 CONNECTORS

A. Copper Connectors (modular jacks) for Voice:
   1. Provide Voice connectors and install using the **USOC** wiring pattern.
   2. Mount connectors at 90-degrees (i.e. straight, not angled), in the upper left and upper right positions in the faceplate.
   3. Where two connectors are used for a single cable, terminate the pairs as follows:
      a. 1st connector: blue pair=primary pair, orange pair=secondary pair
      b. 2nd connector: green pair=primary pair, brown pair=secondary pair
   4. Punch down cable using only the selected SCS Manufacturer approved impact tool.

B. Copper Connectors (modular jacks) for Data:
   1. Provide Data connectors and install using **T568B** wiring pattern.
   2. Mount connectors in angled orientation.
   3. Punch down cable using only the selected SCS Manufacturer-approved impact tool.

C. Copper Plugs for Data:
   1. Provide Data plugs only for specifically designated field-connectorized applications and install using **T568B** wiring pattern.
   2. Terminate cables using manufacturer-approved tools and methods.

D. Fiber Connectors:
   1. Fiber Pigtail Cassettes: Provide Cassettes per manufacturer recommendations and install into Patch Panels. Fusion-splice all pigtails to all cable strands.
   2. Fiber Pigtails: Provide Connector Panels and Fiber Pigtails per manufacturer recommendations and install into Patch Panels. Fusion-splice all pigtails to all cable strands.
   3. Fiber Connectors: Provide Connector Panels, Connectors and Adapters per manufacturer recommendations and install into Connector Panels. Terminate all cable strands with Fiber Connectors.

3.4 STATIONS

A. Faceplates: Provide faceplates for stations in the locations and gang counts shown on the Contract Documents. Faceplates shall completely conceal outlet boxes, reducer plates, etc. Faceplates shall provide a snug and sure fit for connectors – loose connectors are not acceptable.

B. Flush-mount connectors in faceplates. Provide blank inserts for any unfilled connector positions.

C. Surface Device Boxes: Provide surface mount device boxes as required and as shown for surface mounted communications outlets.

3.5 CABLE

A. General (applicable to all cable types): Most horizontal cabling applications at UVU facilities require plenum-rated cabling. If a cable is run entirely via conduit and junction boxes and does not pass through cable tray, then provide non-plenum (CM/CMR, OFNR) rated cable. Otherwise, provide plenum (CMP, OFNP) rated cable. Cabling shall bear plenum or non-plenum markings for the environment in which it is installed.
   1. Do not paint cabling. Painted cabling will not be covered by the manufacturer's warranty.
   2. For Data: Provide station cable in types, sizes, and quantities as defined by the Symbol Schedule and as shown on the Contract Documents. Install cable between the station and its associated telecommunications room and patch panel. Provide one cable for each data connector at each station. Provide cables of the specified color.
   3. For Voice: Provide station cable in types, sizes, and quantities as defined by the Symbol Schedule and as shown on the Contract Documents. Install cable between the station and its associated telecommunications room and 110-block. Provide one cable per **two** voice connectors at each station. Provide cables of the specified color.
   4. Install cable in compliance with ANSI/TIA/EIA and ISO/IEC 11801 requirements and BICSI TCIM practices.
   5. Adhere to the bending radius and pull strength requirements as detailed in the ANSI/TIA/EIA standards and the manufacturer's installation recommendations during cable handling and installation.
      a. Pull all cables simultaneously where more than one cable is being installed in the same raceway.
      b. Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation (Polywater, or approved equal).
      c. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway. Repair or replace conduit bushings that become damaged during cabling installation.
   6. Install cable in a continuous (non-spliced) manner unless otherwise indicated.
   7. Install exposed cable parallel and perpendicular to surfaces on exposed structural members and follow surface contours where possible.
   8. Tie or clamp cabling. Attaching cables to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system (grids, hanger wires, etc. – with the exception of ceiling support anchors) is not acceptable. Install tie-wraps in conformance with the SCS manufacturer's

installation recommendations. Do not over-tighten tie wraps or cause cross-sectional deformation of cabling.

9. Cable at the backboards:
   a. Lay and dress cables to allow other cables to enter raceway (conduit or otherwise) without difficulty at a later time by maintaining a working distance from these openings.
   b. Route cable as close as possible to the ceiling, floor, sides, or corners to insure that adequate wall or backboard space is available for current and future equipment and for cable terminations.
   c. Lay cables via the shortest route directly to the nearest edge of the backboard from mounted equipment or blocks. Support cables so as not to create a load on the equipment upon which the cables are terminated. Tie-wrap similarly routed and similar cables together and attach to D-rings vertically and/or horizontally, then route over a path that will offer minimum obstruction to future installations of equipment, backboards or other cables.
   d. See COPPER TERMINATION BLOCKS above for details on routing copper cabling to termination blocks.
10. Cable in the telecommunications rooms:
   a. Lay cable neatly in ladder rack in evenly-sized loose bundles and loosely secure cabling to the ladder rack at regular intervals with velcro straps.
   b. Route cables to patch panels on racks via ladder rack, across top of rack and then down vertical cable management to patch panel.
   c. Route cables to 110-blocks via ladder rack and then down wall via D-rings to 110-blocks.
   d. For cables that are within distance limitations, route cabling around room before terminating, creating a usable slack loop. For cables that would not otherwise meet distance limitations, do not route first around the room (do not provide this slack loop).

B. Copper Cable: Terminate all pairs within a cable. Un-terminated cable pairs are not acceptable.
   1. Provide station cable in the locations shown on the Contract Documents. Provide service loops with a minimum length of 12 inches in outlet boxes and no less than 10 feet in the telecommunications rooms.
      a. For workstation outlets with both Category 5E and 6A and coaxial cable for TV Distribution, terminate Category 5E and 6A cabling after coaxial cable has been installed and terminated.
      b. For copper station cabling installed in wet areas use outdoor-rated CAT6 cabling, including floor boxes in slab-on-grade applications, and applications for outdoor cameras and wireless access points.
      c. Route station cable that is exposed (not in conduit) to comply with ANSI/TIA/EIA-569 requirements for avoiding potential EMI sources and as follows:
         1) 48 inch separation distance from motors or transformers
         2) 12 inch separation distance from conduit and cables used for electrical power distribution
         3) 5 inch separation distance from fluorescent lighting. In telecommunications rooms, raise pendant fluorescent light fixtures such that they are at least 12 inches away from copper cabling.
   2. For horizontal cables serving wireless access point locations, provide an additional service loop no less than 20 feet stored in the cable tray where the horizontal conduit terminates.

C. Fiber Cable: Terminate all fiber strands within a fiber cable. The installation of “dark fiber” is not acceptable.
   1. Test fiber optic cable on the reel upon delivery to the job site, and again prior to installation. Permanently affix the test results to the reel and submit a copy to the Owner prior to installation. Do not install cables that fail the on-reel test. Replace any cables that fail the on-reel test at no additional expense to the Owner.
      a. Test shall conform to the procedures as outlined in the paragraph entitled TESTING at the end of this specification section.

b. Demonstrate that the test results agree with the factory test results as shipped with the reel.

2. For shielded cable, bond both ends of the metallic shield (or metallic strength) member to the nearest TGB (as furnished under Division 27 Section — "Grounding and Bonding for Communications Systems").
3. Provide a service loop long enough in the ER/TRs to reach termination equipment if moved to the farthest side of the room in the future, but no less than a minimum of 10 feet at each end.
4. The service slack stored inside the fiber patch panel cabinets shall be 1 meter length.

D. Provide hook-and-loop cable managers for managing horizontal cabling in the telecommunications rooms.

3.6 LABELING AND ADMINISTRATION

A. Horizontal Cables:
1. At Outlet: Affix label at end of the cable within 4" of the cable end near the jack. Provide a clear vinyl adhesive wrapping applied over the label in order to permanently affix the label to the cable. Using transparent tape to affix labels to cables is not acceptable. Affix a second label on the exterior of the faceplate, adjacent to the jack corresponding to the cable.
   a. Labeling shall be in the form "BB ###-X@" where "BB" is the building abbreviation, "###" is the room number where the outlet is located, "X" is the sequential number of the outlet within the room, and "@" is either A, B, C or D corresponding to the jack location within the faceplate.
      1) For example: if room number 214C in building LA has 3 outlets, and the third outlet is used to terminate one voice cable serving two jacks and two data cables, the labels on the faceplate would indicate: "LA 214C-3A", "LA 214C-3B", "LA 214C-3C" and "LA 214C-3D". Where labeling space is limited, it is permitted to combine labels, for example "LA 214C-3A B" and "LA 214C-3C D".
   b. Label colors: WHITE.

2. At Patch Panels: Affix label at end of the cable within 4" of the cable end near the patch panel termination point. Provide a clear vinyl adhesive wrapping applied over the label in order to permanently affix the label to the cable. Using transparent tape to affix labels to cables is not acceptable. Provide a second label on the front of the patch panel adjacent to the port associated with the cable.
   a. Labels shall be in the form of the room number and outlet number that appears on the faceplate label.
      1) Label colors: If a horizontal cable is intended to serve a Power-over-Ethernet (POE) device, provide PURPLE labels. Otherwise, for all other data applications provide WHITE labels.

3. At 110 Blocks: Affix label at end of the cable within 12" of the cable end near the 110-block termination point. Provide a clear vinyl adhesive wrapping applied over the label in order to permanently affix the label to the cable. Using transparent tape to affix labels to cables is not acceptable. Provide laser-printed Desi-strips showing the labeling.
   a. Labels shall be as described above for the labels at the outlet.
   b. For example: in the case of a voice termination on a 110-block terminating a horizontal copper voice cable that terminates in room number 214C in the 3rd outlet, the text on the 110-block Desi-strip would indicate: "214C-3".
   c. Color Coding: Apply industry standard color coding to cable termination wall fields (110-blocks). Always apply the same color at both ends of any given cable. Cross-connections are generally made between termination fields of different colors. The color may be applied to the backboard behind the termination equipment, may be the color of a cover on the termination equipment, or may be the actual color of the insert label on the termination equipment. Use the following color code:

1) Blue: Identification of the horizontal distribution (station) cables. A blue color coding is only required at the telecommunications room end of the cable, not at the station end of the cable.
2) Yellow: Identification of auxiliary circuits, alarms, maintenance, security, and other miscellaneous circuits.

4. Before applying the cable numbering scheme described above, verify that the room numbers shown on the drawings match the actual room numbers that appear on building signage. The room numbering scheme may change between design and construction. All labeling and numbering schemes that incorporate room numbers shall reflect the finished, as-built room numbering, which may be different than the numbering shown in the construction documents.

3.7 TESTING

A. Test the SCS after installation for compliance with all applicable standards as follows:
1. For Data Cables: Test all pairs of each copper station cable, in accordance with the field test specifications defined in the "Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6 Cabling" by the Telecommunications Industry Association (TIA); ANSI/TIA/EIA-568-B.2.10 and ANSI/TIA/EIA-568-C.2. This document will be referred to as the Augmented Category 6 Standard. The test equipment shall comply with the accuracy requirements for the level III field testers as defined in the TIA Cat 6 Document. To the extent possible, perform tests with building electrical systems fully powered on (i.e. Lights, HVAC, etc.).
   a. Test each end-to-end link (from the connector at the station to the connector or termination in the telecommunications room) utilizing sweep tests, for continuity, shield continuity, shorts, polarity, attenuation, installed length, transposition (wire map), mutual capacitance, characteristic impedance, resistance, ACR, Insertion Loss, Pair-to-Pair Near End Crosstalk (NEXT), Power Sum Near End Crosstalk (PSNEXT), Equal Level Far End Crosstalk (ELFEXT), Power Sum Equal Level Far End Crosstalk (PSELFEXT), Return Loss, and presence of AC voltage. Test each cable in both directions.
   b. Use a TIA/EIA Level III testing instrument, re-calibrated within the manufacturer's recommended calibration period, with the most current software revision based upon the most current ANSI/TIA/EIA testing guidelines, capable of storing and printing test records for each cable within the system and equipped with the current Category 6A test adapters. Level IV testers as specified in Draft IEC61935-1 are also permitted.
      1) Testing Device: Fluke DTX-1800 with the 10GB Kit (Fluke DTX10GKIT) with latest software and hardware releases for Siemon CAT-6A horizontal distribution cables, or approved equal.
   c. In addition to the above, perform tests both recommended and mandated by Siemon. Tests shall confirm/guarantee compliance to Siemon Ethernet Category 6A 10GB applications based on the data contained in the Siemon performance specifications.
2. For Voice Cables: Test all pairs of each copper station cable, in accordance with the field test specifications defined in the "Transmission Performance Specifications for 4-pair 100 Ω Category 5E Cabling" by the Telecommunications Industry Association (TIA); ANSI/TIA/EIA-568-C. The test equipment shall comply with the accuracy requirements for the level III field testers as defined in the TIA Cat 5E Document. To the extent possible, perform tests with building electrical systems fully powered on (i.e. Lights, HVAC, etc.).
   a. Test each end-to-end link (from the connector at the station to the termination in the telecommunications room) utilizing sweep tests, for continuity, shorts, polarity, near-end cross talk (NEXT), far-end cross talk (FEXT), attenuation, installed length, transposition (wire map), mutual capacitance, characteristic impedance, resistance, ACR, and presence of AC voltage. Use the Power Sum method to test NEXT and FEXT. Test each cable in both directions.
   b. Use a TIA/EIA Level III testing instrument, re-calibrated within the manufacturer's recommended calibration period, with the most current software revision based upon the most current ANSI/TIA/EIA testing guidelines, capable of storing and printing test records

for each cable within the system and equipped with the current Category 5E test adapters. Level IV testers as specified in Draft IEC61935-1 are also permitted.
1) Testing Device: Fluke DTX-1800, or approved equal.

B. Cables and equipment that do not pass tests shall be identified and discussed with the Owner and Engineer. Determine the source of the non-compliance and replace or correct the cable or the connection materials, and retest the cable or connection materials at no additional expense to the Owner. Provide new test results to the Owner and Engineer in the same manner as above.
1. In addition to the above, if it is determined that the cable is at fault, remove the damaged cable and replace it with a new cable. Cable “repairs” are not acceptable. The procedure for removing the cable shall be as follows:
a. Prior to removal of damaged cable and installation of new cable:
1) Inform the Owner and Engineer of the schedule for the removal and installation.
2) Test the new cable on the reel per paragraph B, above.
3) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable per paragraph B, above, regardless of whether or not they are new cables installed as part of this project or existing cables installed prior to this project.
4) Provide test results to the Owner and Engineer for approval by the Owner and Engineer.
b. Remove the damaged cable and provide new cable.
c. After the removal of the damaged cable and installation of the new cable:
1) Test the new cable per the paragraph titled TESTING.
2) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable per paragraph B, above, regardless of whether they are new cables installed as part of this project or existing cables installed prior to this project.
a) If any of the cables requiring testing are in use, coordinate with the Owner to schedule an outage opportunity during which the testing can be performed.
3) Provide test results to the Owner and Engineer for approval by the Owner and Engineer.
d. If a cable which occupies the same innerduct or conduit as a damaged cable is damaged by the extraction and re-installation process, replace that cable also at no additional expense to the Owner.
1) Damaged cables which are replaced shall be subject to the testing procedures of the paragraph titled TESTING.

C. Provide the test results for each cable tested with identification as discussed under LABELING AND ADMINISTRATION above. Include the cable identifier, outcome of test, indication of errors found, cable length, retest results, and name and signature of technician completing the tests. Provide test results to the Owner and Engineer for review and acceptance within two weeks of Substantial Completion.
1. Print test records in Adobe PDF format for each cable directly from the Fluke software and submit in electronic form (on CDROM) to the Owner and Engineer for review. Handwritten test results will not be accepted.
2. Also submit native Fluke test files downloaded from the tester in electronic form (on CDROM).
3. Any cabling discovered to have unsatisfactory test results shall be reterminated or replaced and retested.
4. After all performance and testing issues have been addressed, resubmit the complete set of corrected test reports (in Adobe PDF and as native Fluke test files) to the Owner and Engineer on CDROM.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all patch cord materials to serve an inside plant telecommunication system. This section includes copper and fiber optic patch cords.

1.2 SYSTEM DESCRIPTION

A. Furnish all patch cords to serve a complete ANSI/TIA/EIA, NECA/NEIS and ISO/IEC compliant communications Structured Cabling System (SCS) as hereinafter specified and/or shown on the Contract Documents. The system is intended to be capable of integrating voice, data, and video signals onto a common media, and shall be tested for and be capable of 10 Gigabit Ethernet operation as specified in IEEE 802.3z.

B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant SCS.

PART 2 - PRODUCTS

2.1 GENERAL

A. SCS components shall be manufactured by the manufacturers listed below. Components shall not be intermixed between different manufacturers unless the manufacturer of the SCS has listed (in writing) another manufacturer's component as an "Approved Alternative Product" and will warrant the "Approved Alternative Product" as part of the SCS Manufacturer Warranty (see PART 1 - WARRANTY).
   1. Bid only the following SCS Manufacturers and only bid manufacturers for which the Contractor is certified. The SCS Manufacturers shall be the following. Substitution is not acceptable:
      a. Siemon for copper-related products
      b. Corning for fiber optic-related products

B. All copper-related components shall be part of the copper SCS product line and all fiber optic-related components shall be part of the fiber optic SCS product line – components shall not be intermixed between manufacturers' SCS product lines. The SCS product lines shall be engineered "end-to-end" – the system and all of its components shall be engineered to function together as a single, continuous transmission path.
   1. The SCS Product Line shall be the following, per manufacturer. Substitution is not acceptable:
      a. For Category 6A Copper Distribution: Siemon Category 6A
      b. For Fiber Distribution: Corning LANScape

2.2 COPPER CABLE ASSEMBLIES (PATCH CORDS)

A. Pre-manufactured (factory-terminated), stranded unshielded twisted pair (UTP), with 8-pin modular plugs that have snagless boots. Patch cables shall be manufactured by the selected SCS Manufacturer.
   1. For Horizontal Distribution:
      a. Category 6A: Shall exceed Category 6A transmission as specified in TIA/EIA 568-B.2-10 and ISO/IEC 11801:2002/Amd 1:2008.
         1) Modular-to-modular plugs (8-pin to 8-pin):
            a) WHITE: Siemon ZM6A-XX-02 (where xx = length)
            b) BLUE: Siemon ZM6A-XX-06 (where xx = length)

2.3 FIBER OPTIC CABLE ASSEMBLIES (PATCH CORDS)

A. Pre-manufactured (factory-terminated) by the selected SCS Manufacturer with a UL rating of OFNR. Fiber patch cables shall be singlemode with UPC connectors:
   1. Singlemode, UPC:
      a. For Corning:
         1) Duplex SC-to-SC: 7272-02R5120-xxx-x (where xxx = length)
         2) Duplex LC-to-SC: 0472-02R5120-xxx-x (where xxx = length)

PART 3 - EXECUTION

3.1 COPPER CABLE ASSEMBLIES (PATCH CORDS)

A. For Telecommunications Rooms:
   1. Furnish copper patch cables for patch panels in the sizes and colors below. Furnish a quantity of 1 patch cord per horizontal cable terminated in a patch panel.

Total Quantity:	# of Horiz in patch panel minus AV	# of AV Podium Devices
Length	**White, Quantities of each length**	**Blue, Quantities of each length**
3 ft	25%	25%
5 ft	50%	50%
7 ft	25%	25%
	100%	100%

   2. Mark each box of WHITE patch cords with the words: “FOR USE IN TELECOM ROOMS.”
   3. Mark each box of BLUE patch cords with the words: “BLUE PATCH CORDS FOR USE WITH AV DEVICES IN TELECOM ROOMS.”
   4. Deliver boxes of patch cords to the Owner. The Owner will install all patch cords.

B. For Workstations and other applications:
   1. Furnish copper patch cables for workstations, wireless access points, cameras, and other applications in the sizes, colors and quantities below.
   2. Furnish a quantity of 1 white patch cord for 40% of the horizontal cables terminated in a patch panel serving non-Audio-Visual applications. In other words, furnish a white patch cord quantity equal to 0.4 * (total horizontal cables terminated in patch panels minus horizontal cables serving Audio-Visual devices).
   3. Furnish a quantity of 1 blue patch cord for 80% of the horizontal cables terminated in a patch panel serving Audio-Visual applications. In other words, furnish a blue patch cord quantity equal to 0.8 * (number of horizontal cables serving Audio-Visual devices). The table below indicates the quantities of patch cords of each length.

Total Quantity:	40% of (# Horiz in patch panel minus AV)	100% of AV Podium Devices
Length	**White, Quantities of each length**	**Blue, Quantities of each length**
3 ft	none	10%
5 ft	none	50%
7 ft	none	40%
12 ft	50%	none
15 ft	40%	none
25 ft	10%	none
	100%	100%

   4. Mark each box of WHITE patch cords with the words: “FOR USE AT WORKSTATIONS.”

5. Mark each box of BLUE patch cords with the words: “BLUE PATCH CORDS FOR USE WITH AV DEVICES.”
6. Deliver boxes of patch cords to the Owner. The Owner will install all patch cords.

3.2 FIBER OPTIC CABLE ASSEMBLIES (PATCH CORDS)

A. Furnish a quantity of 1 duplex patch cord for 30% of the terminated fiber optic strands. For example, for a 144-strand cable, furnish 0.3 * 144 = 43 patch cords. Furnish SC-SC Duplex for half of the total and LC-SC Duplex for the other half of the total.

1. For Singlemode (YELLOW), furnish fiber optic patch cables in the lengths and quantities below:

Length	Quantity
1 m	30%
2 m	40%
3 m	30%

2. Mark each box of SC-SC patch cords with the words: “SC-SC FIBER OPTIC PATCH CORDS.”
3. Mark each box of LC-SC patch cords with the words: “LC-SC FIBER OPTIC PATCH CORDS.”
4. Deliver boxes of patch cords to the Owner. The Owner will install all patch cords.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials and labor for the installation of specialty telephone equipment.

1.2 SYSTEM DESCRIPTION

A. Furnish, install, and place into satisfactory and successful operation all materials, devices, specialty telephone equipment, and necessary appurtenances to provide complete, permanent emergency telephone systems as hereinafter specified and/or shown on the Contract Documents. The systems shall be compatible with the Owner's existing emergency telephone systems and with the local E911 emergency call handling center.

B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working system.

PART 2 - PRODUCTS

2.1 2-WAY COMMUNICATION EMERGENCY TELEPHONES

A. 2-way communication emergency telephones shall be:
1. E-1600-30A from Viking Electronics, Inc. http://www.vikingelectronics.com (715) 386-8861

PART 3 - EXECUTION

3.1 2-WAY COMMUNICATION EMERGENCY TELEPHONES

A. Provide 2-way communication emergency telephone unit for each location noted on Contract Documents.

B. Telecommunications:
1. Provide telecommunications conduits, outlet boxes and circuits as shown on Contract Documents and as required by manufacturer.
2. Terminate horizontal cable onto terminals of telephone device.

3.2 COMMISSIONING

A. Work with the Owner's designated Telecommunications Representative to identify suitable telephone circuits for each telephone device. Connect telephone circuits to telephones and verify that calls can successfully be placed.

3.3 TESTING

A. Testing of all cable and devices shall be conducted by the Contractor in accordance with manufacturer's requirements and shall demonstrate that the devices interoperate with the Owner's existing systems.

B. All tests shall be coordinated through and witnessed by the Owner's designated Telecom Representative.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials and labor for the installation of a pathway system for outside plant communications circuits. Work in this section includes excavation and trenching, conduit (raceway) construction, cutting and patching, concrete, maintenance hole and handhole construction, and landscaping.

B. Products installed (but not furnished) under this section:
   1. Grounding Conductor

1.2 REFERENCES

A. Incorporate by reference the applicable portions of the following specifications, standards, codes into this specification section.
   1. General:
      a. UDOT/APWA 2008 Standards Specifications for Road, Bridge and Municipal Construction (APWA Standard Specifications)
   2. Concrete:
      a. Reinforcement:
         1) ACI 301: Structural Concrete for Buildings
         2) ACI SP-66: American Concrete Institute - Detailing Manual
         3) ANSI/ASTM A82: Cold Drawn Steel Wire for Concrete Reinforcement
         4) ANSI/AWS D1.4: Structural Welding Code for Reinforcing Steel
         5) ANSI/AWS D12.1: Reinforcing Steel Welding Code
         6) ASTM A615: Deformed and Plain Billet Steel Bars for Concrete Reinforcement
         7) AWS D12: Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete Construction
      b. Cast-in-Place:
         1) ACI 212.3R: Chemical Admixtures for Concrete
         2) ACI 301: Structural Concrete for Buildings
         3) ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
         4) ACI 305R: Hot Weather Concreting
         5) ACI 306R: Cold Weather Concreting
         6) ASTM C33: Concrete Aggregates
         7) ASTM C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
         8) ASTM C94: Ready-Mixed Concrete
         9) ASTM C150: Portland Cement
         10) ASTM C143: Standard Test Method for Slump of Hydraulic Cement Concrete
         11) ASTM C173: Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
         12) ASTM C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
         13) ASTM C260: Air Entraining Admixtures for Concrete
         14) ASTM C309: Standard Specifications for Liquid Membrane Forming Compound for Curing Concrete
         15) ASTM C494: Chemical Admixtures for Concrete
      c. Pre-Cast:
         1) ASTM C478: Standard Specification for Precast Reinforced Concrete Manholes Sections

2) ASTM C857: Standard Practice for Minimum Structural Design Loading for Underground Precast Utility Structures
3) ASTM C858: Standard Specification for Underground Precast Concrete Utility Structures
4) ASTM C891: Standard Practice for Installation of Underground Precast Concrete Utility Structures
5) ASTM C1037: Standard Practice for Inspection of Underground Precast Concrete Utility Structures
6) ASTM D1751: Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

3. Trenching and Backfill:
   a. ASTM D1557: Test Method for Laboratory Compaction Characteristics Using Modified Effort

1.3 DEFINITIONS

A. Aggregate: Mineral materials such as sand or stone used in making concrete.

B. Backfill: Earth material used specifically for filling and grading excavations back to a finished state. Backfill is placed on top of the bedding surrounding encased ductbanks and direct-buried conduits.

C. Base: Earth material used specifically to level and grade an excavation's subgrade for the subsequent placement of encased ductbanks, direct-buried conduit, maintenance holes and handholes. Base material is placed on top of the subgrade and beneath the bedding surrounding encased ductbanks, conduits, maintenance holes or handholes.

D. Bedding: Earth material used specifically for filling excavations. Bedding is placed around encased ductbank, conduits, maintenance holes or handholes. Bedding is placed on top of the base and beneath the backfill.

E. Fill: The collective term for base, bedding, and backfill.

F. Handhole (HH): A structure similar to a small maintenance hole through which cable can be pulled, but not large enough for a person to fully enter to perform work.

G. Maintenance Hole (MH): A vault located in the ground or earth as part of an underground conduit system and used to facilitate placing, connectorization, and maintenance of cables as well as the placing of associated equipment, in which it is expected that a person will enter to perform work.

H. RNC: Rigid Non-Metallic Conduit (PVC)

I. PSC: PVC Coated Rigid Steel Conduit.

J. RGC: Rigid Galvanized Steel Conduit

1.4 SYSTEM DESCRIPTION

A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete Outside Plant pathway system as hereinafter specified and/or shown on the Contract Documents. The Pathway system shall support an ANSI/TIA/EIA and ISO/IEC compliant communications Structured Cabling System (SCS) as specified in Division 33 Section — "Communications Distribution".

B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant pathway system.

1.5 SUBMITTAL INFORMATION

A. Quality Assurance/Control Submittals: Provide submittal information for review as follows:
1. Submit a copy of the delivery receipt for each concrete delivery. Include date, strength ordered, and location used.

1.6 SEQUENCING

A. Coordinate the installation of underground telecommunications ducts and maintenance holes with the installation of other underground utilities.

B. Prior to concrete encasement of ductbanks, contact the Owner's IT Representative and Engineer to schedule observation of the conduits.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials shall consist of fill, topsoil, concrete formwork, concrete, raceway, maintenance holes, handholes and other incidentals and accessories as required.

2.2 BASE, BEDDING AND BACKFILL

A. Use of on-site soils for base, bedding, and backfill is not acceptable. Provide the following readily-compactable materials:

	Trenches for Ductbanks		**Maintenance Holes and Handholes**	
Backfill:	Provide Sand/Gravel Mix:		Provide Gravel:	
	Sieve Size	Percent Passing	Sieve Size	Percent Passing
	½" Square	100	1" Square	100
	¼" Square	65 - 100	¼" Square	25 - 80
	U.S. No. 10	40 - 100	U.S. No. 200	15 max
	U.S. No. 50	3 - 50	Sand Equivalent	30 min
	U.S. No. 100	0 - 4		
	U.S. No. 200	0 - 3		
Bedding:	Provide Sand:		Provide Sand:	
	Sieve Size	Percent Passing	Sieve Size	Percent Passing
	U.S. No. 10	35 - 100	U.S. No. 10	35 - 100
	U.S. No. 20	20 - 80	U.S. No. 20	20 - 80
	U.S. No. 40	10 - 55	U.S. No. 40	10 - 55
	U.S. No. 100	0 - 10	U.S. No. 100	0 - 10
	U.S. No. 200	0 - 3	U.S. No. 200	0 - 3
Base:	Provide Sand:		Provide Gravel:	
	Sieve Size	Percent Passing	Sieve Size	Percent Passing
	U.S. No. 10	35 - 100	1" Square	100
	U.S. No. 20	20 - 80	¼" Square	25 - 80
	U.S. No. 40	10 - 55	U.S. No. 200	15 max
	U.S. No. 100	0 - 10	Sand Equivalent	30 min
	U.S. No. 200	0 - 3		

2.3 CAST-IN-PLACE CONCRETE

A. Formwork:
1. Forms: Metal or plywood in good condition
   a. Form Release Agent: Burke Form Coating (or equal)
2. Gypsum board

B. Reinforcement:
1. Reinforcing Steel: ASTM A615, Grade 40. Uncoated, free from rust, dirt, and loose scale.
2. Tie Wire: 18 gauge 40 or heavier black annealed wire.
3. Embedded Anchor Bolts: Mild galvanized steel, cold bent.

C. Concrete:
1. Cement: Different types of cement, including the same type of cement provided by more than one manufacturer, are not acceptable: Cement shall conform to:
   a. ASTM C150-7, type 1.
   b. 2500 psi. minimum compressive at 28 days per ASTM C39.
   c. 4 inches maximum slump per ASTM C-143.
2. Aggregate:
   a. Coarse: ASTM C33-71 with a maximum size of 1-¼".
   b. Fine: ASTM C33-71.
3. Water: Fresh, clean, potable and not detrimental to concrete.
4. Admixtures:
   a. Air Entrainment: Conform to ASTM C260 and ASTM C173 or C231 with 5% to 7% air entrainment.
   b. Other: Not allowed without prior approval from the Engineer.
5. Curing Compound: Conform to ASTM C309. Free from petroleum resins or waxes. Formulated for sealing, surface hardening, and curing concrete.

2.4 CONDUIT AND DUCTBANKS

A. Conduit
1. Rigid Non-Metallic Conduit (RNC):
   a. UL-listed, NEMA TC2 Schedule 40 or 80 rigid polyvinyl chloride (PVC) approved for direct burial without concrete encasement.
   b. Fittings: NEMA TC3, matched to conduit and material.
2. Rigid Galvanized Steel Conduit (RGC):
   a. Rigid steel conduit hot-dipped galvanized inside and out with threaded ends meeting ANSI C80.1.
   b. Couplings: Unsplit, NPT threaded with galvanizing equal to (and compatible with) conduit. Running thread or set screw threaded fittings (except for three piece and watertight split couplings) are not acceptable.
   c. Nipples: Same as conduit, factory-made up to 8 inches in diameter, no running threads.
3. PVC Coated Rigid Steel Conduit (PSC):
   a. NEMA RN 1 rigid steel conduit coated with rigid polyvinyl chloride (PVC).
   b. Fittings: NEMA RN 1.
4. Fittings:
   a. Sweeps: Factory manufactured with a single arc of not less than a 15 foot radius. Sweeps shall be one of the following:
      1) Fiberglass
      2) PVC Coated Rigid Steel

3) RGC with half lapped wrap of Scotchrap No. 51 plastic tape or a coat of Kopper's Bitumastic No. 505 (minimum 20 mil thickness).

b. End Caps (Plugs): Pre-manufactured and water tight. Tape is not an acceptable end cap or cover.

5. Pull Ropes: ¼ inch polypropylene with a minimum tensile strength of 200 pounds.
6. Muletape Pull cord with footage marks: WPxxxP

B. Ductbanks:
1. Conduit Spacers/Supports: High-density plastic interlocking spacers/supports. Spacers shall be:
a. Underground Devices Inc.: WUNPEECE
2. Warning Tape: 6" wide metallic warning tape, orange in color.
3. Grounding/Bonding: #2 AWG bare copper ground.

C. Horizontal Directional Boring:
1. Equipment:
a. Horizontal directional drilling equipment shall consist of a hydraulically powered directional drilling rig of sufficient capacity to perform the bore and a guidance system to accurately guide boring operations to drill into the ground at a variable angle.
1) The drill head shall be steerable by changing its rotation and shall provide the necessary cutting surfaces and drilling fluid jets.
b. Equipment shall be in good, safe operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of this project.
1) The hydraulic system shall be free of leaks.
2. Duct:
a. Smooth-wall continuous duct, rated for direct bury and directional bore applications.
1) Carlon Dura-Line
2) Carlon Pinpoint, with integrated trace-wire
3) or approved equal

2.5 UNDERGROUND SPACES

A. General: Underground spaces include Maintenance Holes and Handholes. Incidental and miscellaneous equipment supplied with a MH or HH shall be supplied by the same manufacturer.

B. Handholes: Polymer concrete handholes, 36" deep:
1. Oldcastle Precast model 3048-36 with two-piece Uni-Half Cover labeled "Communications"
2. or pre-approved equal

C. Grounding:
1. ¾" x 10' copperclad steel ground rods
2. #4/0 pigtail for connection to interior ground conductors

D. Concrete Collar: 10" wide, 3" thick concrete collar or ring around circumference of handhole to protect against damage (for example, from landscape equipment contact).

2.6 LANDSCAPING:

A. Topsoil: Imported from off construction site.

2.7 LABELING AND ADMINISTRATION

A. Labels

1. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, waterproof and legible. Paint and other marking substances are acceptable.

PART 3 - EXECUTION

3.1 EXCAVATING, TRENCHING AND FILL

A. Call Before You Dig:
1. Before digging for any reason, Contractor shall contact Blue Stakes of Utah. In turn, Blue Stakes will typically notify UVU to locate any University-owned outside plant ductbanks and cabling. For faster service, the Contractor is welcome to contact UVU/OIT directly after first contacting Blue Stakes.

B. Excavation:
1. Do not excavate when the outside temperature is less than 35° F or when there is standing water or snow on the subgrade.
2. Where crossing of concrete or asphalt is required, saw cut and remove surface material prior to excavating. Remove concrete in complete sections from control joint to control joint regardless of the width of the excavation. Restore concrete and asphalt surfaces following excavation to match existing depth, strength, color, and type of material.
3. If an adjacent structure may be compromised or damaged by excavation work, underpin the structure as required. If the structural integrity is in question, obtain an evaluation and recommendation from a registered Structural Engineer employed by the Contractor prior to proceeding with the work.
4. Maintain adequate separation between the excavation and adjacent underground utilities. Locate excavations such that ductbanks, maintenance holes, and handholes have a minimum separation of 12 inches between the ductbank and/or MH/HH and the nearest underground utility after installation. For gas lines a minimum separation of 18 inches is required. For water a minimum separation of 36 inches is required. Contact the Engineer prior to proceeding if minimum separation distances cannot be achieved.
5. Protect excavations at the end of the work shift. Cover with steel sheets and barricade prior to leaving the job site, in accordance with all applicable rules, regulations, building codes, and ordinances.
6. Install, operate and maintain pump or dewatering equipment as necessary to prevent water from accumulating in the excavation.
7. Excavation Depth/Width:
   a. For MH/HH: Excavate to a sufficient depth to cover the overall assembled height of the vault plus the added height of risers, covers and bedding material consisting of a minimum 6 to 12 inches of base. Excavate to a sufficient width to provide a minimum of 6 inches clearance around each side of the MH/HH.
   b. For trenches: Excavate to a sufficient depth to provide a minimum of 30 inches cover over the conduit or ductbank formation and to allow for the proper alignment of conduits into the MH/HH. Excavate to a sufficient width to provide a minimum of 6 inches to each side of the ductbank formation.
8. Over-excavate, fill, and compact any soft spots in the subgrade.
9. Run trench excavation true and as straight as possible. Clear trenches of stones and soft spots.
10. Slope trench grade to fall 3 inches per 100 feet in general and ¼" per foot where possible.
    a. Slope trench toward lower MH/HH or from high points toward MH/HH at both ends.
    b. Slope trench away from building entrances.
11. Excavation in Vicinity of Trees:
    a. All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5' to prevent damage from the construction operations and/or equipment. Excavation within the outermost limb radius of any trees shall be accomplished with extreme care. Roots located within this outermost limb radius

shall be brought to the attention of the Owner before they are cut or damaged in any way. The Owner will give immediate instructions for the disposition of same.

b. Stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation.

c. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

C. Horizontal Directional Boring:

1. Follow all procedural precautions necessary to ensure that the essential aspects of proper directional bore installation are adequately controlled.
2. Adhere to all applicable environmental regulations.
3. Personnel for horizontal directional drilling shall be fully trained in safety and their respective duties as part of the directional drilling crew.
4. Owner shall be notified 48 hours in advance of starting horizontal directional drilling work. Directional drilling shall not begin until Owner is present at the job site.
5. Site Preparation:
   a. Prior to any alterations to work site, the entry and exit points shall be marked.
   b. No alterations to the work site beyond what is required for operations shall be made.
   c. All activities shall be confined to designated work areas.
6. Drill Path Survey:
   a. The entire drill path shall be accurately surveyed with entry and exit stakes placed in the appropriate locations within the areas indicated on drawings.
   b. If a magnetic guidance system is being used, the drill path shall be surveyed for any surface geomagnetic variations or anomalies.
7. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the boring.
8. The machine shall be prepared and operated according to manufacturer’s recommendations and instructions.
9. Following drilling operations, the equipment shall be de-mobilized and the worksite restored to its original condition. All excavations shall be backfilled and compacted to 95% of original density. Landscaping shall be restored to original site conditions.

D. Fill:

1. Drain and/or pump groundwater and surface water from the recipient area prior to the placement of fill.
2. Do not place frozen fill.
3. Base:
   a. Scarify and moisture-condition the subgrade bed to receive fill prior to placing materials.
   b. Moisture-condition base material to within 3 percent of optimum moisture content and place in loose, horizontal layers.
   c. Level the subgrade bed using sand for trenches and gravel for MH/HH as necessary to form an even base.
4. Bedding: Do not exceed 4” depth of bedding lifts/layers before compacting.
5. Backfill: Do not exceed 6” depth of backfill lifts/layers before compacting.
6. Compaction: Compact using a vibratory plate or roller or other mechanical device. Compaction through jetting and/or pounding is not acceptable. Compact per APWA Standard Specification Paragraph 7-10.3 (11).
   a. Bedding: Compact material to a dense state equaling at least 95% of the maximum dry density per ASTM D1557.
   b. Backfill: Compact material up to 2 feet below the finished grade with a minimum relative compaction of 90% of the maximum dry density per ASTM D1557. Compact material from

2 feet below the finished grade up to the finished grade with a minimum relative compaction of 95% of the maximum dry density per ASTM D1557.

E. Waste Disposal: Remove excavation materials and other construction debris from the site in a timely manner and dispose of legally.

3.2 CAST-IN-PLACE CONCRETE

A. Construct concrete in accordance with the applicable portions of the specifications, standards, codes and regulations (latest editions and/or amendments) listed in Section 1, References.

B. Formwork:
   1. Construction:
      a. Forms: Use the most advantageous panel sizes and panel joint locations. Neat patches and minor surface imperfections will be permitted. Form surfaces in true planes within ¼ inch in 10 feet. Clean forms and remove debris prior to pouring concrete. Make braces unyielding and tight to prevent leakage. Maintain formwork construction tolerances complying with ACI 347. Formwork shall be readily removable without impact, shock, or damage to concrete surfaces and adjacent materials. Use chamfer strips fabricated to produce uniform smooth lines and tight edge joints for exposed corners and edges. Note: chamfer strips are not required for concrete-encased ductbank corners and edges.
         1) Gypsum board shall not be used for forms except to form concrete encased ductbank.
      b. Reinforcement: Construct reinforcement in accordance with ACI SP-6. Weld reinforcement in accordance with ANSI/AWS D1.4 or ANSI/AWS D12.1. Accurately position, support, and secure reinforcement against displacement. Support reinforcement by metal/plastic chairs, runners, bolsters, spacers, hangers, or other incidental materials as required.
      c. Where metal or plywood forms are used, coat the forms with a form release agent prior to placement of concrete. Coat faces and edges of forms applied at a rate of 500 to 550 square feet per unit.
      d. Curved Surfaces: Use only curved forms for constructing curved structures and surfaces.
   2. Slope: For flatwork, construct forms with 1% side slope to both south and east sides.
   3. Joints:
      a. Control: Build into form.
      b. Expansion: Build expansion joints into form, premolded ½" thick, and conforming to ASTM D1751. Seal the top ½" of expansion joints with an approved joint sealer.
   4. Removal: Remove forms after concrete has cured (see Curing below) for 7 days or after concrete has attained a compressive strength of 2000 psi.
      a. Where gypsum board forms are used to form concrete-encased ductbank, they can be left in place and backfilled after the specified curing period.

C. Concrete:
   1. Transport: Comply with ACI 304. Transport concrete from the mixer to the construction location via methods preventing separation of materials.
   2. Application:
      a. Prior to placement, inspect and complete formwork construction, reinforcement, and items to be embedded or cast-in.
         1) Provide rebar between ductbanks and pre-cast vaults and also at cold-joints in ductbanks to prevent differential settling forces from damaging conduits or cabling.
      b. Deposit concrete in forms in layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer on the preceding layer while the preceding layer is still plastic. Cold joints are not acceptable.
      c. Deposit concrete in a plastic condition and uniformly work around reinforcements.

d. Consolidate concrete using internal machine vibration (stinger) during pouring.
e. Once concrete work has commenced, work continuously until the work segment and/or section has been completed.
f. Cold Weather: Protect concrete from damage caused by frost, freezing, or low temperatures in compliance with ACI 306R. When temperature is below 40° F, heat water and aggregates before mixing to obtain a concrete mixture of not less than 50° F and not more than 80° F.
g. Hot Weather: Protect concrete from damage caused by hot weather in compliance with ACI 305R. When temperature is above 90° F, chill water before mixing to obtain a concrete mixture of not more than 90° F. Cover reinforcing steel with water-soaked burlap if it becomes too hot immediately before placement of concrete. Temperature of steel shall not exceed the ambient air temperature.

3. Curing:
   a. Curing method and rate of application shall be according to manufacturer's recommendations.
   b. Protect concrete from premature drying, rain, excessive temperatures, and mechanical injury during the curing period.
   c. Cure concrete for 7 days in accordance with ACI 301 and keep continuously moist during this time. Maintain concrete temperature between 50° and 90° F during the curing period.
   d. Provide curing and sealing compound to exposed slabs, sidewalks, curbs, etc. as soon as final finishing operations are complete (within 2 hours). Re-coat areas subjected to heavy rainfall within 3 hours of the initial application.
4. Finish:
   a. Consolidate, level and screen surfaces for evenness and uniformity. Remove excess concrete. Fill low spots. Float the surface after water sheen has disappeared from surface.
   b. Finish flatwork with a special tool to match patterned finish of adjacent existing concrete.
   c. Tool edges, control, and expansion joints to make finish work straight and even.
5. Ductbanks:
   a. Reinforce ductbanks along full length with formed sides. Install reinforcement at each corner of the conduit spacers/supports.
   b. Do not pour concrete against trench walls. Consolidate concrete during placement using an internal concrete vibrator.
   c. Provide each MH/HH penetration with reinforcing bars tied to MH/HH reinforcement. Provide dowel reinforcement in foundation wall of building penetrations.
   d. Secure conduit spacers/supports and reinforcing to prevent movement during concrete placement. Use stakes and/or tie wire to minimize floating and spreading.
6. Protection for exposed concrete: Cover exposed concrete (i.e. sidewalk, driveway, etc.) with plywood, weighted with concrete blocks or similar heavy object in order to prevent surface damage.
7. Bond and ground reinforcement bars to the nearest approved ground.

3.3 CONDUITS AND DUCTBANKS

A. Conduits:
   1. Outdoor underground: Provide either
      a. RNC Schedule 40 (Type 1).
      b. RGC with half lapped wrap of Scotchrap No. 51 plastic tape or a coat of Kopper's Bitumastic No. 505 (minimum 20 mil thickness).
   2. Outdoor exposed: Provide RGC.
   3. Transitions: Transition to PSC at stub up locations. Transition to PSC for building entrances a minimum of 10 feet before reaching building foundation. Transitioning back to RNC after passing 5 feet inside the building foundation is acceptable.
   4. Sweeps:

a. Shallow curves comprised of continuous lengths of individual straight RNC conduit are permissible with a minimum sweep radius of 40 feet.
b. Where the conduit sweep radius is less than 40 feet, sweeps shall be factory-manufactured bends with a minimum of 48 inch radius. Bending conduit in the field using manual or mechanical methods is not acceptable.
c. Do not exceed 90 degrees for an individual sweep.
d. Where unique construction requirements for bend radius or arc length do not permit the use of factory-manufactured sweeps, sweeps shall be field-manufactured using factory-recommended equipment. The internal diameter of the sweep shall not be changed during the sweep field-manufacturing process.
e. A conduit section shall have not more than the equivalent of two 90-degree sweeps (a total of 180 degrees) between pull points. The 180-degree maximum shall include kicks and offsets. Where it is not possible to construct a section of conduit within the 180-degree sweep maximum, an intermediate MH/HH shall be installed.
f. Two 90-degree sweeps separated by less than 10 feet is not permissible.
g. Construct sweeps for conduits within a common ductbank parallel, measured from the same center-point.
h. Do not install LBs, condulets, or 90 degree electrical elbows.

5. Fittings:
   a. Cut conduit ends square and ream to remove burrs and sharp ends. Extend conduits the maximum distance into fittings, couplings, and/or connectors. Tighten fittings securely and seal watertight (see below).
   b. End Caps (Plugs): Provide end caps on conduit ends throughout construction to prevent the intrusion of water or debris. Install end caps on conduit that is not directly being worked on during the workday and on conduits at night. Leave end caps in place upon final completion of the work.
   c. End Bells: Provide end bells for terminating conduit in maintenance holes and handholes. Install protective end bells on conduits flush with MH/HH walls.
6. Sealing: Apply a watertight, conductive thread compound (for PSC) or solvent-type cement (for RNC) to make conduit connections waterproof and rustproof. Seal and grout conduit terminations in maintenance holes and handholes to ensure that voids in the joints are filled. Seal conduit terminations in buildings until used for cable.
7. Cleaning: After installation, and within five days prior to releasing conduit for cabling installation, clean each conduit with a wire brush and swab. Clean each conduit a minimum of two times in the same direction and swab with clean rags until the rag comes out of the conduit clean and dry. Swab away from buildings for conduit sections connected to buildings.
8. Test Mandrels: Prove out each conduit with a minimum 16 inch long test mandrel that is ¼ inch smaller than the inside diameter of the conduit. Pull the test mandrel after backfilling but prior to the replacement of landscaping. Repair or replace any conduit that does not prove out at no cost to the Owner.
9. Conduit Entrances:
   a. MH/HH: Conduit entrances at opposite ends of a maintenance hole or handhole shall be at the same level and in the same position with respect to the side walls. Ensure that each conduit leaving a MH/HH in any position enters the next MH/HH in the same relative position.
   b. Buildings: Terminate conduits 4 inches above the finished floor.
10. Length: Unless otherwise shown on the Drawings, do not exceed 600 feet of ductbank between pulling points. Contact the Engineer prior to proceeding if a ductbank section will exceed 600 feet.
11. Pull Ropes & Muletape Pull Cord: Install in each conduit immediately after the conduit has been cleaned and mandreled. Leave a minimum of 10 feet looped and tied off at each end of the conduit.
12. Protection: Insure that after installation the conduit coatings and finishes are without damage. Repair as follows:

a. PVC Coated Rigid Steel Conduit: Patch nicks and scrapes in PVC coating after installing conduits.
b. Rigid Non-metallic Conduit: Repair damage with matching touchup coating recommended by the manufacturer.

B. Ductbanks:
1. Unless otherwise noted on the Contract Documents or required for sweep radius, construct ductbanks without concrete encasement. Where shown as concrete-encased, use concrete encased RNC. See CAST-IN-PLACE CONCRETE, above.
2. Encased in Concrete:
a. See CAST-IN-PLACE CONCRETE, above.
3. Conduit Spacers/Supports: Place supports on 8 foot centers if encased in concrete and 5 foot centers otherwise. Interlock spacers horizontally only. Stagger spacers encased in concrete at least 6 inches vertically.
4. Warning Tape: Install metallic warning tape half the distance between the top of the ductbank and finished grade.
5. Grounding/Bonding: Install ground wire along length of ductbank. Bond to grounding electrodes of MH/HH and to building service grounds.
6. Slope ductbank grade to fall 3 inches per 100 feet in general and ¼" per foot where possible.
a. Slope ductbank toward lower MH/HH or from high points toward MH/HH at both ends.
b. Slope ductbank away from building entrances.

3.4 UNDERGROUND SPACES

A. Provide handholes in the sizes and locations shown on the Drawings.

B. Precast handholes shall be free from damaged joint surfaces, cracks, or other damage that would permit infiltration. Repair of defects is not acceptable. Handholes and incidental and miscellaneous equipment (such as cable racking brackets and supports) shall be supplied by a single manufacturer.

C. Install handholes according to manufacturer's instructions.

D. Setting and Placement: Remove water from excavation and properly install bedding material prior to setting the handholes.
1. Carefully set handholes level, plumb, and firmly positioned. Ensure that the rim or lid elevation is set one inch above finished grade. For handholes located in paved areas, taper pavement up to the handhole rim.
2. Where handholes are placed in un-level terrain provide curbing or other methods of earthwork-retention above and below the handhole.

E. Concrete Collars:
1. For handholes installed in softscape, provide concrete collar at surface where top of collar is level with the lid of the handhole.
2. For handholes installed in hardscape, do not provide concrete collar.

F. Grounding/Bonding: Provide a minimum of one ¾" x 10' copperclad steel ground rod, and one #4/0 pigtail for connection to interior ground conductors. Bond metallic hardware in the vault to the pre-cast bonding tabs. Bond the bonding tabs to the ground rod.

G. Cleaning: Clean and dry handholes after construction activity is complete and prior to releasing handholes to the Owner for the Owner's use.

3.5 LABELING AND ADMINISTRATION

A. Outside Plant Conduits:
   1. Conduits shall be labeled by permanently marking the maintenance hole wall adjacent to each conduit. The markings shall indicate the maintenance hole name/number or building name where the opposite end of the conduit terminates.

B. Outside Plant Maintenance Holes:
   1. Maintenance holes shall be labeled by permanently marking the wall of the maintenance hole in a location that is as high as possible while remaining visible and readable from above ground. Preferably, the location should be higher than the groundwater level in the maintenance hole. The markings shall indicate the maintenance hole name/number.

3.6 LANDSCAPING

A. Topsoil: Provide imported topsoil for excavations in grass and/or landscaped areas. Provide loosely compacted topsoil to a depth of 4” or depth of excavation for excavations less than 12”. Restore existing grades where disturbed. Rake and smooth topsoil following proper placement. Installation shall be approved by the Owner prior to placing sod. Place topsoil per APWA Paragraph 8-01.3(2).

B. Provide sod for grass areas disturbed by construction activity and replace shrubbery and trees damaged, removed or disturbed by construction activity. The use of seed/hydroseed is only acceptable when approved in advance by the Owner and the Engineer prior to installation.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials and labor for the installation of a customer-owned outside plant telecommunication system. This section includes Customer-Owned Outside Plant Communications cabling, termination, and administration equipment and installation requirements for the specified Outside Plant Structured Cabling System (OSP-SCS - See Definition Below).

B. Products installed (but not furnished) under this section:
1. Grounding Conductor

1.2 SYSTEM DESCRIPTION

A. Furnish, install, test and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete ANSI/TIA/EIA and ISO/IEC compliant communications Outside Plant Structured Cabling System as hereinafter specified and/or shown on the Contract Documents. The system is intended to be capable of integrating voice, data, and video signals onto a common media, and shall be tested for and be capable of Gigabit Ethernet operation as specified in IEEE 802.3z.

B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant Outside Plant Structured Cabling System.

1.3 DEFINITIONS

A. "OSP-SCS" shall mean *Outside Plant - Structured Cabling System*. The OSP-SCS is defined as all required equipment and materials including, but not limited to, ANSI/TIA/EIA and ISO/IEC compliant copper and fiber optic cable (multimode and singlemode), connectors, splices, splice closures and other incidental and miscellaneous equipment and materials as required for a fully operational, tested, certified, and warranted system, compliant with all applicable codes and standards.

B. "MH" shall mean *Maintenance Holes* or *Handholes* used for the routing of communications cables.

C. "TMGB" shall mean *Telecommunications Main Grounding Busbar.* There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.

D. "TGB" shall mean *Telecommunications Grounding Busbar.* There is typically one TGB per telecommunications room. The TGB is connected both to the TMGB and to building structural steel or other permanent metallic systems.

E. "TBB" shall mean *Telecommunications Bonding Backbone.* The TBB is a conductor used to connect TMGBs to TGBs.

1.4 SEQUENCING

A. Provide coordination with OSP-SCS manufacturer's representatives to ensure that the manufacturer's inspectors are available to schedule site visits, inspections, and certification of the system. Provide and coordinate any modifications required by the manufacturer and have the manufacturer re-inspect and certify the system prior to the scheduled use of the system by the Owner.

B. The Contractor is solely responsible for all costs associated with scheduling the OSP-SCS manufacturer's inspection, the inspection itself and any required re-inspections, and for any modifications to the installation as required by the OSP-SCS manufacturer.

PART 2 - PRODUCTS

2.1 RACEWAY

A. As specified under Division 33 Section – "Communications Underground Ducts, Manholes and Handholes," Division 27 Section – "Hangers and Supports for Communications Systems" and Division 27 Section – "Conduits and Boxes for Communications Systems" except where noted below.

B. Innerduct: Corrugated, thin wall, bright orange with pre-installed pull-line.
1. Outside Plant: Rated for outdoor duct installation.
2. Intrabuilding: Plenum rated.
3. Acceptable Sizes:
   a. 1" Diameter
   b. 1-1/4" Diameter
4. Acceptable manufacturers:
   a. Carlon DG4X1C-nnnn
   b. Dura-line Corrugated
   c. Or approved equal

2.2 EQUIPMENT RACKS/ENCLOSURES

A. As specified in Division 27 Section – "Communications Equipment Room Fittings."

2.3 TERMINATION EQUIPMENT

A. Voice Backbone Copper Building Entrance Terminals (BETs): Complete with lockable covers and plug-in protector modules for each pair terminated on the chassis. Gas-tube protector modules shall provide 350V over-voltage and sneak current protection. BEPs and protectors shall be manufactured by the following manufacturers:
1. For Circa Enterprises, Inc.:
   a. 1880ECA1 Series
      1) Single pair (for Emergency Phone): 1360B
      2) Less than or equal to 25-pair to be terminated: 1880ECA1-25GT2
      3) 26-pair to 50-pair to be terminated: 1880ECA1-50GT2
      4) 51-pair to 100-pair to be terminated: 1880ECA1-100GT2
      5) 101-pair to 200-pair to be terminated: 1880ECA1/NSC-200
   b. Protectors shall be:
      1) 4B1E (PTC)
2. For Siecor:
   a. 810 Series with MOXS Connectors
      1) Less than or equal to 25-pair to be terminated: A0350252
      2) 25-pair to 50-pair to be terminated: A0350254
      3) 50-pair to 100-pair to be terminated: A0350256
   b. Protectors shall be:
      1) Black: A0353716
      2) Red: A0353717
3. For 3M:
   a. 10-pair — Porta Systems 504PX210GT, complete with over-voltage protectors
   b. 25-pair — Porta Systems 581P225GT, complete with over-voltage protectors

2.4 CABLE

A. Outdoor Cable: Rated for outdoor use, duct installation, and/or direct burial installation as dictated by the application.
   1. Copper Cable:
      a. For Backbone: Shielded, with 24-AWG solid copper conductors insulated with color-coded PVC. UL Verified to ANSI/TIA/EIA 568-B for Category 3 performance. Insulated with filled foam skin-DEPIC and conform to RUS 7 CFR 1755.890 (REA PE-89). Cable shall be manufactured by or listed as an “approved alternative product” by the selected OSP-SCS Manufacturer:
         1) Essex:
            a) Inter-building Shielded Copper Cable, Outside Plant PIC: SEALPIC-FSF
         2) General Cable:
            a) Filled Foam Skin QUALPETH Cable, Spec. 2007
      b. For Termination Block Connections (back-side): Unshielded, non-plenum multi-pair copper cable, 24-AWG, solid copper conductor, insulated with color coded PVC. UL Verified to ANSI/TIA/EIA 568-B for Category 3 performance. Cable shall be manufactured by the selected OSP-SCS Manufacturer:
         1) For General Cable: Category 3 UTP Cable 57242-x
   2. Fiber Optic Cable: All-dielectric, meeting or exceeding ANSI/TIA/EIA and industry standards including Bellcore GR-20-CORE specifications. Cables and fan-out kits shall be manufactured by the selected OSP-SCS Manufacturer:
      a. Singlemode: Loose-tube, gel-free, with a maximum attenuation of 0.4 dB/km at 1300 nm and 0.3 dB/km at 1550 nm.
         1) For Corning LANscape:
            a) Outdoor rated: ALTOS xxxEU4-T4101D20 (where xxx = strand count)
            b) Indoor/Outdoor/Riser rated: FREEDM xxxEWF-T4101D20 (where xxx = strand count)
            c) Fan-Out kit: FAN-ODxx-xx
         2) For Siemon:
            a) Outdoor rated: Mohawk AdvanceLite M9X5xxT, Grade SM2
            b) Indoor/Outdoor/Riser rated: Mohawk RiserLite M9X81x, Grade SM2
            c) Breakout kit: Mohawk AX10110x

2.5 FIBER SPLICE CLOSURES

A. Shall be outdoor rated and re-enterable without the destruction of the housing. Closures shall not require special tooling for entry and sealing of the closure. Closures shall be complete with all incidental and/or required hardware including, but not limited to end caps, grommet kits, splice trays, and grounding/bonding hardware. Closures shall be butt-style (in-line is not permitted). Closures shall be manufactured by the following manufacturer:
   1. For TE Connectivity:
      a. Splice Closure Family (SCF): FOSC 450, with splice trays
         1) 24” long: FOSC 450-B6-6-24-1-B3V
            a) Trays: FOSC- ACC-B-TRAY-24
         2) 30” long: FOSC 450-D6-6-72-1-D6V
            a) Trays: FOSC-ACC-D-TRAY-72
      b. Encapsulation: Waterblocking gel per manufacturer’s recommendation.
   2. Or pre-approved equal

2.6 GROUNDING AND BONDING

A. As specified under Division 27 Section – “Grounding and Bonding for Communications Systems” and Division 33 Section – “Grounding and Bonding for Communications Distribution.”

2.7 LABELING AND ADMINISTRATION

A. Labels
1. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, typed, and created by a hand-carried label maker or an approved equivalent software-based label making system. Handwritten labels are not acceptable.
a. Inside Telecommunication Rooms:
1) Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)
b. Outside Plant: Waterproof
1) 3/16 inch stainless steel strap ¾" wide, embossed with punch-pressed characters, attached to the cable sheath with stainless steel lashing wire.
a) Panduit ½" 316 Stainless Steel tape METS3-X
2) Reflective lettering.
a) 3M 5005
2. Hand-carried label maker:
a. Brady: ID Pro Plus (or approved equal).

PART 3 - EXECUTION

3.1 GENERAL

A. Store all materials so as to be protected from the elements. Pathway materials (conduit, fittings, maintenance holes, etc.) are permitted to be stored outdoors if stacked on boards to avoid direct contact with the ground. The Contractor shall be responsible for any deteriorating effects on the materials due to improper storage (or outdoor storage) prior to installation including damage caused by prevailing weather conditions.

3.2 DEMOLITION

A. Demolish existing telecommunications equipment, cable, materials, and incidentals no longer in use after installation of the new OSP-SCS.
1. Mandrel, clean, and cap outside plant conduits left empty after demolition of outside plant cables.
a. Clean each conduit with a wire brush, swab, and prove out with a minimum 16 inch long test mandrel that is ¼ inch smaller than the inside diameter of the duct. Clean conduit a minimum of two times in the same direction. Swab with clean rags until the rag comes out of the conduit clean and dry. Swab away from buildings for duct sections connected to buildings.
2. Properly and legally dispose of demolished materials.

B. Coordinate the demolition schedule with the Owner. Do not proceed with demolition prior to approval from the Owner.

3.3 RACEWAY

A. Provide and install as specified under Division 33 Section – "Communications Underground Ducts, Manholes and Handholes," Division 27 Section – "Hangers and Supports for Communications Systems" and Division 27 Section – "Conduits and Boxes for Communications Systems" except where noted.

B. Innerduct:
1. Provide sufficient innerduct slack to allow for innerduct shrinkage after stretching during installation.
2. Avoid excessive pulling tension. Replace innerduct showing evidence of excessive pulling tension at no cost to the Owner.
3. Innerduct shall be continuous. Do not splice innerduct between pullpoints.

4. Cap innerduct immediately after placement in order to prevent debris from entering. Uncap only when cable is to be installed.
5. Outside Plant Innerduct:
   a. Provide in quantities, sizes and locations as shown on the Contract Documents. Where not shown on the Contract Documents:
      1) Install copper cabling without innerduct.
      2) Install fiber optic cabling inside innerduct.
      3) Fill the remaining space in a used conduit with empty innerduct, with pull strings in each empty innerduct.
      4) Do not provide innerduct in vacant conduits.
   b. Rack and secure innerduct inside maintenance holes and handholes. If existing maintenance holes and handholes have insufficient racking to support new cabling, provide racking.
6. Intrabuilding Innerduct:
   a. Provide in quantities, sizes and locations as shown on the Contract Documents. Where not shown on the Contract Documents:
      1) Install copper cabling without innerduct.
      2) Install fiber optic cabling inside innerduct.

3.4 TERMINATION EQUIPMENT

A. Copper Building Entrance Protectors: Provide BEPs in types, sizes and quantities as shown on the Contract Documents and as required for protection of building-to-building copper circuits. Provide BEPs in sufficient quantity to protect each pair of each cable plus an additional 10% for future use. Install BEPs per manufacturer's instructions. Route outside plant copper cables through a BEP.
   1. Connect each BEP's ground lug to the nearest TGB with a #6 AWG copper grounding conductor.

3.5 GROUNDING AND BONDING

A. Bond non-current carrying metal telecommunications equipment and materials to the nearest TGB (if within a building – as specified under Division 27 Section – "Grounding and Bonding for Communications Systems") or the nearest grounding conductor if in the outside plant – as specified under Division 33 Section – "Grounding and Bonding for Communications Distribution."
   1. Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.

3.6 CABLE

A. For each conduit in which innerduct or cable is to be installed:
   1. Test Mandrels: Clean each conduit with a wire brush and swab with clean rags a minimum of two times in the same direction until the rag comes out of the conduit clean and dry. Swab away from buildings for duct sections connected to buildings. Prove out each conduit with a minimum 16 inch long test mandrel that is ¼ inch smaller than the inside diameter of the duct.

B. General (applicable to all cable types):
   1. Test fiber optic cable on the reel upon delivery to the job site, and again prior to installation. Permanently affix the test results to the reel and submit a copy to the Owner prior to installation. Do not install cables that fail the on-reel test. Replace any cables that fail the on-reel test at no additional expense to the Owner.
      a. Test shall conform to the procedures as outlined in the paragraph entitled TESTING at the end of this specification section.
   2. Install cables in compliance with ANSI/TIA/EIA requirements, BICSI practices, and manufacturers' recommendations. Adhere to the requirements detailed in the manufacturer's recommendations and ANSI/TIA/EIA Standards relating to bending radius, pulling tension, other mechanical stresses, and pulling speed.

a. Monitor pulling tension on runs of 300 feet or longer. Acceptable monitoring devices are:
   1) Winch with a calibrated maximum tension
   2) Breakaway link (swivel)
   3) In-line tensiometer

3. Set up cable reels on the same sides of maintenance holes and hand holes as the conduit sections in which cables are to be placed. Level and align reels with conduit sections to prevent twisting of cables during installation into conduits. Pull cables into conduits from tops of reels in long smooth bends. Do not pull cables into conduits from bottoms of reels. Use a cable feeder guide (shoe) of suitable dimensions between the cable reel and the face of the duct to protect the cable and to guide it into the duct. Carefully inspect the cables for sheath defects as the cables are payed off the reel. If defects are found during the pulling operation or if the cable on the reel binds, twists, or does not pay off freely, stop the pulling operation immediately and notify the Owner's representative.
4. Cables of 1-¼ inch diameter or larger shall be equipped with factory-installed pulling eyes, or install a core hitch on site. Use pulling grips for cables smaller than 1-¼ inches in diameter. Do not pound grips into the cable sheath to prevent the grips from slipping. Use a ball-bearing-based swivel between the pulling-eyes or grips and the pulling strand.
5. Once pulling begins, and tension is applied to the cable, continue the pull at a steady rate. If it is necessary to stop the pull at any point, the tension shall not be released unless it is necessary to do so.
6. Do not splice cables unless specifically noted on the Contract Documents.
7. For new ductbank, install cables in the lowest available conduit in a duct bank, working up as additional cables are installed. For existing ductbanks, do not place cables in ducts other than those indicated on the Contract Documents.
8. Where cables are pulled through maintenance holes or handholes, select the same duct at both sides of maintenance holes or handholes unless specifically noted on the Contract Documents. Avoid changes in duct selections, especially in elevations, to ensure that no damage occurs to the cable sheaths and that pulling tensions are kept as low as possible.
9. Maintain a sufficient length of cable in each maintenance hole or handhole to properly rack the cable. Rack cables in maintenance holes and handholes as soon as practicable, but no more than one week after cable installation. Route cables in maintenance holes and handholes to avoid blocking duct access.
10. When more than one cable is being installed in a conduit, pull all cables through the conduit simultaneously.
11. Where practicable, feed cables into ducts from the end of the duct that creates the least sidewall pressure on a bend during installation (i.e. feed cable from the end closest to the bend).
12. Use pulling compound or lubricant where necessary. Use lubricants that are compatible with the cable jacket material and in accordance with the manufacturer's recommendations. Do not use soap-based lubricants. Where cable is pulled through a maintenance hole or handhole, re-lubricate the cable prior to feeding into the next duct. Immediately after cables have been installed, clean lubricant from exposed cables in maintenance holes and handholes and at termination points using dry rags.
13. Seal cable ends with end caps immediately after installation and until terminated in a termination enclosure, to prevent moisture entry into the core of filled cables and to prevent damage during installation.
14. Provide a service loop in the ER/TR long enough to reach termination equipment if moved to the farthest side of the room in the future, but no less than a minimum of 25 feet at each end.
15. Comply with the NEC 50-ft rule when installing outdoor-rated cable (i.e. do not exceed 50 feet of exposed outdoor-rated cable length within a building).
16. Cable at the backboards:
    a. Lay and dress cables to allow future cabling to enter raceway (conduit or otherwise) without obstruction by maintaining a working distance from these openings.
    b. Route cable as close as possible to the ceiling, floor or other corners to insure that adequate wall or backboard space is available for current and future equipment and for cable terminations.

c. Lay cables via the shortest route directly to the nearest edge of the backboard from mounted equipment or blocks. Support cables so as not to create a load on the equipment upon which the cables are terminated. Tie-wrap together similarly routed and similar cables and attach to D-rings vertically and/or horizontally, then route over a path that will offer minimum obstruction to future installations of equipment, backboards or other cables.

17. Cable in the Telecommunications Rooms:
    a. For telecommunications rooms with ladder rack, lay cable neatly in ladder rack in even bundles and loosely secure cabling to the ladder rack at regular intervals.
18. Building Entrances: Seal conduits (both in-use and spare) that enter the building from the outside plant to prevent intrusion of water, gases, and rodents.

C. Copper Cable:
1. Provide copper cable in quantities and pair counts as shown on the Contract Documents.
2. Test copper cable on the reel upon delivery to the job site, prior to installation. Permanently affix test results to the reel and provide a copy to the Owner prior to installation. Do not install cables that fail. Replace failing cables at no additional expense to the Owner.
    a. Conform to the test procedures as outlined in the paragraph entitled TESTING at the end of this specification.
    b. Demonstrate that the test results are similar to the factory test results as shipped with the reel.
3. Terminate all pairs within a cable. Un-terminated cable pairs are not acceptable.
4. For shielded cable, bond the shield at both ends to the ground lug on the Building Entrance Protector.
5. Copper splices are not acceptable.

D. Fiber Cable:
1. Provide singlemode fiber optic cable in quantities and strand counts, as shown on the Contract Documents. Provide cable with fan-out kits for both ends.
2. Test fiber optic cable on the reel upon delivery to the job site, prior to installation. Permanently affix test results to the reel and provide a copy to the Owner prior to installation. Do not install cables that fail. Replace failing cables at no additional expense to the Owner.
    a. Conform to the test procedures as outlined in the paragraph entitled TESTING at the end of this specification.
    b. Demonstrate that the test results are similar to the factory test results as shipped with the reel.
3. Terminate all fiber strands within a fiber cable. The installation of “dark fiber” is not acceptable.
4. For shielded cable, bond the shield at both ends to the TGB.
5. Fiber splices are not acceptable.

3.7 FIBER SPLICE CLOSURES

A. Provide fiber splice closures in sizes and quantities as shown on the Contract Documents. Do not install splice closures where not shown on the Contract Documents. Install closures per manufacturer’s instructions. Closures shall be sized to accommodate the quantity of strands to be spliced with spare capacity to support a minimum of 200% additional strands in the future. Closures shall be outdoor or indoor rated (depending upon the use). Closures shall be butt-style.
1. Splice closures located in maintenance holes shall be supported on racks and shall be located to avoid blocking duct access.
2. Connect each closure’s ground lug to the nearest TGB with a #6 AWG copper grounding conductor.
3. Fiber splices shall be fusion splices. Provide splice trays designed to mount within the closure to manage each splice. Protect each bare/stripped optical fiber strand with heat shrink or silicon adhesive to prevent exposure to moisture.
4. Closures shall be properly sealed and demonstrated watertight. Test seals after closure by pressurizing the closure and checking seals for leaks.

3.8 LABELING AND ADMINISTRATION

A. Cables:
1. Label Location: Affix at each end of the cable, within 6 feet of telecommunications room entrance and again within 12" of termination point.
2. Fiber Optic Cables shall be labeled in the form of "##SM to BB rm#" where "##" is the number of strands, "SM" is the fiber type, "BB" is the building abbreviation and "rm#" is the telecommunications room or lab where the far end of the cable is terminated.
   a. For example: A 48-strand singlemode cable whose far end terminates in building "LA" in telecommunications room 005 would be labeled on the near end "48SM to LA 005".
3. Copper Backbone Cables shall be labeled in the form of "###PR to BB rm#" where "###PR" is the number of copper pairs, "BB" is the building abbreviation and "rm#" is the telecommunications room where the far end of the cable is terminated.
   a. For example: A 200PR copper backbone cable whose far end terminates in building "LA" in telecommunications room 005 would be labeled on the near end "200PR to LA 005".

B. Innerduct:
1. Label Location: Affix at each end of the innerduct, within 6 feet of telecommunications room entrance and again within 12" of the end of the innerduct.
2. Innerduct shall be labeled in the form of "BB rm#", where "BB" is the building abbreviation and "rm#" is the telecommunications room.
   a. For example: An innerduct whose far end terminates in building "LA" in telecommunications room 005 would be labeled on the near end "LA 005".

C. Termination Blocks:
1. Desi-strips for termination blocks used for copper backbone distribution shall be laser printed with the following information:
   a. The identifier for the cable terminated on the blocks.
   b. The pair numbers, with the first and last pairs and a pair number for each interval of 5 pairs, with the pair numbers spaced to match the termination location for each pair.
      1) For example: A 50-pair backbone cable whose far end terminates in building "LA" in telecommunications room 005 would be labeled on the near end:

01	05	10	15	20	25
		50PR to LA 005			
26	30	35	40	45	50

2. Color Coding: Apply industry standard color coding to cable termination fields. Always apply the same color at both ends of any given cable. Cross-connections are generally made between termination fields of different colors. The color may be applied to the backboard behind the termination equipment, may be the color of a cover on the termination equipment, or may be the actual color of the insert label on the termination equipment. Use the following color code:
   a. Green: Identification of network connections on the customer side of the demarcation point.
   b. Brown: Identification of inter-building backbone cables.
   c. Yellow: Identification of auxiliary circuits, alarms, maintenance, security, and other miscellaneous circuits.

D. Building Entrance Protectors:
1. Label Locations: Affix labels on the front cover of each BEP and on the termination blocks.
2. On the cover of the BEP, the label shall indicate the identifier for the cable terminated inside, as described above.
3. Desi-strips for termination blocks used for copper backbone distribution shall be laser printed with the identifier for the cable terminated on the blocks and the pair numbers, as described above.

E. Fiber Optic Patch Panels:
   1. Fiber optic patch panels shall be labeled on the face of the patch panel with the same identifier as the cable that terminates in the patch panel. See paragraph A above.

F. Before applying the cable numbering scheme described above, verify that the room numbers shown on the drawings match the actual room numbers that appear on building signage. The room numbering scheme may change between design and construction. All labeling and numbering schemes that incorporate room numbers shall reflect the finished, as-built room numbering, which may be different than the numbering shown in the construction documents.

G. Grounding/Bonding Conductors:
   1. Label bonding conductors “WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!”

3.9 TESTING

A. Test the SCS after installation for compliance to all applicable standards as follows:
   1. Intrabuilding Backbone Copper: Test all cable pairs for length, shorts, opens, continuity, polarity reversals, transposition (wire map), and the presence of AC voltage. All pairs shall demonstrate compliance to TIA/EIA 568-B Category 3 standards.
      a. Test copper cable after installation, from termination block to termination block.
      b. Use a TIA/EIA Level III testing instrument, re-calibrated within the manufacturer’s recommended calibration period, with the most current software revision based upon the most current TIA/EIA testing guidelines, capable of storing and printing test records for each cable within the system.
         1) Fluke DSP-4000, or approved equal.
   2. Fiber: Test fiber optic cable after installation.
      a. Prior to testing, calculate the cable loss budget for each fiber optic cable and clearly show the result on the test documentation. Calculate maximum loss using the following formula, assuming no splices:
         1) For Horizontal Distribution:
            a) Max Loss = 2.0db (per ANSI/TIA/EIA 568-B)
         2) For Backbone Distribution:
            a) Max Loss = [(allowable loss/km) * (km of fiber)] + [(.3db) * (# of connectors)]
            b) A mated connector to connector interface is defined as a single connector for the purposes of the above formula.
            c) A given fiber strand shall not exceed its calculated maximum loss (per the above formula).
      b. Test all strands using a bi-directional end-to-end optical transmission loss test instrument (such as an OTDR) trace performed per ANSI/TIA/EIA 455-61 or a bi-directional end-to-end power meter test performed per ANSI/TIA/EIA 455-53A, and ANSI/TIA/EIA 568-B.
         1) Calculate loss numbers by taking the sum of the two bi-directional measurements and dividing that sum by two.
         2) Provide test measurements as follows:
            a) Test singlemode cables at both 1310 and 1550nm.
      c. Test results shall conform to:
         1) The criteria specified in ANSI/TIA/EIA-568B
         2) The Contractor’s calculated loss budget above
         3) The criteria specified in IEEE 802.3z (1000Base-X Gigabit Ethernet)
            a) In addition to the above, perform tests both recommended and mandated by the manufacturer. Tests shall confirm/guarantee compliance with the manufacturer’s performance standards and also IEEE 802.3z for a maximum end-to-end dB loss of 2.5 dB.
         4) The criteria specified in IEEE 802.3z (1000Base-X Gigabit Ethernet)

B. Cables and equipment that do not pass tests shall be identified and discussed with the Owner and Engineer. Determine the source of the non-compliance and replace or correct the cable or the connection materials, and retest the cable or connection materials at no additional expense to the Owner. Provide new test results to the Owner and Engineer in the same manner as above.
   1. In addition to the above, if it is determined that the cable is at fault, remove the damaged cable and replace it with a new cable. Cable “repairs” are not acceptable. The procedure for removing the cable shall be as follows:
      a. Prior to removal of damaged cable and installation of new cable:
         1) Inform the Owner and Engineer of the schedule for the removal and installation.
         2) Test the new cable on the reel per paragraph B, above.
         3) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable per paragraph B, above, regardless of whether or not they are new cables installed as part of this project or existing cables installed prior to this project.
         4) Provide test results to the Owner and Engineer for approval by the Owner and Engineer.
      b. Remove the damaged cable and provide new cable.
      c. After the removal of the damaged cable and installation of the new cable:
         1) Test the new cable per the paragraph titled TESTING.
         2) Test cables that occupy the same innerduct or conduit as the damaged cable per paragraph B, above, regardless of whether they are new cables installed as part of this project or existing cables installed prior to this project.
         3) If any of the cables requiring testing are in use, coordinate with the Owner to schedule an outage opportunity during which the testing can be performed.
         4) Provide test results to the Owner and Engineer for approval by the Owner and Engineer.
      d. If a cable which occupies the same innerduct or conduit as a damaged cable is damaged by the extraction and reinstallation process, replace the cable at no additional expense to the Owner.
         1) Damaged cables which are replaced shall be subject to the testing procedures of the paragraph titled TESTING.

C. Provide test records on a form approved by the Owner and Engineer. Include the test results for each cable in the system. Submit the test results for each cable tested with identification as discussed under LABELING AND ADMINISTRATION above. Include the cable identifier, outcome of test, indication of errors found, cable length, retest results, and name and signature of technician completing the tests. Provide test results to the Owner and Engineer for review and acceptance within two weeks of Substantial Completion.
   1. Print test records in Adobe PDF format for each cable directly from the test software and submit in electronic form (in Adobe PDF and native Fluke test files) on CDROM to the Owner and Engineer for review. Handwritten test results will not be accepted.
   2. Any cabling discovered to have unsatisfactory test results shall be reterminated or replaced and retested.
   3. After all performance and testing issues have been addressed, resubmit the complete set of corrected test reports to the Owner and Engineer on CDROM.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials and labor for the installation of a grounding and bonding system for outside plant telecommunications infrastructure. This section includes requirements for providing a permanent grounding and bonding infrastructure for communications ductbanks, maintenance holes, handholes, and splice closures. These requirements are in addition to any that may exist in Section 26 and Section 27.

1.2 SYSTEM DESCRIPTION

A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete, permanent Grounding and Bonding infrastructure for outside plant telecommunications circuits, termination hardware, raceways, and spaces as hereinafter specified and/or shown on the Contract Documents. The Grounding and Bonding system shall support an ANSI/TIA/EIA and ISO/IEC compliant outside plant communications cabling system as specified in section 338200 – “Communications Distribution.”

B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant Grounding and Bonding system.

1.3 DEFINITIONS

A. “TMGB” shall mean *Telecommunications Main Grounding Busbar*. There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.

B. “TGB” shall mean *Telecommunications Grounding Busbar*. There is typically one TGB per telecommunications room. The TGB is connected both to the TMGB and to building structural steel or other permanent metallic systems.

C. “TBB” shall mean *Telecommunications Bonding Backbone*. The TBB is a conductor used to connect TMGBs to TGBs.

D. “MH” shall mean *Maintenance Hole*.

E. “HH” shall mean *Handhole*.

F. “OSPBB” shall mean *Outside Plant Bonding Backbone*. The OSPBB is a conductor used to connect the grounding and bonding hardware in maintenance holes and hand holes, and also to the TMGB.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials shall consist of busbars, supports, bonding conductors and other incidentals and accessories as required.

2.2 BUS BARS

1. Telecommunications Main Grounding Bus Bar (TMGB):

a. Large (20” x 4” x ¼”), Pre-drilled: CPI 10622-020
b. Small (10” x 4” x ¼”), Pre-drilled: CPI 10622-010

2. Telecommunications Grounding Bus Bar (TGB):
a. Large (20” x 4” x ¼”), Pre-drilled: CPI 10622-020
b. Small (10” x 4” x ¼”), Pre-drilled: CPI 10622-010

3. Outside Plant Bonding Backbone: #2 AWG non-insulated stranded copper conductor.
4. Grounding Conductor: #6 AWG insulated (green in color) copper conductor.

2.3 GROUND RODS

1. Ground rods shall be copper-clad, ¾" X 10.
2. Connections to ground rods shall be with lugs, above grade.

2.4 LABELS:

A. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.

1. Labels:
a. Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)
b. Panduit Marker Tie (or approved equal)
2. Hand-carried label maker:
a. Brady: ID Pro Plus (or approved equal)

PART 3 - EXECUTION

3.1 INSTALLATION

A. The grounding and bonding infrastructure system shall not make use of the building plumbing system, unless required to do so by the NEC.

1. Coordinate the installation of the grounding and bonding system with the electrical power distribution system grounding infrastructure.

3.2 BUS BARS

A. Outside Plant Bonding Backbone: Provide an OSPBB running continuously through each section of ductbank. Bond the OSPBB for each ductbank section to each other and also the grounding and bonding hardware in each MH and HH. Bond the OSPBB to the TMGB in each building where a ductbank terminates.

B. Bond all equipment having grounding lugs and contained in MHs and HHs to the OSPBB.

C. TMGB: Provide a minimum of one TMGB per telecommunications room for each building and as shown on the Contract Documents. Install TMGB(s) and directly bond TMGB(s) to electrical service ground and to associated TBB(s). Group protector, busbar bonding, and approved building grounding conductors toward the left end and leave space for equipment grounding conductors to the right end.

D. TBB(s) and Grounding Conductors: Provide TBB(s) and grounding conductors as shown on the Contract Documents and as required to bond all non-current-carrying metal telecommunications equipment and materials to the nearest TGB. Use TBB(s) to connect the TMGB to each TGB. Route along the shortest and straightest path possible with minimal bends. Bends shall be sweeping. Insulate TBB(s) and conductors from their support. TBB(s) and grounding conductors shall be continuous (without splices).

1. Ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware.

3.3 GROUND RODS

A. Provide a ground rod in each outdoor maintenance hole, handhole or pull hole. Drive ground rod 9 feet into the ground. Terminate trace-wire conductors from ductbank on ground rod using a ground lug or clamp.

3.4 LABELS:

A. Label TMGB(s) with “TMGB”. If the TMGBs are existing and unlabeled, provide labels for each.

B. Label TGB(s) with “TGB”. If the TGBs are existing and unlabeled, provide labels for each.

C. Label TBB(s) and OSPBB(s) “WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!”

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials, software, cabinets, racks, enclosures, cabling, connectors, power hardware, equipment, and labor for the installation of audio/visual systems.

1.2 QUALITY ASSURANCE

A. See section 27 05 00 for Audio/Visual contractor pre-qualification requirements.

1.3 SYSTEM DESCRIPTION

A. Furnish, install, test, and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances associated with audio/visual equipment cabinets, racks, frames, enclosures, cable management, and power hardware to support standards-compliant audio/visual systems as shown on the Contract Documents.

B. Each type of material and type of equipment shall be of the same manufacturer and product family throughout the work.

C. The work shall include all materials, equipment, software, and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working system, compatible with and complementary to the existing campus systems.

D. Provide the systems listed below and as shown on the Contract Drawings, unless otherwise indicated:
   1. Wiring and cabling
   2. Equipment racks, cabinets, and enclosures
   3. Furniture
   4. Amplifiers
   5. Audio DSP (Digital Signal Processor)
   6. Speakers
   7. Assistive listening devices
   8. Microphones
   9. CD players
   10. Digital audio recorders
   11. In-ear monitors
   12. Soundboards
   13. Blu-ray players
   14. Video cameras
   15. Video conferencing systems
   16. Video distribution amplifiers
   17. HDBaseT distribution equipment
   18. Video switches/matrices
   19. Projection screens
   20. Video projectors
   21. Video panels
   22. Computer monitors
   23. Touch panel interfaces
   24. Button panel interfaces
   25. Control processors
   26. Lighting controllers

27. Large portable outdoor A/V systems
28. Presentation wireless remote controls

1.4 SUBMITTAL INFORMATION

A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Combine product submittals for all products and submit together as a single submittal.
   1. Submit a cover letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. State in the letter that the Contractor has reviewed the specified items, and agrees that they are applicable to this project in all respects.
   2. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.
   3. For those items noted as allowing "or equal," and which are not being provided as specifically named, submit a written description detailing the reason for the substitution, along with standard manufacturer's cut sheets or other descriptive information.

B. Preliminary Schematic Wiring Diagrams: Provide a schematic wiring diagram for each audio/visual application. The diagrams shall show all equipment with equipment model numbers. The diagrams shall also show all cables and wiring connections, indicating cable/wire types.

C. As-built Schematic Wiring Diagram: Upon successful operation of each audio/visual application, provide a schematic wiring diagram for each building and room having an audio/visual application. The diagrams shall show all equipment with equipment models and serial numbers. The diagrams shall show all cables and wiring connections, indicating cable/wire type and wire labeling.
   1. For rooms that have identical audio/visual systems (including wire numbers), a single drawing will be sufficient as long as it lists the building and rooms to which it applies.
   2. Sometimes name and number changes occur during construction. Before creating drawings and labeling, verify that the room names and numbers are correct.

D. Operation, Installation, and Maintenance Manuals: At the conclusion of the project, provide electronic copies of the Operation, Installation, and Maintenance Manuals for each piece of audio/visual equipment. Each document shall be provided in Adobe Acrobat PDF format on a CDROM or DVDROM. Each PDF file shall be an original document prepared by the manufacturer. For each document that is not available from a manufacturer's website, scan the hardcopy documentation provided with the equipment.
   1. Organize the PDF files on the CDROM or DVDROM in a folder structure as follows:
      a. Each room per building shall have a separate folder containing all documents for the equipment in that room.
      b. The folders shall be named in the following format: "BUILDING – NAME - ###" where BUILDING is the name of the building, NAME is the name (and/or number) of the room, and ### is the room number.
   2. Provide to the Owner a single set of hardcopy printed documentation for each piece of audio/video equipment. Organize the documentation in a 3-ring (or similar) binder. Dispose of all other copies of the original printed documentation after verification that the electronic (PDF) version of each is stored on the CDROM or DVDROM.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless specifically stated as “Or equal,” equal items are not acceptable. Provide items as specified. Pre-approval (prior to bid) by the Owner is required for all “or equal” substitutions.

B. Part numbers and model numbers are specified in the Appendix at the end of this section.

C. Provide batteries for all hand-held remote controls.

2.2 GROUNDING AND BONDING

A. See Section 27 05 26 – “Grounding and Bonding for Communications Systems.”

2.3 STANDARD CABLE ASSEMBLIES/PATCH CORDS

A. General: The cabling listed below shall be used where referenced in this specification section. Cable colors shall be used consistently throughout as indicated.

B. Standard Audio Cabling:
   1. Non-plenum rated cabling shall be 22 AWG, stranded copper, twisted pair, shielded with 22 AWG drain wire, white colored, unless otherwise indicated:
      a. Belden 9451 009U1000
      b. or commercial grade equal
   2. Plenum-rated cabling shall be 22 AWG, stranded copper, twisted pair, shielded with drain wire, white colored, unless otherwise indicated:
      a. Belden 9451P 009U1000
      b. or commercial grade equal
   3. Permitted terminations shall be:
      a. XLR: Neutrik.
      b. RCA: Neutrik or equal.
      c. 3.5mm TRS: commercial grade connectors acceptable.
      d. Screw-type (Phoenix): typically supplied by equipment manufacturer.
      e. Screw-type (open): typically supplied by equipment manufacturer.
      f. Drain wire sleeved with Teflon or PVC sleeving as appropriate.

C. Standard SDI Cabling:
   1. Non-plenum rated cabling shall be RG-59/U, 20 AWG, black colored, unless otherwise indicated:
      a. Belden 1505A
      b. or commercial grade equal.
   2. Plenum-rated cabling shall be RG-59/U, 20 AWG, black colored, unless otherwise indicated:
      a. Belden 1506A
      b. or commercial grade equal.
   3. Permitted terminations shall be:
      a. BNC, 75-ohm, compression: Belden, Liberty
      b. BNC, 75-ohm with a crimp plug: Belden, Liberty, AMP, or Canare.
      c. BNC-to-RCA Adapter: Canare, Liberty, or RCI Custom.

D. Standard HDMI Cabling:
   1. Pre-manufactured HDMI cables shall be commercial grade, HDMI 2.0 or higher, and not longer than 40 feet unless pre-approved on a case-by-case basis:

a. Plenum-rated: any cables between 16 feet and 40 feet in length, black in color.
   1) Comprehensive Cable Pro AV/IT series with ProGrip
b. Not plenum-rated: any cables shorter than 16 feet
   1) Comprehensive Cable Pro AV/IT Microflex series with ProGrip
      a) 3 ft cables shall be blue (MHD-MHD-3PROBLU)
      b) 6 ft cables shall be green (MHD-MHD-6PROGRN)
      c) 12-15 ft cables shall be orange (MHD-MHD-12PROORG) when concealed from audience
      d) 12-15 ft cables shall be black (MHD-MHD-12PROBLK) when visible to audience
c. or pre-approved equal.

2. Where HDMI applications would require lengths exceeding 40 feet, provide HDBaseT transmitters and/or receivers appropriate for each application as specified below under HDBaseT Distribution Equipment.

E. Standard HDBaseT Cabling:
1. Cabling shall be Shielded Category 6A Cabling per Section 27 15 00 – "Communications Horizontal Cabling," installed and terminated by the certified telecommunications contractor.
2. Permitted terminations shall be as shown in the Contract Documents, including:
   a. Outlets, jacks and faceplates for Category Cabling per Section 27 15 00 – "Communications Horizontal Cabling."

F. Standard DVI-D Cabling:
1. Pre-manufactured DVI-D cables shall be commercial grade cables, from:
   a. Comprehensive Cable Pro AV/IT
   b. or pre-approved equal.
2. All DVI cabling shall be interoperable with HDMI 2.0 for signal conversion.

G. Standard USB Cabling:
1. Pre-manufactured USB cables shall be commercial grade, from:
   a. Comprehensive Cable
   b. or pre-approved equal.

H. Standard Contact Closure Cabling:
1. Plenum-rated cabling shall be 18-20 AWG, stranded copper, three conductor, white colored, shielded with drain wire, unless otherwise indicated:
   a. Belden 6401FE
   b. or commercial grade equal.

I. Standard Control System Cabling:
1. Projection screen control cables shall be 18-22 AWG, plenum rated, stranded copper, five-conductor, shielded with drain wire, white colored:
   a. Belden 6504FE 8771000
   b. or commercial grade equal.
2. RS232 cables shall be 18-22 AWG, plenum rated, stranded copper, five-conductor, twisted pair, shielded with 22 AWG drain wire, white colored.
   a. Belden 6504FE 8771000
   b. or commercial grade equal.
3. Crestron Cresnet cable shall be plenum rated, certified Cresnet Cable, 22 AWG, single twisted pair, with two 18 AWG runners:
   a. Crestron Cresnet-P
   b. or commercial grade equal.

4. Crestron Network shall be Category 6A Cabling per Section 27 15 00 – “Communications Horizontal Cabling” with RJ45 connectors (not jacks), installed and terminated by the certified telecommunications contractor.
5. IR control cables (extension cables) shall be 22 AWG, stranded, twisted pair, shielded with 22 AWG drain wire, white colored, and terminated with a Screw-type (Phoenix) termination. Cables shall include IR Emitter provided by Room Control System manufacturer.
    a. Belden 6401FE
    b. or commercial grade equal.

J. Standard Speaker Wiring:
1. Speaker wiring shall be 12 AWG, stranded copper, two-conductor, unshielded, white or gray-colored, and plenum-rated (regardless of the plenum rating of the space):
    a. Belden 6000UE
    b. or pre-approved commercial grade equal.
2. Permitted terminations shall be as required by the attached device:
    a. Spring clip
    b. Screw-type (banana plug)
    c. Speakon

K. Standard Cable Management:
1. Hook-and-loop straps (Velcro style).

2.4 EQUIPMENT RACKS/ENCLOSURES

A. All A/V Equipment Racks and Enclosures shall include all necessary mounting hardware and grounding/bonding hardware.

B. A/V Equipment Racks (Full-Height) shall have a capacity of at least 40U, shall be 32” deep, and be black powder coated with a vented rear door. Racks shall be Middle Atlantic VRK Series or approved equal, with the following accessories:
1. Drawer
2. Cable Management
3. Rack-Mount Power Strip
4. Solid Blank Panels
5. Vented Blank Panels
6. Security Covers
7. Shelf

C. A/V Equipment Racks (Portable) shall have a capacity of 10U (minimum), shall be 20” deep, and be black powder coated with removable side panels. Racks shall be Middle Atlantic PTRK Series or approved equal, with the following accessories:
1. Swivel Casters - Middle Atlantic or approved equal
2. Cable Management
3. Rack-Mount Power Strip
4. Solid Blank Panels
5. Vented Blank Panels
6. Security Covers
7. Shelf

D. A/V Equipment Racks (In-Podium Slide-Out applications/Casework) – A/V Equipment Racks shall have a capacity of 18U, shall be at least 19 1/4” deep, black powder coated without sides, back, or top panels. Racks shall be capable of pulling out for installation and servicing of equipment. Racks shall be Middle Atlantic SRSR Series or approved equal, with the following accessories:

1. Rack-Mount Power Strip
2. Solid Blank Panels
3. Vented Blank Panels
4. Security Covers
5. Shelf

E. A/V Equipment Racks (In-Podium Fixed applications) – A/V Equipment Rack Rails shall be mounted in 19 ¼" furniture space and have a capacity of at least 18U. The following accessories are required:
   1. Equipment Rack Rails
   2. Rack-Mount Power Strip
   3. Solid Blank Panels
   4. Vented Blank Panels
   5. Security Covers
   6. Shelf

F. Cable Management:
   1. Middle Atlantic
   2. or approved equal.

G. Drawer:
   1. Middle Atlantic D Series
   2. or approved equal.

H. Equipment Rack Rails:
   1. Middle Atlantic RRF Series
   2. or approved equal.

I. Security Covers:
   1. Middle Atlantic SF
   2. or approved equal.

J. Blank Panels:
   1. Vented - Middle Atlantic VT
   2. Solid - Middle Atlantic EB
   3. or approved equal.

K. Power Strips shall not have a user-facing on/off switch:
   1. Middle Atlantic Powercool Series
   2. or approved equal.

L. Shelves:
   1. Middle Atlantic RSH Custom Rackshelf for components if available from Middle Atlantic or Generic U Series, or approved equal.
   2. Middle Atlantic MS Series Rackshelf for loose devices that shall be secured to a shelf.

M. Rack Screws shall be Middle Atlantic HW Series 10-32. All other screw products are prohibited.

N. Exhaust Fans for A/V Equipment Racks:
   1. Middle Atlantic Blower or QFAN Panel

O. Standard Equipment Mounting:
   1. Equipment Clamps: Middle Atlantic "-C"
   2. Double-sided, adhesive, 2" wide, industrial hook/loop fastener:

a. 3M MP3526N
b. Velcro 90593

P. Mesh Sleeve for routing exposed cables:
1. Braided, expandable plastic mesh sleeve, black colored, sized appropriately for the application (typically 1" and 1-1/2" diameter):
a. TechFlex, Panduit or equal.

2.5 FURNITURE

A. Cable Access Box for Conference Room Tables and Teacher Stations:
1. Table-top cable access box shall be: Legrand TB672APBK or equal from Altinex or Crestron.
a. The following connectors shall be configured with Retractors for cable access box:
1) HDMI 2.0
2) 3.5mm audio input
3) HD15 VGA video input
4) Data (Category 6 or higher)
b. The following connectors shall be configured with a fixed connector (not retractors) for cable access box:
1) USB (quantity 2)
2) Electrical Power (minimum of one receptacle, but two if the box supports it)

B. Teacher Stations shall be as shown in the Contract Documents:
1. Type: XXXXXX
2. Orientation: Left Hand / Right Hand
3. Material: XXXXXX
4. Finish: XXXXXX

C. Podiums shall be as shown in the Contract Documents:
1. Type: XXXXXX
2. Material: XXXXXX
3. Finish: XXXXXX

D. Credenzas shall be as shown in the Contract Documents:
1. Type: XXXXXX
2. Material: XXXXXX
3. Finish: XXXXXX

E. Computer security cable and lock:
1. Securetech
2. or pre-approved equal.

2.6 AUDIO SYSTEMS

A. Mono system (public address) amplifiers shall provide 75 watts per channel output (minimum), and provide a minimum of 15 watts per installed speaker, be Class D rated, with appropriate inputs and rack-mount brackets. The amplifier shall also have intrinsic 70V speaker outputs. Amplifiers shall be sized appropriately for each application.
1. Ashly TRA series or approved equal.
2. Cables shall be Standard Audio Cabling with XLR plugs, RCA plugs, spring clip, or Screw-type (open) terminals.

B. Stereo system amplifiers shall have a per-channel wattage rating (RMS) at least 50 percent higher than the RMS power rating of the connected speaker load. Amplifiers shall be Class D rated, with appropriate inputs and rack-mount brackets. Amplifiers shall support 4 ohm and 8 ohm speakers.
   1. Amplifiers shall be:
      a. Crown XLS Drivecore 2 Series
      b. Crown XTi 2 Series
      c. or approved equal
   2. Cables shall be Standard Audio Cabling with XLR, Phoenix terminals, or Screw-type (open) terminals.

C. Digital Signal Processing (DSP) systems shall be:
   1. BSS London Series
   2. Cables shall be Standard Audio Cabling with XLR plugs, Phoenix Terminals, RCA plugs, spring clip, or Screw-type (open) terminals.

D. Speakers:
   1. For Speech (Public Address): 70 Volt, monaural audio speakers, 6-10 inch driver, taps from 7.5W to 30W, suitable for ceiling mounting. Speakers shall be:
      a. JBL Control 26
      b. or approved equal
   2. For Content (Stereo): 8 ohm stereo audio speakers, suitable for wall mount or hanging, depending on size of speakers and application.
      a. Speakers shall be:
         1) JBL Control Series
         2) or approved equal
      b. Speakers for hanging applications in large venue shall be:
         1) JBL AE or VRX Array Series
         2) or approved equal
   3. Mounting hardware shall be either integrated mounts or attachable mounting hardware provided by the speaker manufacturer.
   4. Wiring shall be Standard Speaker Wiring with standard terminations.

E. Assistive Listening Devices:
   1. RF Systems
      a. Transmitter: Listen Technologies
         1) Power supply
         2) Power cable
         3) Rack mounting kit
         4) Road case
      b. Receivers: Listen Tech
         1) Mono Headset Receiver: Listen Technologies with rechargeable batteries.
         2) Ear Tips: Listen Technologies
      c. Receiver Charging Station:
         1) Listen Technologies
   2. Loop Systems
      a. Transmitter:
         1) Listen Technologies with:
            a) Power supply
            b) Power cable
            c) Rack mounting kit
      b. Receivers:
         1) Mono Headset Receiver: Listen Technologies with rechargeable batteries.
         2) Ear Tips: Listen Technologies
      c. Receiver Charging Station:
         1) Listen Technologies

3. Signage
    a. Listen Technologies ADA wall plaque

F. Microphones:
1. Ceiling-hung microphones shall be:
    a. Audix M3
    b. or pre-approved equal.
2. Desk-mounted microphones shall have a cardiod pattern, LED's to indicate multiple states with built-in logic, and able to be secured to table surface:
    a. Shure MX395 Series
    b. Shure MX Series Gooseneck (shock-mount)
    c. or pre-approved equal.
3. Wireless Microphones shall be RF, tunable, and able to automatically identify available radio frequencies:
    a. Shure ULXD Series
        1) Body pack: Shure ULXD1
        2) Lapel: Shure MX150
        3) Over-the-ear: Countryman E6, flesh colored, with the TA4F connector
        4) Headworn/Fitness: Shure SM31F8
        5) Handheld: Shure ULXD2
    b. RF Cables shall be:
        1) Antenna extension cable: RG-6U with BNC connectors on both ends.
        2) Antenna mount: BNC barrel connector.
    c. Larger Antennas and Antenna Distribution shall be provided where appropriate given the size of the venue
4. Wireless frequencies for all microphones shall comply with FCC requirements.
5. Cables shall be Standard Audio Cabling with Phoenix terminals, or XLR.

G. CD Players
1. CD Players shall provide stereo-balanced audio output, be IR or RS-232 controllable, with Bluetooth, and shall be:
    a. Tascam CD-200BT
    b. or pre-approved equal.

H. Digital Audio Recorders
1. Digital audio recorders shall be 1RU form factor, with balanced audio inputs on the rear, with discrete controls on the front panel. Recorders shall record to SD cards or USB flash drives in MP3 format, and shall be:
    a. Denon DN-500R
    b. or pre-approved equal.

I. In-Ear Monitors
1. In-Ear monitors shall be:
    a. Shure PSM 900 or PSM 1000 Series with protective storage enclosure.

J. Soundboards
1. Soundboards shall be digital with Dante functionality, and shall be:
    a. Yamaha CL Series

2.7 VIDEO SYSTEMS

A. Blu-ray Player Devices:
1. Blu-ray players shall be:
    a. Sony, Oppo

b. or pre-approved equal.
2. 1U Rack-mounted shelf or manufacturer-specific rack-mount ears.
3. Cables shall be Standard HDMI Cables.

B. Video Cameras:
1. Table-top Document Camera: HD, 1080p/60fps, HDMI or DVI output.
a. Cameras shall be Samsung SDP-860 or pre-approved equal.
b. Cables shall be Standard HDMI cables.
2. Classroom Camera: HD, 1080p/30fps, HDMI, SDI, or USB Video output depending on project, with wall- or ceiling-mount bracket depending on project. Lens shall be PTZ or fixed lens depending on project.
a. Panasonic HE40 Series or equal.
b. Cables and any adapters/extenders required must be approved.
3. Conference Room Soft Conferencing Camera: HD, 1080p, HDMI or USB dependent on application, wall-mount, PTZ or fixed lens dependent on application.
a. Panasonic HE40 Series
b. Logitech C920 HD Webcam (or newest iteration)

C. Video Conferencing Endpoints:
1. Shall be high definition Video Conferencing Endpoint (VCE), and shall be Utah Educational Network (UEN) approved:
a. Cisco
b. or pre-approved equal.

D. Video Distribution Amplifiers:
1. HDMI Amplifiers shall have a maximum data rate of at least 10.2 Gbps, 4K compliant:
a. Kramer
b. Extron
c. Crestron
d. pre-approved equal
2. Mounting shelves shall be:
a. Middle Atlantic
b. Manufacturer-specific rack shelf or ears
c. or pre-approved equal.

E. HDBaseT Distribution Equipment:
1. All HDBaseT distribution equipment shall be 4K capable over a distance of at least 230 feet and shall carry control signals (including RS-232) and provide power at the endpoint.
2. Transmitter / Receiver Pairs shall be:
a. Crestron
b. Kramer
c. Extron
d. or pre-approved equal.
3. Transmitters shall be compatible with the HDBaseT inputs on the specified Video Switches/Matrices. Transmitters shall be able to receive power from the Video Switch/Matrix through integrated means or an external power supply:
a. Crestron
b. Kramer
c. Extron
d. or pre-approved equal.
4. Receivers shall be compatible with the HDBaseT outputs on the specified Video Switches/Matrices. Receivers shall be able to receive power from the Video Switch/Matrix through integrated means or an external power supply:
a. Crestron
b. Kramer

c. Extron
d. or pre-approved equal.

5. Mounting shelves shall be:
   a. Middle Atlantic
   b. Manufacturer specific rack shelf or ears
   c. or pre-approved equal.
6. Wallplate Transmitters shall be compatible with the HDBaseT inputs on the specified Video Switches/Matrices. Wallplate transmitters shall be able to receive power from the Video Switch/Matrix through integrated means or an external power supply:
   a. Crestron
   b. Kramer
   c. Extron
   d. or pre-approved equal.
7. Wallplate Receivers shall be compatible with the HDBaseT outputs on the specified Video Switches/Matrices. Wallplate receivers shall be able to receive power from the Video Switch/Matrix through integrated means or an external power supply:
   a. Crestron
   b. Kramer
   c. Extron
   d. or pre-approved equal.

F. Video Switches/Matrices
1. All Audio/Video Switches/Matrices shall support resolutions no less than 1080p at 60 frames per second, provide EDID management, and be RS-232 and LAN controllable. Audio/Video Switches/Matrices shall have either an integrated audio digital signal processor with direct analog audio outputs or shall have discrete analog audio outputs for each input. It is preferred (but not required) that Audio/Video Switches/Matrices support 4K video at 4-4-2, and provide scaling functions.
2. Audio/Video Switches/Matrices shall be:
   a. Crestron
   b. Kramer
   c. Extron
   d. or pre-approved equal.

2.8 VIDEO DISPLAYS

A. Projection Screens:
1. All projection screens shall be manufactured by Da-Lite or their pre-approved equivalent from Draper.
2. Motorized Screens:
   a. Motorized projection screens shall be **Electric Tensioned Advantage** or **Tensioned Contour** product line.
   b. Motorized projection screens shall have a 16:10 aspect ratio and **HD Progressive Screen Surface**. Matte white screen surfaces are not acceptable.
   c. Other requirements include:
      1) Screens shall be electrically operated and support low-voltage control via a built-in screen controller.
      2) Motor shall be 120VAC and silent. 220VAC motors are not acceptable.
      3) Cases and trim kits shall be white.
      4) Internal junction box.
      5) Without video projector interface.
   d. **XXX"** Screen: Da-Lite **XXXXXXXX**.
   e. **XXX"** Screen: Da-Lite **XXXXXXXX**.
   f. **XXX"** Screen: Da-Lite **XXXXXXXX**.
   g. or pre-approved equal models and materials from Draper.

3. Projection screen mounts shall be manufactured by the screen manufacturer, and shall be wall-mounted or ceiling-mounted per manufacturer's specifications and as shown on the Contract Documents. A ceiling trim kit shall be provided where shown on the Contract Documents.

B. Video Projectors:
1. All video projectors shall be WUXGA or better, and shall have horizontal and vertical lens adjustment, IP connectivity, RS232 control, HDBaseT Video Input, and HDMI video input.
2. For spaces up to 100 seats: Standard-throw Video projectors shall have a minimum of 4800 ANSI lumen output:
   a. Panasonic PT-VZ575N (or latest equal model meeting these specifications)
   b. or pre-approved equal.
3. For spaces up to 150 seats: Standard-throw video projectors shall have a minimum of 6000 ANSI lumen output:
   a. NEC PA-622U (or latest equal model meeting these specifications)
   b. or pre-approved equal.
4. For spaces up to 250 seats: Standard-throw video projectors shall have a minimum of 8,000 ANSI lumen output, with a lens approved by the projector manufacturer to match the throw distance of the room:
   a. Panasonic PT-DZ870K (or latest equal model meeting these specifications)
   b. Lens: **XXXXXXXX**
   c. or pre-approved equal.
5. For spaces above 250 seats: Standard-throw video projectors shall have a minimum of 12,000 ANSI lumen output, with a lens approved by the projector manufacturer to match the throw distance of the room:
   a. Panasonic PT-DZ13K (or latest equal model meeting these specifications)
   b. Lens: **XXXXXXXX**
   c. or pre-approved equal.
6. Video projector cables:
   a. Data: One Category 6A cable (per Section 27 15 00, by Telecommunications Contractor) running between an outlet near the projector and the telecommunications room.
   b. Video: One Category 6A cable (per Section 27 15 00, by Telecommunications Contractor) running directly from the projector to the video switch in the the A/V Equipment Rack, with any necessary extenders required to support HDMI/DisplayPort via Category 6A cabling.
   c. Control: One RS-232 cable running directly to the projector from the control system in the A/V Equipment Rack.
   d. Video (40 ft runs or less): One Standard HDMI cable running directly between the projector and the A/V Equipment Rack.
7. Video projector mounts shall be:
   a. Chief Manufacturing RSMA Series Custom mount for specific projector
   b. or pre-approved equal.

C. Video Panels:
1. Video Walls:
   a. Panels shall be commercial grade, with LED backlighting, LCD, with HDMI and Displayport 1.2 inputs, and DisplayPort 1.2 outputs for daisy chaining. Panels shall accept RS232 control, IP connectivity, and daisy chaining, with direct input selection ability.
      1) 46" diagonal: Video Panels shall be NEC X464UN or current equal model.
      2) 55" diagonal: Video Panels shall be NEC X554UN or current equal model.
      3) or pre-approved equal from Panasonic or Samsung.
   b. Video Wall surface mounts shall have height, tilt, and plumb adjustments, and pull-out and tilt for maintenance, and shall be:

1) Premier LMVS
2) Chief LWM series (for banner applications only)
3) or pre-approved equal.

c. Video Wall ceiling mounts shall have tilt adjustment and shall be:
1) Chief LCM Series
2) or pre-approved equal.

2. Digital Signage:
a. Panels shall be commercial grade, LED, sized for specific project, 46", 55" or larger (diagonally measured) with HDMI inputs, and an OPS slot.
1) NEC V Series
2) NEC E Series
3) or pre-approved equal.

b. Media Players shall have an external LAN port, at least two external USB ports, an external video port (DisplayPort or HDMI), and have a 3-year manufacturer warranty.
1) OPS Type:
a) NEC
b) or pre-approved equal.
2) Media Player (PC type)
a) Lenovo Tiny
b) Intel NUC
c) or pre-approved equal.
3) Media Player (stand-alone, single function, system-on-a-chip)
a) Pre-approved device.

3. Classrooms and Conference Rooms:
a. Panels shall be commercial grade, LED, sized for specific project (diagonally measured), with HDMI input(s) and RS-232 control.
1) Video Panels shall be NEC E Series
2) or pre-approved equal.

4. Wall-mounting brackets shall have locking security features, and shall be fixed, tilting, or full-articulating:
a. For fixed-mount applications:
1) Premier Low Profile Mount
2) Chief Fusion Series
3) or pre-approved equal.

b. For tilting-mount applications:
1) Premier Low Profile Mount
2) Chief Fusion Series
3) or pre-approved equal.

c. For fully articulating-mount applications:
1) Chief TS or PDR Series Mounts
2) or pre-approved equal.

d. For In-Wall applications:
1) Chief TS, PDR for mounting into Chief wall-boxes
2) Chief PIWRFUB

5. Ceiling-mounting bracket shall be 1.5" NPT pipe compatible and shall be:
1) Chief XCM Series
2) or pre-approved equal.

6. Video Panel Cables:
a. Cables shall be HDBaseT for all applications regardless of distance, and in addition, shall be HDMI for distances up to 40 feet.

7. Video Panel Interface Box:
a. Chief PAC501B (for in-wall applications)
b. Chief TS500 (for in-wall applications)
c. Chief PAC526 (for fixed or tilting applications)

D. Computer Monitors:
   1. Computer Monitors shall be provided as confidence monitors on teacher stations and in other locations as required. Monitors shall have an HDMI input, be at least 1920 x 1080 at 60 Hz resolution at 16:9 aspect ratio. Touch monitors may be requested as needed. They shall be:
      a. Dell P2314T
      b. or pre-approved equal.

2.9 SYSTEM CONTROLLERS

A. Touch Panel Interfaces:
   1. Touch panels shall be 7” to10” size, be powered via Power-Over-Ethernet (POE), operate via Ethernet, and have a table-top swivel mount.
      a. Touch panel shall be: Crestron TSW-752 (or newest model)
      b. Touch panel shall be: Crestron TSW-1052 (or newest model)
      c. or pre-approved equal.
   2. Flip-top Touch Panels shall be powered via Power-Over-Ethernet (POE):
      a. Without controller:
         1) Black: Crestron FT-TS600-B
         2) Silver: Crestron FT-TS600-BALUM
      b. With embedded controller:
         1) Black: Crestron FT-TSC600-B
         2) Silver: Crestron FT-TSC600-BALUM
   3. Control wiring shall be Cresnet as well as Ethernet via Category 6A cabling per Section 27 15 00.

B. Button Panel Interfaces:
   1. Button Panels shall have 10 to 50 buttons, and operate via both Ethernet and low voltage signaling.
      a. Button panels shall be: Crestron MPC series
      b. or pre-approved equal.
   2. Flip-top Button Panels without controller shall be:
      a. Black: Crestron C2N-FTB-D-B
      b. Silver: Crestron C2N-FTB-D-BALUM
   3. Control wiring shall be Cresnet.

C. Control Processors:
   1. Control Processors shall be Crestron Series 3 with Ethernet, Cresnet, RS-232, IR, and additional control ports necessary for applications. Devices shall be controlled by the processor over RS-232 when possible, or optionally over IR and LAN.

2.10 LIGHTING SYSTEMS

A. Lighting Controllers
   1. Lighting Controllers shall be:
      a. ETC ION 1000, 6000
      b. ETC EOS Ti
   2. Lighting Fixtures shall be:
      a. ETC ColorSource Series
      b. ETC Desire Series
      c. ETC Source4 Series

2.11 LARGE PORTABLE OUTDOOR A/V SYSTEM

A. All video projectors shall be WUXGA or better, and shall have horizontal and vertical lens adjustment, IP connectivity, RS232 control, HDBaseT Video Input, and HDMI video input. Projectors shall have a minimum of 20,000 ANSI lumen output, with a lens approved by the projector manufacturer to match the throw distance of the space:
   1. Panasonic PT-DZ21K2 (or latest equal model meeting these specifications)
   2. Lens: Panasonic ET-D75LE10
   3. Video projector cables:
      a. Video: One Standard HDMI cable running directly between the projector and the video source equipment.

B. Portable Projection Screens shall be 270” high x 480” wide:
   1. Screen: Draper 383503
   2. Leg Kit: Draper 383788

C. Media Center Projector Cart:
   1. Marvel MVMMA3030OKDT (Oak)

D. Speakers shall be outdoor rated:
   1. JBL VRX932LAP
   2. Hand-crank pole: JBL SS5-BK
   3. Road Case: JBL JBL-FLIGHT-VRX932-LAP

E. Subwoofers shall be outdoor rated:
   1. JBL VRX918SP
   2. Road Case: JBL JBL-FLIGHT-SRX718S/VRX918S

2.12 PRESENTATION WIRELESS REMOTE CONTROL

A. Presentation wireless remote control devices with batteries shall provide page-up/page-down functions, have a red laser pointer, and connect to the Owner-provided computer via a USB port in a Plug-and-Play fashion.
   1. Logitech R400
   2. or pre-approved equal.

2.13 LABELING AND ADMINISTRATION

A. Cable Labels shall be as recommended in ANSI/TIA/EIA 606. Labels shall be permanent polyester, not subject to fading or erasure, permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
      a. 1” inch black on white: DYMO Rhino Series
      b. or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all audio/visual systems, equipment, and materials shown on the Contract Documents and as depicted in the table below.

B. All audio/visual systems and applications shall be arranged, assembled, wired, and configured identically to other applications in similar rooms within this project. Component arrangement, wire

numbering, wire color, wire type, wire manufacturer, wire routing, etc. shall all be consistent throughout the project.

C. All cables shall be unspliced and not coupled.

D. The rooms listed below are designated with the application functions indicated. For each room listed, provide the equipment, cabling and functionality defined for each application.

	Classrooms and Instructional Spaces				Collaboration Labs				Conference Spaces, Huddle Space Pods & Boardroom					Video Panel Applications				
	Auditorium	Classroom	Distance Education Classroom	Classroom	Collaboration Lab #1	Collaboration Lab #2	Collaboration Lab #3	Multipurpose Room	Group Study	Conference Room	Conference Room	Conference Room	Boardroom	Corridor	Corridor	Corridor	Corridor	Outdoor West Plaza
A/V Equipment	**101**	**223**	**301**	**436**	**110A**	**110B**	**110C**	**122**	**202**	**220**	**230**	**330**	**420**	**10**	**41**	**300**	**400**	**0W**
A/V Equipment Racks (Full-Height)													1					
A/V Equipment Racks (Portable)																		1
A/V Equipment Racks (In-Podium Slide-Out)								1		1	1	1						
A/V Equipment Racks (In-Podium Fixed Applications)	1	1	1	1	1	1	1											
Mono System Amplifiers (Public Address)	1	1	1	1	1	1	1	1		1	1	1	1					1
Stereo System Amplifiers	1	1	1	1	1	1	1	1		1	1	1	1					1
Digital Signal Processing (DSP)	1												1					
Speakers for Speech (Public Address)	12	4	4	4	2	2	2	12		4	4	4	8					5
Speakers for Content (Stereo)	2	2	2	2	2	2	2	6		2	2	2	2					
Assistive Listening Systems	1	1	1	1	1	1	1	3		1	1	1	1					
Microphones (Ceiling-Hung)	4		2								2							
Microphones (Desk-Mounted)													12					
Microphones (Wireless)	1	1	1	1	1	1	1						1					
Digital Audio Recorders													1					
Blu-Ray Player Devices	1	1	1	1	1	1	1			1	1	1	1					
Table-Top Document Camera	1	1	1	1	1	1	1											
Classroom Camera			1															
Conference Room Soft Conferencing Camera										1		1						
Video Conferencing Endpoints											1		1					
Video Switches/Matrices	1	1	1	1	1	1	1	1		1	1	1	1					
Projection Screens	1	1	1	1	1	1	1	3					1					1
Video Projectors	1	1	1	1	1	1	1	3					1					1
Video Panels			2		6	6	6		1	1	2	1	2	1	9	3	3	
Media Players														1	1	1	1	
Computer Monitors	1	1	1	1														
Control Interfaces	1	1	1	1	1	1	1	1	1	1	1	1	2					
Control Processor										1	1	1	1					
Lighting Controllers	1	1	1	1	1	1	1	1	1	1	1	1	1					

E. In addition to the major equipment listed above, provide all equipment shown on the Drawings or listed in the specification, as required for a complete, operational system.

F. Configure, program, adjust, and tune all equipment according to manufacturer requirements such that it will perform as required. From the perspective of users of the audio/visual systems, all systems shall be installed to look, feel, and operate similarly to all of the existing facilities throughout the Owner's campus.

G. Any accessory hardware (including adapters, batteries, brackets, cables, connectors, covers, dongles, remote controls, and tools) that is provided by the manufacturer with equipment, but which does not become permanently installed, shall be furnished to the Owner.

H. Furnish to the Owner one set of original packaging material for each piece of audio/visual equipment.

3.2 GROUNDING AND BONDING

A. Grounding conductor shall be installed to bond all non-current-carrying metal equipment and materials to the nearest telecommunications grounding system (as provided under Section 27 05 26 – "Grounding and Bonding for Communications Systems"). Ground conductor shall be run directly to the cable tray grounding conductor, and shall not rely upon metallic conduit for a grounding path.
   1. Ensure that active electronic equipment is properly grounded per manufacturer's requirements.

3.3 STANDARD CABLE ASSEMBLIES/PATCH CORDS

A. Provide all patch cables, cords, and connectors required for a completely functional system. Cable lengths shall be kept to practical minimum lengths (not more than 25 ft.), while providing slack to be able to reterminate each end of the cable 3 times. Avoid long cables that require slack coils. Where slack coils are required, store slack coil under the base of A/V Equipment Rack.

B. All wiring and cables shall be free of grounds and shorts.

C. Plenum-rated cables shall be used for all in-wall/ceiling applications except where cables are fully enclosed in conduit from end to end.

D. All wiring and cables shall be properly supported with strain relief measures. Cables shall not rest upon ceiling grid, but shall be secured between 16 and 24 inches above the finished ceiling.

E. The use of nylon tie wraps ("zip-ties") is prohibited everywhere, with the few exceptions listed below. Where "zip ties" are used, they should not be tightened down excessively, as doing so may damage cables. Excess shall be removed using flush-cut tools to produce a cut flush with the ratchet head, without leaving sharp or snagging remnants.
   1. Permanently affixed power wiring.
   2. In ceilings where cables exit the wire basket to transition or terminate on equipment, zip ties may be used to suspend cables above the ceiling grid.
   3. As a cable management pathway affixed to spot anchors attached to the inside of furniture, creating a loop for Velcro to pass through and anchor cables.

F. A/V Equipment Racks:
   1. After the system has been completely tested, neatly bundle and dress cables using Velcro-style straps to secure cables against lacing bars in a neat and professional manner. Provide sufficient cable slack such that equipment can be serviced without binding or kinking the cables.

G. Instructor Consoles:

1. Prior to cabling, screw-attached cable tie bases (tie-wrap backs) shall be installed on inside of furniture with “zip ties” attached to create a loop in order to facilitate pathways between equipment.
2. After the system has been completely tested, neatly bundle and dress cables using Velcro-style straps to secure cables against the underside of the console in a neat and professional manner.

H. Mesh Sleeves:
1. Provide mesh sleeves, with the ends of the sleeves cut with a hot iron to the appropriate length, and secured with an overwrapping tie-wrap at each end, for the following applications:
   a. Anywhere cables would be exposed to public view.
   b. Between floor boxes and conference tables.
   c. Where friction may damage cables over time.
2. Prevent mesh sleeves from pulling out of their termination points, thus keeping cabling concealed and protected inside the sleeves.
3. Do not use tape, tie wraps, or Velcro-style straps to bundle cables inside mesh sleeves and conduits. Cables shall be loose inside mesh sleeves and conduits, allowing them to be pulled out individually and replaced without disturbing the other cables.

3.4 EQUIPMENT RACKS/ENCLOSURES

A. Provide junction panels, racks, cabinets, and enclosures with all associated hardware according to locations, elevations, and plan views as shown in the Contract Documents.

B. A/V Equipment Racks, Cabinets, and Enclosures:
1. Provide racks, cabinets, and enclosures as shown on the Contract Documents.
2. Assemble racks and install components as shown, and ensure that all moving parts (doors, drawers, latches, etc.) function as intended.
3. Provide exhaust fans as shown on the Contract Documents and as required for reliable operation of the equipment.
4. Work with the electrician to ensure that the power outlets and data boxes designated to serve the A/V equipment are installed in the proper locations.

C. All equipment shall be securely attached to racks using all available screw holes (minimum 4).

D. All shelf-mounted equipment shall be securely attached to the shelf using equipment clamps provided by the equipment manufacturer or Middle Atlantic equipment clamps. Where neither of these options are available, use double-sided, adhesive, 2” wide, industrial hook/loop fasteners. Leaving equipment sitting loose on a shelf is not acceptable.

3.5 FURNITURE

A. Provide cable access boxes with the specified connectors, or retractors in each designated conference table location, cut in and mounted as shown on the Contract Documents.

B. Provide Teacher Stations, Podiums and Credenzas as shown on the Contract Documents.
1. Provide computer security cable, attached securely to the A/V Equipment Rack.
2. Protect furniture from damage prior to Owner acceptance. Repair or replace any damaged furniture.
3. Provide documentation, maintenance, and warranty information associated with furniture to the Owner.

3.6 AUDIO SYSTEMS

A. Maintain the following minimum separation distances:
   1. 24” between all ceiling-hung speakers and pendant microphones.
   2. 24” between all pendant microphones and air ducts (return or discharge).
   3. 12” between all pendant microphones and video projection paths.
   4. 12” between all pendant speakers and video projection paths.
   5. 12” between all pendant lighting and video projection paths.

B. Amplifiers and Digital Signal Processors:
   1. Provide amplifiers and digital signal processors with any required input modules, fully configured as required, and installed in equipment rack as shown on the Contract Documents.
   2. Provide cabling and wires.

C. Speakers:
   1. Provide speakers and mounting hardware, installed as shown on the Contract Documents.
   2. Provide cabling and wires.

D. Assistive Listening Systems:
   1. RF Transmitters
      a. In the quantities and locations indicated in the table below, furnish (uninstalled) RF transmitters, and provide (installed) a program audio output in each Teacher Station table-top cable box for use with an Owner-deployed RF transmitter.
      b. Deliver transmitters to the Owner during system demonstration.
   2. Wired Loops
      a. Provide (installed) loop systems in quantities and locations shown in the Contract Documents and indicated in the table below.
      b. Perform an initial loop test before system installation.
      c. Saw-cut the floor per manufacturer guidelines, install wire, fill the trough, and sand/finish the concrete floor.
      d. Terminate the loop wiring in the Teacher Station.
      e. For systems where the transmitter will be installed, install transmitter in equipment rack, then calibrate and commission the system.
   3. Loop Transmitters:
      a. Furnish uninstalled in the quantities indicated in the table below. Deliver transmitters to the Owner during system demonstration.
      b. Provide (installed) in the quantities and locations indicated in the table below.
   4. Loop Receivers:
      a. Furnish uninstalled in the quantities and locations indicated in the table below.
      b. Provide batteries for all receivers.
      c. Provide charger stations, mounted in equipment rack drawer with power wiring groomed and secured within the rack.
      d. Deliver receivers to the Owner during system demonstration.

Seating Capacity of Room	Number of RF Transmitters	Number of Wired Loops in Room	Number of Transmitters for Loop systems	Minimum Number of Loop Receivers
65 or less	1 per 10 rooms 65 seats or less*	1	1 per 10 rooms 65 seats or less* (furnish uninstalled)	2
66 to 250	None	1	1 per 5 rooms over 65 seats*	2, plus 1 per 25 seats over 65

			(furnish uninstalled)	seats*
251 to 500	None	1	1 per 5 rooms over 250 seats* (furnish uninstalled)	2, plus 1 per 25 seats over 250 seats*
501 to 1000	None	1	1 per room over 500 seats (installed)	20, plus 1 per 33 seats over 500 seats*
1001 to 2000	None	phased array loop/double loop coverage	2 per room over 1000 seats or as required to serve the loops in a room (installed)	35, plus 1 per 50 seats over 1000 seats*
2001 and over	None			55, plus 1 per 100 seats over 2000 seats*

* or fraction thereof

5. Signage
   a. Provide sign indicating the availability of a loop-based assistive listening system.
   b. Mount sign in location near the seating where the signal strength will be the highest and as directed by the Architect and/or Owner.

E. Microphones:
1. Provide all microphones shown on the Contract Documents. Provide mounts, cabling and wires.
2. For wireless microphones:
   a. Provide receivers, installed in A/V Equipment Rack as shown on the Contract Documents.
      1) Configure the wireless microphone receivers to operate in the following frequency ranges:

Room Name	Room #	Frequency Range
room name	###	MHz
room name	###	MHz
room name	###	MHz
room name	###	MHz
room name	###	MHz
room name	###	MHz
room name	###	MHz

   b. Install the antennas in the ceiling out of public view near the front of the room, 5-15ft away from the front and side walls and no less than 10 ft apart, using manufacturer-provided external antenna mounting bracket.
   c. Connect the external antennas to the wireless mic receivers using standard cabling.
   d. Furnish body pack transmitters, wireless microphones and associated cables, stored in the drawer in each A/V Equipment Rack.
   e. Furnish manufacturer-specific charging station and battery packs, with enough docking spaces for all mics to be charged simultaneously.
   f. Drawer shall be large enough to accommodate charger and bodypack transmitter height when docked.
3. For ceiling-hung microphones:
   a. Provide grommet through the ceiling tile that matches the color of the tile.

F. CD Players

1. Provide CD players as shown in the Contract Documents, rack-mounted unless otherwise indicated.
    a. Provide audio cables as required.

G. Digital Audio Recorders
1. Provide digital audio recorders as shown in the Contract Documents, rack-mounted unless otherwise indicated.
    a. Provide audio cables as required.

H. In-ear Monitors
1. Provide in-ear monitors as shown in the Contract Documents and protective storage enclosure.
    a. Provide audio cables as required.

I. Soundboards
1. Provide soundboards as shown in the Contract Documents, installed on desktop unless otherwise indicated.
    a. Provide all cables as required.

3.7 VIDEO SYSTEMS

A. Blu-ray Player Devices:
1. Provide shelves, installed in equipment rack as shown on the Contract Documents.
2. Provide Blu-ray player, attached to shelf.
3. Provide cables and wires.

B. All Cameras:
1. Provide cameras, mounted as shown on the Contract Documents.
2. Provide mounts, cables, and wires.

C. Video Conferencing Endpoints:
1. Provide video conferencing endpoints, installed in conference rooms as shown on the Contract Documents.
2. Provide mounts, cabling, and wires.
3. Configure system to integrate with the equipment in the conference room.

D. Video Distribution Amplifiers:
1. Provide video distribution amplifiers as shown on the Contract Documents.
2. Provide rack-mounted shelving and attach devices to shelf.
3. Provide cables and wires.

E. HDBaseT Distribution Equipment:
1. Provide HDBaseT transmitters and receivers as shown on the Contract Documents.
2. Provide rack-mounted shelving and attach devices to shelf.
3. Remote end devices shall be secured in a professional manner with screws. Where screw attachment is not practical, use double-sided, adhesive, industrial hook/loop fasteners.
4. Provide cables and wires.

F. Audio/Video Switches/Matrices
1. Provide audio/video switches/matrices, installed in equipment racks as shown on the Contract Documents.
2. Provide cabling and wires.
3. Provide all required configuration and programming.

3.8 VIDEO DISPLAYS

A. Projection Screens:
1. Provide projection screens installed as shown on the Contract Documents.
   a. For Rooms **XXX, XXX, XXX and XXX** **Screen size**
   b. For Rooms **XXX, XXX, XXX and XXX** **Screen size**
   c. All other rooms requiring screens **Screen size**
2. Screens shall be mounted as close as possible to the wall (preferably not more than 4" away from the wall) while also permitting the projection surface to clear any obstructions on the wall (such as whiteboard and pen tray).
3. Provide at least one manual, low voltage control switch, located near the Teacher Station. Do not mount switch behind screen.
4. Provide mounts, power, power disconnect switch, control raceways, and wiring as shown on the Contract Documents.

B. Video Projectors:
1. Provide video projector mounts, attached to structure as shown on the Contract Documents. Position mounts such that:
   a. The projector is located the proper distance from the projection surface or screen.
   b. The projector achieves peak performance without the use of specialty lenses.
   c. The projector achieves peak performance without the use of keystoning and with only minor use of image adjustment features (contrast, etc.).
2. Provide video projectors, attached to the projector mounts. Adjust and focus projector to properly display on projection screen. Provide lenses where required.
3. Tighten down mounting screws once projector is properly adjusted and focused, to prevent unintentional misalignment.
4. Provide cables and wires.
5. Verify that lighting and other ceiling-hung objects do not obstruct the image on the screen. Under the direction of the Owner and A/V Engineer, resolve any physical obstructions (such as lighting or other obstructing objects) prior to making any adjustments to the projector, projector mount location, or projection screen.
6. Color calibration is required.

C. Video Panels:
1. Provide video panel mounting brackets, attached to structure as shown on the Contract Documents.
2. Provide video panels, attached to the mounting brackets. Adjust angle and tilt of panel for optimal viewing angle.
3. Provide cables and wires.
4. For video panels designated for us as digital signage, provide media player.
   a. Install OPS-type player inside of display slot of video panel.
   b. For other media player types, mount with screws when possible. Otherwise mount with double-sided, adhesive, industrial hook/loop fasteners.
5. For video wall panels, provide all associated equipment that is required for a functioning video wall system, including video wall processor, video extenders, and all required cabling.
6. Color calibration is required. Adjust all panels to match each other.

D. Computer Monitors:
1. Provide computer monitors in locations shown on Contract Documents, attached to top of Teacher Station unless otherwise indicated.
2. Provide USB cable and video cable as indicated on Contract Documents.

3.9 SYSTEM CONTROLLERS

A. Button and Touch Panel Interfaces:
   1. Provide Button Panel and Touch Panel Interface devices in locations and quantities shown on the Contract Documents.
   2. The Owner will furnish sample layout templates to the Contractor. The Contractor shall produce the layout, functionality, and control program to operate the system, matching the look and feel of the Owner's existing systems.

B. Control Processor
   1. Provide Control Processor and necessary control expansion devices according to Contract Documents.
   2. The A/V Contractor shall program the control processors to work with the touch panel and/or button interfaces in order to control all necessary equipment as shown in the Contract Documents.

C. Provide fully documented, uncompiled, editable copies of all control programming and layout source code to the Owner in native electronic format on USB Drive during Demonstration and Training, at the very latest. This software shall become the property of the Owner.

3.10 LIGHTING SYSTEMS

A. Provide Lighting Boards, Controllers, Panels, Switches, Dimmers, and Fixtures as shown in Contract Documents.

B. Provide all necessary cabling properly terminated to each device.

C. Provide mounting hardware.

D. Install and focus light fixtures.

3.11 LARGE PORTABLE OUTDOOR A/V SYSTEM

A. Provide large portable A/V system as a kit, with the equipment types and quantities indicated in the Contract Documents. Provide road cases, mounting poles, and all other accessories required for an operational and storable system.

B. Set up and test all kit components. Demonstrate operation for the Owner as indicated below.

C. After demonstration, strike the system and package it for storage in road cases. Deliver to Owner's designated storage location.

3.12 PRESENTATION WIRELESS REMOTE CONTROL

A. Provide one presentation wireless remote control with batteries, stored in the drawer in each A/V Equipment Rack.

3.13 LABELING AND ADMINISTRATION

A. Equipment Identifiers:
   1. Equipment Identifiers shall be as assigned on the Contract Documents and as shown in the table below:

Equipment Type	Abbreviation	Sequence	Example

Controller	IC	. ##	IC. ##
Touch Panel	TP	. ##	TP. ##
Camera	CAM	. ##	CAM. ##
Codec Video Conference	VC	. ##	VC. ##
Video Switcher	SW	. ##	SW. ##
Computer	PC	. ##	PC. ##
Computer Monitor	MON	. ##	MON. ##
Doc Cam	DOC	. ##	DOC. ##
Laptop	LPTP	. ##	LPTP. ##
Video Wall Processor	VWP	. ##	VWP. ##
Audio Mixer	MIX	. ##	MIX. ##
Digital Signal Processor	DSP	. ##	DSP. ##
Projector	PRJ	. ##	PRJ. ##
Video Panel	VP	. ##	VP. ##
Distribution Amplifier	DA	. ##	DA. ##
Assistive Listening	ADA	. ##	ADA. ##
Speaker	SP	. ##	SP. ##
Projection Screen	SCR	. ##	SCR. ##
Blu-ray Player	BDP	. ##	BDP. ##
Wireless Mic	WMIC	. ##	WMIC. ##
Wired Microphone Input	MIC	. ##	MIC. ##
Line Input	AUX	. ##	AUX. ##

(## = 2-digit number with leading zero for numbers less than 10)

B. Cable Identifiers:
   1. Cable Identifiers shall be as assigned on the Contract Documents and as shown in the table below:

Cable Type	Abbreviation	Sequence	Example
DVI-D	DVI	. ##	DVI. ##
VGA	VGA	. ##	VGA. ##
HDMI	HDMI	. ##	HDMI. ##
DisplayPort	DP	. ##	DP. ##
HDBaseT	HDBT	. ##	HDBT. ##
DC Power	PWR	. ##	PWR. ##
Mic Cable	MIC	. ##	MIC. ##
Speaker Audio	SP	. ##	SP. ##
Ethernet	DATA	. ##	DATA. ##
RS232 Serial Control	RS232	. ##	RS232. ##
RS485 Serial Control	RS485	. ##	RS485. ##
Infrared Control	IR	. ##	IR. ##
Relay / Dry Contact Control	RLY	. ##	RLY. ##
Crestron Cresnet	CRES	. ##	CRES. ##
GPIO Control	I/O	. ##	I/O. ##

(## = 2-digit number with leading zero for numbers less than 10)

C. Cable Labels:
   1. Label Location: Affix at each end of the cable, not less than 1 inch or more than 3 inches from the connector, aligned such that the label is readable without adjusting the cable.
   2. Include a clear vinyl adhesive wrapping applied over the label, in order to permanently affix the label to the cable and prevent smudges to label text. Using transparent tape to affix labels to cables is not acceptable.

3. Label Content: Labels shall be formatted all uppercase, with a dash between the item type and two-digit sequential number, and spaces between each segment, as follows:

[CABLE#] SOURCE –> DESTINATION

For example, the first RS232 control cable, connected to RS232 port #1 on Crestron Controller #1, to Video Switch #1 would be given the following label:

RS232.01 IC.01 –> SW.01

D. Cabling Color Scheme:
1. Use a consistent color scheme throughout the project, matching the existing scheme in the building.

E. Grounding/Bonding Conductors:
1. Label bonding conductors: “WARNING! BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!”

3.14 COMMISSIONING

A. General
1. Provide a comprehensive verification of all A/V equipment and systems using a commissioning agent. Determine whether A/V systems meet the construction specifications, Contract Document requirements, standards, objectives, and manufacturer-listed performance guidelines.
2. Prior to beginning the commissioning process, the Contractor and commissioning agent shall hold a meeting with the Owner to review the commissioning requirements, commissioning process, and required metrics.
3. Any shortcomings discovered during the commissioning process shall be resolved by the Contractor.
4. The Owner may conduct an independent commissioning process.

B. Commissioning Checklist – Commissioning agents shall use the InfoComm ASPVC as the basis of the commissioning checklist. The ASPVC check list can be found at:

http://www.infocomm.org/cps/rde/xbcr/infocomm/CAVSP_Checklist.pdf

C. Additional Commissioning Requirements – The following additions to the InfoComm ASPVC are required, listed below with references to each section of the ASPVC:

1. I AP Audio Performance
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
2. II VP Video Performance
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
   b. Verify that there is no pixel failure.
   c. VP-102.1 Verify that keystoning has been avoided wherever possible.
3. III AVP Audio/Video Performance
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
4. IV CABL Cable Management, Termination, and Labeling
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.

b. IV CABL: CABL 117

5. V CON Control Performance
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
   b. V CON: CON-106 Verify that Programming Code is well documented with detailed comments throughout all code.
   c. V CON: CON-107 Verify that all programming modules are unlocked and editable by the customer.
   d. V CON: CON-108 Verify that Layouts and Source Code have been delivered and accepted.
6. VI ELEC Electrical
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
7. VII IT Information Technology
   a. Perform all A/V IT commissioning as specified in the InfoComm CAVSP Checklist.
   b. Coordinate with the telecommunications contractor to perform all IT commissioning as specified in Section 27 15 00.
8. VIII OP Operational
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
9. IX PHYSE Physical Environment
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
10. X PHYSI Physical Installation
    a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
11. XI SERV Serviceability
    a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
12. XII WL Wireless
    a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
    b. XII WL: WL-103 Verify that wireless microphone frequencies are laid out so as to avoid interference.
    c. XII WL: WL-104 Verify that Wireless IP network has adequate coverage for up to three devices per person in each space.
13. XIII DOC Documentation
    a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
14. Perform the following commissioning tasks to ensure that the system is consistent with existing campus infrastructure:
    a. Verify that all classroom equipment layouts conform to documentation and existing systems in use.
    b. Verify that all touch panel and button panel layouts conform to documentation and existing systems in use. Look and feel shall be similar, but positioning shall be in the exact locations.

D. All functions and features shall be verified operational. Configure, program, adjust, and tune equipment such that it will perform as required.

E. Replace underperforming or non-performing equipment and cables.

3.15 WARRANTY REGISTRATION

A. Contractor-provided warranties on labor and workmanship shall commence on the date that the system is accepted by the Owner. Acceptance does not necessarily mean the date of Owner occupancy or Substantial Completion, but rather the date that the Owner accepts the audio/visual systems as complete and operational. Warranty documentation showing effective start date and coverage period shall be provided to the Owner immediately upon Owner acceptance.

B. Manufacturer Warranty Registration
   1. Equipment managed under Owner's Accounts:

a. All equipment manufactured by Crestron shall be registered by the Owner's representatives. The Contractor shall provide an electronic document listing the installed location, model numbers, and serial numbers for each Crestron device that has been installed.

2. All other equipment:
   a. Submit equipment manufacturer warranty registration forms and online warranty registration to the equipment manufacturers on behalf of the Owner, providing the Owner's name and contact information.
   b. Coordinate with the Owner to obtain appropriate contact information for the forms and documentation.
   c. Provide PDF documentation (scanned completed forms, and printed online applications) to the Owner to demonstrate that warranty registration has been completed for all equipment.
   d. Provide an electronic document listing all equipment (installed location, manufacturers, model numbers, and serial numbers) along with the warranty start dates and coverage period for each device.

C. Warranty Coverage Periods
   1. Provide extended warranties with 5-year coverage periods for all projectors, video panels, control systems, audio/visual switchers/matrices, digital signal processors, and other major equipment.

3.16 DELIVERABLES

A. All deliverables shall be provided to the Owner prior to Audio/Visual System acceptance and shall include, but not be limited to:
   1. Manufacturer user manuals shall be delivered to UVU in a single binder as well as in PDF form on USB flash drive.
   2. Wireless licensing documentation.
   3. Video and Audio system test reports shall be delivered to UVU in digital PDF format.
   4. All programs and modules loaded on A/V systems shall be delivered to the Owner. Programs shall be editable and executable. The Owner shall retain the rights and ability to edit programs, modules, and layouts.
   5. All software licensing shall be loaded and certificates delivered to the Owner
   6. All as-built drawings indicating all A/V devices, device locations, mounting detailed wiring schematics, and labeling.

3.17 DEMONSTRATION AND TRAINING

A. Provide 4 hours of demonstration and training to Owner's Representatives.

B. Demonstrate operation of each space to the A/V Engineer and the Owner's Representatives.

APPENDIX – MODEL NUMBERS

The following table lists manufacturers, model numbers, part numbers and other relevant information for the materials specified in Part II above.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials, software, cabinets, racks, enclosures, cabling, connectors, power hardware, equipment, and labor for the installation of audio/visual systems in theater spaces.

1.2 QUALITY ASSURANCE

A. See section 27 05 00 for Audio/Visual contractor pre-qualification requirements.

1.3 SYSTEM DESCRIPTION

A. Furnish, install, test, and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances associated with audio/visual equipment cabinets, racks, frames, enclosures, cable management, and power hardware to support standards-compliant audio/visual systems in theater spaces as shown on the Contract Documents.

B. Each type of material and type of equipment shall be of the same manufacturer and product family throughout the work.

C. The work shall include all materials, equipment, software, and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working system, compatible with and complementary to the existing campus systems.

D. Provide the systems listed below and as shown on the Contract Drawings, unless otherwise indicated:
   1. Wiring and cabling
   2. Equipment racks, cabinets, and enclosures
   3. Furniture
   4. Amplifiers
   5. Audio DSP (Digital Signal Processor)
   6. Speakers
   7. Assistive listening devices
   8. Microphones
   9. CD players
   10. Digital audio recorders
   11. In-ear monitors
   12. Soundboards
   13. Intercom System
   14. Blu-ray players
   15. Video cameras
   16. Video conferencing systems
   17. Video distribution amplifiers
   18. HDBaseT distribution equipment
   19. Video switches/matrices
   20. Projection screens
   21. Video projectors
   22. Video panels
   23. Computer monitors
   24. Touch panel interfaces
   25. Button panel interfaces
   26. Control processors

27. Lighting controllers
28. Presentation wireless remote controls

1.4 SUBMITTAL INFORMATION

A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Combine product submittals for all products and submit together as a single submittal.
   1. Submit a cover letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. State in the letter that the Contractor has reviewed the specified items, and agrees that they are applicable to this project in all respects.
   2. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.
   3. For those items noted as allowing "or equal," and which are not being provided as specifically named, submit a written description detailing the reason for the substitution, along with standard manufacturer's cut sheets or other descriptive information.

B. Preliminary Schematic Wiring Diagrams: Provide a schematic wiring diagram for each audio/visual application. The diagrams shall show all equipment with equipment model numbers. The diagrams shall also show all cables and wiring connections, indicating cable/wire types.

C. As-built Schematic Wiring Diagram: Upon successful operation of each audio/visual application, provide a schematic wiring diagram for each theater space having an audio/visual application. The diagrams shall show all equipment with equipment models and serial numbers. The diagrams shall show all cables and wiring connections, indicating cable/wire type and wire labeling.
   1. Sometimes name and number changes occur during construction. Before creating drawings and labeling, verify that the room names and numbers are correct.

D. Operation, Installation and Maintenance Manuals: At the conclusion of the project, provide electronic copies of the Operation, Installation, and Maintenance Manuals for each piece of audio/visual equipment. Each document shall be provided in Adobe Acrobat PDF format on a CDROM or DVDROM. Each PDF file shall be an original document prepared by the manufacturer. For each document that is not available from a manufacturer's website, scan the hardcopy documentation provided with the equipment.
   1. Organize the PDF files on the CDROM or DVDROM in a folder structure as follows:
      a. Each room per building shall have a separate folder containing all documents for the equipment in that room.
      b. The folders shall be named in the following format: "BUILDING – NAME - ###" where BUILDING is the name of the building, NAME is the name (and/or number) of the room, and ### is the room number.
   2. Provide to the Owner a single set of hardcopy printed documentation for each piece of audio/video equipment. Organize the documentation in a 3-ring (or similar) binder. Dispose of all other copies of the original printed documentation after verification that the electronic (PDF) version of each is stored on the CDROM or DVDROM.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless specifically stated as "Or equal," equal items are not acceptable. Provide items as specified. Pre-approval (prior to bid) by the Owner is required for all "or equal" substitutions.

B. Part numbers and model numbers are specified in the Appendix at the end of this section.

C. Provide batteries for all hand-held remote controls.

2.2 GROUNDING AND BONDING

A. See Section 27 05 26 – “Grounding and Bonding for Communications Systems.”

2.3 STANDARD CABLE ASSEMBLIES/PATCH CORDS

A. General: The cabling listed below shall be used where referenced in this specification section. Cable colors shall be used consistently throughout as indicated.

B. Cabling shall be as specified in Section 27 41 00 – “Audio Visual Systems” unless otherwise specified below.

C. Production Cable Kit:
   1. Microphone Cables:
      a. Non-plenum rated cabling shall be 22 AWG, stranded copper, twisted pair, shielded with 22 AWG drain wire, and a rubberized black-colored jacket:
         1) Belden 9451 009U1000
         2) or commercial grade equal.
      b. Terminations shall be Neutrik XLR.
      c. Lengths and Quantities:
         1) 3 feet, quantity 24
         2) 25 feet, quantity 36
         3) 50 feet, quantity 24
         4) 100 feet, quantity 12
   2. Category 6 Cables:
      a. Cabling shall be Shielded Category 6A Cabling, stranded wire, factory cut and terminated with a rubberized black-colored jacket:
         1) Mfr/Model info
      b. Terminations shall be Ethercon RJ45.
      c. Lengths and Quantities:
         1) 25 feet, quantity 36
         2) 50 feet, quantity 24
         3) 100 feet, quantity 12
   3. DMX Cables
      a. Cabling shall have a characteristic impedance of 110-ohms and a capacitance of 12pF per foot. Cabling shall be have 2 conductor pairs (22 AWG), and two shields, stranded wire, factory cut and terminated with a rubberized black-colored jacket:
         1) Belden 1802B
         2) or pre-approved commercial grade equal.
      b. Terminations shall be Neutrik XLR
      c. Lengths and Quantities:
         1) 6 feet, quantity 24
         2) 25 feet, quantity 24
         3) 50 feet, quantity 24
         4) 100 feet, quantity 12
   4. Speaker Cables:
      a. Speaker cabling shall be 12 AWG, stranded copper, two-conductor, unshielded, with a rubberized black-colored jacket:
         1) Belden 6000UE

2) or pre-approved commercial grade equal.
b. Terminations shall be Speakon
c. Lengths and Quantities:
1) 6 feet, quantity 12
2) 25 feet, quantity 24
3) 50 feet, quantity 24

5. Power Cables:
a. Power cables shall be 12 AWG, three conductor, 20A-rated or higher, stranded copper, SOOW rated, with a rubberized black-colored jacket:
1) Commercial grade product
b. Terminations shall be Powercon 20A
c. Lengths and Quantities:
1) 25 feet, quantity 24
2) 50 feet, quantity 24
3) 100 feet, quantity 6

6. Cable Management:
a. Individually coil each cable and wrap each cable with hook-and-loop straps (Velcro style).

7. Cable Trunks:
a. Cable trunks shall be “ATA” road cases with dividers for three compartments and four 4” heavy duty casters. Cases shall be manufactured with 3/8” plywood and shall be at least 43” wide x 20” deep x 23” high (overall inside dimensions). Cable trunks shall be permanently labeled on the exterior with the cable type. Compartments inside the trunks shall be labeled with the cable type and length.
b. Cable trunks shall be:
1) Road Cases USA SKU: 610373669914
2) or pre-approved commercial grade equal.
c. Provide the five cable trunks for the following applications:
1) Microphone Cable Trunk
2) Category 6 Cable Trunk
3) Speaker Cable Trunk
4) DMX Cable Trunk
5) Power Cable Trunk

2.4 EQUIPMENT RACKS/ENCLOSURES

A. All A/V Equipment Racks and Enclosures shall include all necessary mounting hardware and grounding/bonding hardware.

B. A/V Equipment Racks (Full-Height) shall have a capacity of at least 40U, shall be 32” deep, and be black powder-coated with a vented rear door. Racks shall be Middle Atlantic VRK Series or approved equal, with the following accessories:
1. Drawer
2. Cable Management
3. Rack-Mount Power Strip
4. Solid Blank Panels
5. Vented Blank Panels
6. Shelf

C. A/V Equipment Racks (Portable) shall have a capacity of 10U (minimum), shall be 20” deep, and be black powder-coated with removable side panels. Racks shall be Middle Atlantic PTRK Series or approved equal, with the following accessories:
1. Swivel Casters - Middle Atlantic or approved equal
2. Cable Management
3. Rack-Mount Power Strip

4. Solid Blank Panels
5. Vented Blank Panels
6. Shelf

D. A/V Equipment Rack (In-Desk Slide-Out applications/Casework):
1. A/V Equipment Rack shall have a capacity of 18U, shall be at least 19 1/4" deep, black powder-coated without sides, back or top panels. Racks shall be capable of pulling out for installation and servicing of equipment. Racks shall be Middle Atlantic SRSR Series or approved equal, with the following accessories:
2. Rack-Mount Power Strip
3. Solid Blank Panels
4. Vented Blank Panels
5. Shelf

E. A/V Equipment Rack (Desktop Playback, low-profile applications) - A/V Equipment Rack Rails shall be mounted in 19 ¼" furniture space and have a capacity of at least 8U. The following accessories are required:
1. Equipment Rack Rails
2. Rack-Mount Power Strip
3. Solid Blank Panels
4. Vented Blank Panels
5. Shelf

F. Cable Management:
1. Middle Atlantic
2. or approved equal.

G. Drawer:
1. Middle Atlantic D Series
2. or approved equal.

H. Equipment Rack Rails:
1. Middle Atlantic RRF Series
2. or approved equal.

I. Security Covers:
1. Middle Atlantic SF
2. or approved equal.

J. Blank Panels:
1. Vented - Middle Atlantic VT
2. Solid - Middle Atlantic EB
3. or approved equal.

K. Power Strips shall not have a user-facing on/off switch:
1. Middle Atlantic Powercool Series
2. or approved equal.

L. Shelves:
1. Middle Atlantic RSH Custom Rackshelf for components if available from Middle Atlantic, otherwise from Generic U Series or approved equal.
2. Middle Atlantic MS Series Rackshelf for loose devices that shall be secured to a shelf.

M. Rack Screws shall be Middle Atlantic HW Series 10-32. All other screw products are prohibited.

N. Exhaust Fans for A/V Equipment Racks:
   1. Middle Atlantic Blower or QFAN Panel

O. Standard Equipment Mounting:
   1. Equipment Clamps: Middle Atlantic "-C"
   2. Double-sided, adhesive, 2" wide, industrial hook/loop fastener:
      a. 3M MP3526N
      b. Velcro 90593

P. Mesh Sleeve for routing exposed cables:
   1. Braided, expandable plastic mesh sleeve, black colored, sized appropriately for the application (typically 1" and 1-1/2" diameter):
      a. TechFlex, Panduit or equal.

2.5 FURNITURE

A. Podiums shall be as shown in the Contract Documents:
   1. Type: XXXXXX
   2. Material: XXXXXX
   3. Finish: XXXXXX

B. Sound booth desks shall be as shown in the Contract Documents:
   1. Type: XXXXXX
   2. Material: XXXXXX
   3. Finish: XXXXXX

C. Lighting booth desks shall be as shown in the Contract Documents:
   1. Type: XXXXXX
   2. Material: XXXXXX
   3. Finish: XXXXXX

D. Computer security cable and lock:
   1. Securetech
   2. or pre-approved equal.

2.6 AUDIO SYSTEMS

A. Mono system (public address) amplifiers shall provide 75 watts per channel output (minimum), and provide a minimum of 15 watts per installed speaker, be Class D rated, with appropriate inputs, and rack-mount brackets. The amplifier shall also have intrinsic 70V speaker outputs. Amplifiers shall be sized appropriately for each application.
   1. Ashly TRA series or approved equal.
   2. Cables shall be Standard Audio Cabling with XLR plugs, RCA plugs, spring clip, or screw-type (open) terminals.

B. Stereo system amplifiers shall have a per-channel wattage rating (RMS) at least 50 percent higher than the RMS power rating of the connected speaker load. Amplifiers shall be Class D rated, with appropriate inputs and rack-mount brackets. Amplifiers shall support 4 ohm and 8 ohm speakers.
   1. Amplifiers shall be:
      a. Crown XLS Drivecore 2 Series
      b. Crown XTi 2 Series
      c. or approved equal.
   2. Cables shall be Standard Audio Cabling with XLR, Phoenix terminals or screw-type (open) terminals.

C. Digital Signal Processing (DSP) systems shall be:
   1. BSS London Series
   2. Cables shall be Standard Audio Cabling with XLR plugs, Phoenix Terminals, RCA plugs, spring clip, or screw-type (open) terminals.

D. Speakers:
   1. For Speech (Public Address): 70 Volt, monaural audio speakers, 6-10 inch driver, taps from 7.5W to 30W, suitable for ceiling mounting. Speakers shall be:
      a. JBL Control 26
      b. or approved equal.
   2. For Content (Stereo): 8 ohm stereo audio speakers, suitable for wall mount, or hanging depending on size of speakers and application.
      a. Speakers shall be:
         1) JBL Control Series
         2) or approved equal.
      b. Speakers for hanging applications in large venue shall be:
         1) JBL AE or VRX Array Series
         2) or approved equal.
   3. Mounting hardware shall either be integrated mounts or attachable mounting hardware provided by the speaker manufacturer, suspended with aircraft cables attached to ceiling/structure mounted unistrut with appropriate adjustable hardware.
   4. Wiring shall be Standard Speaker Wiring with standard terminations.

E. Assistive Listening Devices:
   1. Loop Systems
      a. Transmitter:
         1) Listen Tech with:
            a) Power supply
            b) Power cable
            c) Rack mounting kit
      b. Receivers:
         1) Mono Headset Receiver: Listen Tech with rechargeable batteries.
         2) Ear Tips: Listen Tech
      c. Receiver Charging Station:
         1) Listen Tech
   2. Signage
      a. Listen Tech ADA wall plaque

F. Microphones:
   1. Ceiling-hung microphones shall be:
      a. Audix M3
      b. or pre-approved equal.
   2. Desk-mounted microphones shall have a cardiod pattern, LEDs to indicate multiple states with built-in logic, and able to be secured to table surface:
      a. Shure MX395 Series
      b. Shure MX Series Gooseneck (shock-mount)
      c. or pre-approved equal.
   3. Wireless Microphones shall be RF, tunable and able to automatically identify available radio frequencies:
      a. Shure ULXD Series
         1) Body pack: Shure ULXD1
         2) Lapel: Shure MX150
         3) Over the ear: Countryman E6, flesh colored, with the TA4F connector
         4) Headworn/Fitness: Shure SM31F8
         5) Handheld: Shure ULXD2

b. RF Cables shall be:
   1) Antenna extension cable: RG-6U with BNC connectors on both ends.
   2) Antenna mount: BNC barrel connector.
c. Larger Antennas and Antenna Distribution shall be provided where appropriate given the size of the venue

4. Wireless frequencies for all microphones shall comply with FCC requirements.
5. Cables shall be Standard Audio Cabling with Phoenix terminals, or XLR.

G. CD Players:
1. CD Players shall provide stereo balanced audio output, be IR or RS-232 controllable, with Bluetooth, and shall be:
   a. Tascam CD-200BT
   b. or pre-approved equal.

H. Digital Audio Recorders:
1. Digital audio recorders shall be 1RU form factor, with balanced audio inputs on the rear, with discrete controls on the front panel. Recorders shall record to SD cards or USB flash drives in MP3 format, and shall be:
   a. Denon DN-500R
   b. or pre-approved equal.

I. In-Ear Monitors:
1. In-Ear monitors shall be:
   a. Shure PSM 900 or PSM 1000 Series

J. Soundboards:
1. Soundboards shall be digital with Dante functionality, and shall be:
   a. Yamaha CL Series

K. Intercom Systems:
1. Intercom systems shall be 4-channel systems supporting both wired and wireless headsets, with speaker stations, and shall be:
   a. Clear-Com:
      1) Main Station: MS-704
      2) Wireless Intercom Kit: HME DX300ES
      3) Wireless Belt Packs: BO210 with HS15 Headsets
      4) Wired Belt Packs: RS-701 with CC300-X4 Headsets
   b. or Telex equal.

2.7 VIDEO SYSTEMS

A. Blu-ray Player Devices:
1. Blu-ray players shall be:
   a. Sony, Oppo
   b. or pre-approved equal.
2. 1U Rack-mounted Shelf or manufacturer-specific rack-mount ears.
3. Cables shall be Standard HDMI Cables.

B. Video Cameras:
1. Table-top Document Camera: HD, 1080p/60fps, HDMI or DVI output.
   a. Cameras shall be Samsung SDP-860 or pre-approved equal.
   b. Cables shall be Standard HDMI cables.
2. Classroom Cameras: HD, 1080p/30fps, HDMI, SDI, or USB Video output depending on project, with wall or ceiling mount bracket depending on project.

a. Panasonic HE40 Series or equal.
b. Pan-tilt-zoom lens.
c. Fixed lens.
d. Cables and any adapters/extenders required must be approved.

C. Video Conferencing Endpoints:
1. Shall be High Definition Video Conferencing Endpoint (VCE), and shall be Utah Educational Network (UEN) approved:
a. Cisco
b. or pre-approved equal.

D. Video Distribution Amplifiers shall be as specified in Section 27 41 00 – "Audio Visual Systems".

E. HDBaseT Distribution Equipment shall be as specified in Section 27 41 00 – "Audio Visual Systems".

F. Video Switches/Matrices:
1. All Audio/Video Switches/Matrices shall support resolutions no less than 1080p at 60 frames per second, provide EDID management and be RS-232 and LAN controllable. Audio/Video Switches/Matrices shall have either an integrated audio digital signal processor with direct analog audio outputs or shall have discrete analog audio outputs for each input. It is preferred (but not required) that Audio/Video Switches/Matrices support 4K video at 4-4-2, and provide scaling functions.
2. Audio/Video Switches/Matrices shall be:
a. Crestron
b. Kramer
c. Extron
d. or pre-approved equal.

2.8 VIDEO DISPLAYS

A. Projection Screens:
1. All projection screens shall be manufactured by Da-Lite or their pre-approved equivalent from Draper.
2. Motorized Screens:
a. Motorized projection screens shall be Electric Tensioned Advantage or Tensioned Contour product line.
b. Motorized projection screens shall have a 16:10 aspect ratio and HD Progressive Screen Surface. Matte white screen surfaces are not acceptable.
c. Other required options include:
1) Screens shall be electrically operated and support low-voltage control via a built-in screen controller.
2) Motor shall be 120VAC and silent. 220VAC motors are not acceptable.
3) Cases and trim kits shall be white.
4) Internal junction box.
5) Without video projector interface.
d. **XXX"** Screen: Da-Lite **XXXXXXXX**.
e. **XXX"** Screen: Da-Lite **XXXXXXXX**.
f. **XXX"** Screen: Da-Lite **XXXXXXXX**.
g. or pre-approved equal models and materials from Draper.
3. Projection screen mounts shall be manufactured by the screen manufacturer, and shall be wall-mounted or ceiling-mounted per manufacturer's specifications and as shown on the Contract Documents. A ceiling trim kit shall be provided where shown on the Contract Documents.

B. Video Projectors:
   1. All video projectors shall be WUXGA or better, and shall have horizontal and vertical lens adjustment, IP connectivity, RS232 control, HDBaseT Video Input, and HDMI video input.
   2. Standard-throw Video projectors shall have a minimum of 12,000 ANSI lumen output, with a lens approved by the projector manufacturer to match the throw distance of the room:
      a. Panasonic PT-DZ13K (or latest equal model meeting these specifications)
      b. Lens: XXXXXXXXX
      c. or pre-approved equal.
   3. Video projector cables:
      a. Data: One Category 6A cable (per Section 27 15 00, by Telecommunications Contractor) running between an outlet near the projector and the telecommunications room.
      b. Video: One Category 6A cable (per Section 27 15 00, by Telecommunications Contractor) running directly from the projector to the video switch in the A/V Equipment Rack, with any necessary extenders required to support HDMI/DisplayPort via Category 6A cabling.
      c. Control: One RS-232 cable running directly to the projector from the control system in the A/V Equipment Rack.
      d. Video (40 ft runs or less): One Standard HDMI cable running directly between the projector and the A/V Equipment Rack.
   4. Video projector mounts shall be:
      a. Chief Manufacturing RSMA Series Custom mount for specific projector
      b. or pre-approved equal.

C. Video Panels:
   1. Video Wall:
      a. Panels shall be commercial grade, with LED backlighting, LCD, with HDMI and Displayport 1.2 inputs, and DisplayPort 1.2 outputs for daisy-chaining. Panels shall accept RS232 control and IP connectivity and daisy-chaining, with direct input selection ability.
         1) 46” diagonal: Video Panels shall be NEC X464UN or current equal model.
         2) 55” diagonal: Video Panels shall be NEC X554UN or current equal model.
         3) or pre-approved equal from Panasonic or Samsung.
      b. Video Wall Surface mounts shall have height, tilt, and plumb adjustments, and pull-out and tilt for maintenance, and shall be:
         1) Premier LMVS
         2) Chief LWM series (for banner applications only)
         3) or pre-approved equal.
      c. Video Wall ceiling mounts shall have tilt adjustment and shall be:
         1) Chief LCM Series
         2) or pre-approved equal.
   2. Digital Signage:
      a. Panels shall be commercial grade, LED, sized for specific project, 46”, 55” or larger (diagonally measured), with HDMI inputs and an OPS slot.
         1) NEC V Series
         2) NEC E Series
         3) or pre-approved equal.
      b. Media Players shall have an external LAN port, at least two external USB ports, an external video port (DisplayPort or HDMI) and have a 3-year manufacturer warranty.
         1) OPS Type:
            a) NEC
            b) or pre-approved equal.
         2) Media Player (PC type)

a) Lenovo Tiny
b) Intel NUC
c) or pre-approved equal.

3) Media Player (stand-alone, single function, system-on-a-chip)
a) Pre-approved device.

3. Classrooms and Conference Rooms:
   a. Panels shall be commercial grade, LED, sized for specific project (diagonally measured), with HDMI input(s) and RS-232 Control.
      1) Video Panels shall be NEC E Series
      2) or pre-approved equal.
4. Wall-mounting brackets shall have locking security features, and shall be fixed, tilting, or full-articulating:
   a. For fixed-mount applications:
      1) Premier Low Profile Mount
      2) Chief Fusion Series
      3) or pre-approved equal.
   b. For tilting-mount applications:
      1) Premier Low Profile Mount
      2) Chief Fusion Series
      3) or pre-approved equal.
   c. For fully articulating-mount applications:
      1) Chief TS or PDR Series Mounts
      2) or pre-approved equal.
   d. For In-Wall applications:
      1) Chief TS, PDR for mounting into Chief wall-boxes
      2) Chief PIWRFUB
5. Ceiling-mounting bracket shall be 1.5” NPT pipe compatible and shall be:
      1) Chief XCM Series
      2) or pre-approved equal.
6. Video Panel Cables:
   a. Cables shall be HDMI for distances up to 40 feet, and HDBaseT.
7. Video Panel Interface Box:
   a. Chief PAC501B (for In-Wall applications)
   b. Chief TS500 (for In-Wall applications)
   c. Chief PAC526 (for fixed or tilting applications)

D. Computer Monitors:
   1. Computer Monitors shall be provided as confidence monitors on teacher stations and in other locations as required. Monitors shall have an HDMI input, be at least 1920 x 1080 at 60 Hz resolution at 16:9 aspect ratio. Touch monitors may be requested as needed. They shall be:
      a. Dell P2314T
      b. or pre-approved equal.

2.9 SYSTEM CONTROLLERS

A. Touch Panel Interfaces:
   1. Touch panels shall be 7” to10” size, be powered via Power-Over-Ethernet (POE), operate via Ethernet, and shall have a table-top swivel mount.
      a. Touch panel shall be: Crestron TSW-752 (or newest model)
      b. Touch panel shall be: Crestron TSW-1052 (or newest model)
      c. or pre-approved equal.
   2. Control wiring shall be Ethernet via Category 6A cabling per Section 27 15 00 and Cresnet.

B. Button Panel Interface:
   1. Button panels shall be 10 to 50 buttons, and operate via both Ethernet and low voltage signaling.
      a. Button panels shall be: Crestron MPC series
      b. or pre-approved equal.
   2. Control wiring shall be Cresnet.

C. Control Processors:
   1. Control Processors shall be Crestron Series 3 with Ethernet, Cresnet, RS-232, IR, and additional control ports necessary for applications. Devices shall be controlled by the processor over RS-232 when possible, or optionally over IR and LAN.

2.10 LIGHTING SYSTEMS

A. Lighting Controllers
   1. Lighting Controllers shall be:
      a. ETC ION 1000, 6000
      b. ETC EOS Ti
   2. Lighting Fixtures shall be:
      a. ETC ColorSource Series
      b. ETC Desire Series
      c. ETC Source4 Series

2.11 PRESENTATION WIRELESS REMOTE CONTROL

A. Presentation wireless remote control devices with batteries shall provide page-up/page-down functions, have a red laser pointer, and connect to the Owner-provided computer via a USB port in a Plug-and-Play fashion.
   1. Logitech R400
   2. or pre-approved equal.

2.12 LABELING AND ADMINISTRATION

A. Cable Labels:
   1. As recommended in ANSI/TIA/EIA 606. Permanent polyester, not subject to fading or erasure, permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
      a. 1” inch black on white: DYMO Rhino Series
      b. or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all audio/visual systems, equipment, and materials shown on the Contract Documents, Contract Drawings and depicted in the table below.

B. All audio/visual systems and applications shall be arranged, assembled, wired, and configured identically to other applications in similar rooms within this project. Component arrangement, wire numbering, wire color, wire type, wire manufacturer, wire routing, etc. shall all be consistent throughout the project.

C. All cables shall be unspliced and not coupled.

D. The rooms listed below are designated with the application functions indicated. For each room listed, provide the equipment, cabling, and functionality defined for each application.

	Theaters		
	Theater	Theater	Theater
A/V Equipment	**121**	**209**	**313**
A/V Equipment Racks (Full-Height)	2	2	2
A/V Equipment Racks (Portable)			
A/V Equipment Racks (In-Podium Slide-Out)	1	1	1
A/V Equipment Racks (In-Podium Fixed Applications)			
Mono System Amplifiers (Public Address)	1	1	1
Stereo System Amplifiers	1	1	1
Digital Signal Processing (DSP)	1	1	1
Speakers for Speech (Public Address)	12	12	12
Speakers for Content (Stereo)	6	6	6
Assistive Listening Systems	1	1	1
Microphones (Ceiling-Hung)	4	4	4
Microphones (Desk-Mounted)			
Microphones (Wireless)	1	1	1
Digital Audio Recorders			
Soundboards	1	1	1
Intercom System	1	1	1
Blu-Ray Player Devices	1	1	1
Table-Top Document Camera	1	1	1
Classroom Camera	2	2	2
Video Conferencing Endpoints			
Video Switches/Matrices	1	1	1
Projection Screens	1	1	1
Video Projectors	1	1	1
Video Panels	20	20	20
Media Players			
Computer Monitors			
Control Interfaces	1	1	1
Control Processor	1	1	1
Lighting Controllers	1	1	1

E. In addition to the major equipment listed above, provide all equipment shown on the Drawings or listed in the specification, as required for a complete, operational system.

F. Configure, program, adjust, and tune all equipment according to manufacturer requirements such that it will perform as required. From the perspective of users of the audio/visual systems, all systems shall be installed to look, feel and operate similarly to all of the existing facilities throughout the Owner's campus.

G. Any accessory hardware (including adapters, batteries, brackets, cables, connectors, covers, dongles, remote controls, and tools) that is provided by the manufacturer with equipment, but which does not become permanently installed, shall be furnished to the Owner.

H. Furnish to the Owner one set of original packaging material for each piece of audio/visual equipment.

3.2 GROUNDING AND BONDING

A. Grounding conductor shall be installed to bond all non-current-carrying metal equipment and materials to the nearest telecommunications grounding system (as provided under Section 27 05 26 – "Grounding and Bonding for Communications Systems"). Ground conductor shall be run directly to the cable tray grounding conductor, and shall not rely upon metallic conduit for a grounding path.
    1. Ensure that active electronic equipment is properly grounded per manufacturer's requirements.

3.3 STANDARD CABLE ASSEMBLIES/PATCH CORDS

A. Provide all patch cables, cords, and connectors required for a completely functional system. Cable lengths shall be kept to practical minimum lengths (not more than 25 ft.), while providing slack to be able to reterminate each end of the cable 3 times. Avoid long cables that require slack coils. Where slack coils are required, store slack coil under the base of A/V Equipment Rack.

B. All wiring and cables shall be free of grounds and shorts.

C. Plenum-rated cables shall be used for all in-wall/ceiling applications except where cables are fully enclosed in conduit from end to end.

D. All wiring and cables shall be properly supported with strain relief measures. Cables shall not rest upon ceiling grid, but shall be secured between 16 and 24 inches above the finished ceiling.

E. The use of nylon tie wraps ("zip-ties") is prohibited everywhere, with the few exceptions listed below. Where "zip ties" are used, they should not be tightened down excessively, as doing so may damage cables. Excess shall be removed using flush-cut tools to produce a cut flush with the ratchet head, without leaving sharp or snagging remnants.
    1. Permanently affixed power wiring.
    2. In ceilings where cables exit the wire basket to transition or terminate on equipment, zip ties may be used to suspend cables above the ceiling grid.
    3. As a cable management pathway affixed to spot anchors attached to the inside of furniture, creating a loop for Velcro to pass through and anchor cables.

F. A/V Equipment Racks:
    1. After the system has been completely tested, neatly bundle and dress cables using Velcro-style straps to secure cables against lacing bars in a neat and professional

manner. Provide sufficient cable slack such that equipment can be serviced without binding or kinking the cables.

G. Instructor Consoles:
   1. Prior to cabling, screw-attached cable tie bases (tie-wrap backs) shall be installed on inside of furniture with “zip ties” attached to create a loop in order to facilitate pathways between equipment.
   2. After the system has been completely tested, neatly bundle and dress cables using Velcro-style straps to secure cables against the underside of the console in a neat and professional manner.

H. Mesh Sleeves:
   1. Provide mesh sleeves, with the ends of the sleeves cut with a hot iron to the appropriate length, and secured with an overwrapping tie-wrap at each end, for the following applications:
      a. Anywhere cables would be exposed to public view.
      b. Between floor boxes and conference tables.
      c. Where friction may damage cables over time.
   2. Prevent mesh sleeves from pulling out of their termination points, thus keeping cabling concealed and protected inside the sleeves.
   3. Do not use tape, tie wraps, or Velcro-style straps to bundle cables inside mesh sleeves and conduits. Cables shall be loose inside mesh sleeves and conduits, allowing them to be pulled out individually and replaced without disturbing the other cables.

I. Production Cable Kit:
   1. Provide one Production Cable Kit per theater space. Remove cabling from packaging, coil and secure with straps. Place cables inside road case in an organized fashion. Deliver kit to Owner’s Representative.

3.4 EQUIPMENT RACKS/ENCLOSURES

A. Provide junction panels, racks, cabinets, and enclosures with all associated hardware according to locations, elevations, and plan views as shown in the Contract Documents.

B. A/V Equipment Racks, Cabinets, and Enclosures:
   1. Provide racks, cabinets, and enclosures as shown on the Contract Documents.
   2. Assemble racks and install components as shown, and ensure that all moving parts (doors, drawers, latches, etc.) function as intended.
   3. Provide exhaust fans as shown on the Contract Documents and as required for reliable operation of the equipment.
   4. Work with the electrician to ensure that the power outlets and data boxes designated to serve the A/V equipment are installed in the proper locations.

C. All equipment shall be securely attached to racks using all available screw holes (minimum 4).

D. All shelf-mounted equipment shall be securely attached to the shelf using equipment clamps provided by the equipment manufacturer or Middle Atlantic equipment clamps. Where neither of these options are available, use double-sided, adhesive, 2” wide, industrial hook/loop fasteners. Leaving equipment sitting loose on a shelf is not acceptable.

3.5 FURNITURE

A. Provide cable access boxes with the specified connectors, or retractors in each designated conference table location, cut in and mounted as shown on the Contract Documents.

B. Provide Teacher Stations, Podiums, and Credenzas as shown on the Contract Documents.
   1. Provide computer security cable, attached securely to the A/V Equipment Rack.
   2. Protect furniture from damage prior to Owner acceptance. Repair or replace any damaged furniture.
   3. Provide documentation, maintenance, and warranty information associated with furniture to the Owner.

3.6 AUDIO SYSTEMS

A. Maintain the following minimum separation distances:
   1. 24” between all ceiling-hung speakers and pendant microphones.
   2. 24” between all pendant microphones and air ducts (return or discharge).
   3. 12” between all pendant microphones and video projection paths.
   4. 12” between all pendant speakers and video projection paths.
   5. 12” between all pendant lighting and video projection paths.

B. Amplifiers and Digital Signal Processors:
   1. Provide amplifiers and digital signal processors with any required input modules, fully configured as required, and installed in equipment rack as shown on the Contract Documents.
   2. Provide cabling and wires.

C. Speakers:
   1. Provide speakers and mounting hardware, installed as shown on the Contract Documents.
   2. Attach parallel runs of unistrut to structure above the finished ceiling over each speaker location using all-thread and necessary attachment hardware. Suspend speakers from unistrut using four aircraft cables and appropriate adjustable attachment hardware to aim the speaker and prevent swinging.
   3. Provide cabling and wires.

D. Assistive Listening Systems:
   1. RF Transmitters
      a. In the quantities and locations indicated in the table below, furnish (uninstalled) RF transmitters, and provide (installed) a program audio output in each Teacher Station table top cable box for use with an Owner-deployed RF transmitter.
      b. Deliver transmitters to the Owner during system demonstration.
   2. Wired Loops
      a. Provide (installed) loop systems in quantities and locations shown in the Contract Documents and indicated in the table below.
      b. Perform an initial loop test before system installation.
      c. Saw-cut the floor per manufacturer guidelines, install wire, fill the trough, and sand/finish the concrete floor.
      d. Terminate the loop wiring in the Teacher Station.
      e. For systems where the transmitter will be installed, install transmitter in equipment rack, then calibrate and commission the system.
   3. Loop Transmitters:
      a. Furnish uninstalled in the quantities indicated in the table below. Deliver transmitters to the Owner during system demonstration.
      b. Provide (installed) in the quantities and locations indicated in the table below.
   4. Loop Receivers:
      a. Furnish uninstalled in the quantities and locations indicated in the table below.
      b. Provide batteries for all receivers.

c. Provide charger stations, mounted in equipment rack drawer, with power wiring groomed and secured within the rack.
d. Deliver receivers to the Owner during system demonstration.

Seating Capacity of Room	Number of RF Transmitters	Number of Wired Loops in Room	Number of Transmitters for Loop systems	Minimum Number of Loop Receivers
65 or less	1 per 10 rooms 65 seats or less*	1	1 per 10 rooms 65 seats or less* (furnish uninstalled)	2
66 to 250	None	1	1 per 5 rooms over 65 seats* (furnish uninstalled)	2, plus 1 per 25 seats over 65 seats*
251 to 500	None	1	1 per 5 rooms over 250 seats* (furnish uninstalled)	2, plus 1 per 25 seats over 250 seats*
501 to 1000	None	1	1 per room over 500 seats (installed)	20, plus 1 per 33 seats over 500 seats*
1001 to 2000	None	phased array loop/double loop coverage	2 per room over 1000 seats or as required to serve the loops in a room (installed)	35, plus 1 per 50 seats over 1000 seats*
2001 and over	None			55, plus 1 per 100 seats over 2000 seats*

* or fraction thereof

5. Signage:
   a. Provide sign indicating the availability of a loop-based assistive listening system.
   b. Mount sign in location near the seating where the signal strength will be the highest and as directed by the Architect and/or Owner.

E. Microphones:
1. Provide all microphones shown on the Contract Documents. Provide mounts, cabling and wires.
2. For wireless microphones:
   a. Provide receivers, installed in A/V Equipment Rack as shown on the Contract Documents.
      1) Configure the wireless microphone receivers to operate in the following frequency ranges:

Room Name	Room #	Frequency Range
room name	###	MHz
room name	###	MHz
room name	###	MHz
room name	###	MHz
room name	###	MHz
room name	###	MHz
room name	###	MHz

   b. Install the antennas in the ceiling out of public view near the front of the room, 5-15 ft. away from the front and side walls and no less than 10 ft. apart, using manufacturer-provided external antenna mounting bracket.

c. Connect the external antennas to the wireless mic receivers using standard cabling.
d. Furnish body pack transmitters, wireless microphones, and associated cables, stored in the drawer in each A/V Equipment Rack.
e. Furnish manufacturer specific charging station and battery packs, with enough docking spaces for all mics to be charged simultaneously.
f. Drawer shall be large enough to accommodate charger and bodypack transmitter height when docked.

3. For ceiling-hung microphones:
   a. Provide grommet through the ceiling tile that matches the color of the tile.

F. CD Players:
1. Provide CD players as shown in the Contract Documents, rack-mounted unless otherwise indicated.
   a. Provide audio cables as required.

G. Digital Audio Recorders:
1. Provide digital audio recorders as shown in the Contract Documents, rack-mounted unless otherwise indicated.
   a. Provide audio cables as required.

H. In-ear Monitors:
1. Provide in-ear monitors as shown in the Contract Documents and protective storage enclosure.
   a. Provide audio cables as required.

I. Soundboards:
1. Provide soundboards as shown in the Contract Documents, installed on desktop unless otherwise indicated.
   a. Provide all cables as required.

J. Intercom Systems:
1. Provide intercom systems and all accessories, installed as shown in the Contract Documents, unless otherwise indicated.

3.7 VIDEO SYSTEMS

A. Blu-ray Player Devices:
1. Provide shelves, installed in equipment rack as shown on the Contract Documents.
2. Provide Blu-ray player, attached to shelf.
3. Provide cables and wires.

B. All Cameras:
1. Provide cameras, mounted as shown on the Contract Documents.
2. Provide mounts, cables and wires.

C. Video Conferencing Endpoints:
1. Provide video conferencing endpoints, installed as shown on the Contract Documents.
2. Provide mounts, cabling and wires.
3. Configure system to integrate with the equipment in the room.

D. Video Distribution Amplifiers:
1. Provide video distribution amplifiers as shown on the Contract Documents.
2. Provide rack-mounted shelving and attach devices to shelf.

3. Provide cables and wires.

E. HDBaseT Distribution Equipment:
1. Provide HDBaseT transmitters and receivers as shown on the Contract Documents.
2. Provide rack-mounted shelving and attach devices to shelf.
3. Remote end devices shall be secured in a professional manner with screws. Where screw attachment is not practical, use double-sided, adhesive, industrial hook/loop fasteners.
4. Provide cables and wires.

F. Audio/Video Switches/Matrices:
1. Provide audio/video switches/matrices, installed in equipment racks as shown on the Contract Documents.
2. Provide cabling and wires.
3. Provide all required configuration and programming.

3.8 VIDEO DISPLAYS

A. Projection Screens:
1. Provide projection screens installed as shown on the Contract Documents.
   a. For Rooms **XXX, XXX, XXX and XXX** **Screen size**
   b. For Rooms **XXX, XXX, XXX and XXX** **Screen size**
   c. All other rooms requiring screens **Screen size**
2. Screens shall be mounted as close as possible to the wall (preferably not more than 4" away from the wall) while also permitting the projection surface to clear any obstructions on the wall (such as whiteboard and pen tray).
3. Provide at least one manual, low voltage control switch, located near the Teacher Station. Do not mount switch behind screen.
4. Provide mounts, power, power disconnect switch, control raceways, and wiring as shown on the Contract Documents.

B. Video Projectors:
1. Provide video projector mounts, attached to structure as shown on the Contract Documents. Position mounts such that:
   a. The projector is located the proper distance from the projection surface or screen.
   b. The projector achieves peak performance without the use of specialty lenses.
   c. The projector achieves peak performance without the use of keystoning and with only minor use of image adjustment features (contrast, etc.).
2. Provide video projectors, attached to the projector mounts. Adjust and focus projector to properly display on projection screen. Provide lenses where required.
3. Tighten down mounting screws once projector is properly adjusted and focused, to prevent unintentional misalignment.
4. Provide cables and wires.
5. Verify that lighting and other ceiling-hung objects do not obstruct the image on the screen. Under the direction of the Owner and A/V Engineer, resolve any physical obstructions (such as lighting or other obstructing objects) prior to making any adjustments to the projector, projector mount location, or projection screen.
6. Color calibration is required.

C. Video Panels:
1. Provide video panel mounting brackets, attached to structure as shown on the Contract Documents.
2. Provide video panels, attached to the mounting brackets. Adjust angle and tilt of panel for optimal viewing angle.

3. Provide cables and wires.
4. For video panels designated for us as digital signage, provide media player.
   a. Install OPS-type player inside of display slot of video panel.
   b. For other media player types, mount with screws when possible. Otherwise mount with double-sided, adhesive, industrial hook/loop fasteners.
5. For video wall panels, provide all associated equipment that is required for a functioning video wall system, including video wall processor, video extenders, and all required cabling.
6. Color calibration is required. Adjust all panels to match each other.

D. Computer Monitors:
   1. Provide computer monitors in locations shown on Contract Documents, attached to top of Teacher Station unless otherwise indicated.
   2. Provide USB cable and video cable as indicated on Contract Documents.

3.9 SYSTEM CONTROLLERS

A. Button and Touch Panel Interfaces:
   1. Provide Button Panel and Touch Panel Interface devices in locations and quantities shown on the Contract Documents.
   2. The Owner will furnish sample layout templates to the Contractor. The Contractor shall produce the layout, functionality, and control program to operate the system, matching the look and feel of the Owner's existing systems.

B. Control Processor
   1. Provide Control Processor and necessary control expansion devices according to Contract Documents.
   2. The A/V Contractor shall program the control processors to work with the touch panel and/or button interfaces in order to control all necessary equipment as shown in the Contract Documents.

C. Provide fully documented, uncompiled, editable copies of all control programming and layout source code to the Owner in native electronic format on USB Drive during Demonstration and Training, at the very latest. This software shall become the property of the Owner.

3.10 LIGHTING SYSTEMS

A. Provide Lighting Boards, Controllers, Panels, Switches, Dimmers, and Fixtures as shown in Contract Documents.

B. Provide all necessary cabling properly terminated to each device.

C. Provide mounting hardware.

D. Install and focus light fixtures.

3.11 PRESENTATION WIRELESS REMOTE CONTROL

A. Provide one presentation wireless remote control with batteries, stored in the drawer in each A/V Equipment Rack.

3.12 LABELING AND ADMINISTRATION

A. Equipment Identifiers:

1. Equipment Identifiers shall be as assigned on the Contract Documents and as shown in the table below:

Equipment Type	Abbreviation	Sequence	Example
Controller	IC	. ##	IC. ##
Touch Panel	TP	. ##	TP. ##
Camera	CAM	. ##	CAM. ##
Codec Video Conference	VC	. ##	VC. ##
Video Switcher	SW	. ##	SW. ##
Computer	PC	. ##	PC. ##
Computer Monitor	MON	. ##	MON. ##
Doc Cam	DOC	. ##	DOC. ##
Laptop	LPTP	. ##	LPTP. ##
Video Wall Processor	VWP	. ##	VWP. ##
Audio Mixer	MIX	. ##	MIX. ##
Soundboard	DSB	. ##	DSB.##
Digital Signal Processor	DSP	. ##	DSP. ##
Projector	PRJ	. ##	PRJ. ##
Video Panel	VP	. ##	VP. ##
Distribution Amplifier	DA	. ##	DA. ##
Assistive Listening	ADA	. ##	ADA. ##
Speaker	SP	. ##	SP. ##
Projection Screen	SCR	. ##	SCR. ##
Blu-ray Player	BDP	. ##	BDP. ##
Wireless Mic	WMIC	. ##	WMIC. ##
Wired Microphone Input	MIC	. ##	MIC. ##
Line Input	AUX	. ##	AUX. ##

(## = 2-digit number with leading zero for numbers less than 10)

B. Cable Identifiers:

1. Cable Identifiers shall be as assigned on the Contract Documents and as shown in the table below:

Cable Type	Abbreviation	Sequence	Example
DVI-D	DVI	. ##	DVI. ##
VGA	VGA	. ##	VGA. ##
HDMI	HDMI	. ##	HDMI. ##
DisplayPort	DP	. ##	DP. ##
HDBaseT	HDBT	. ##	HDBT. ##
DC Power	PWR	. ##	PWR. ##
Mic Cable	MIC	. ##	MIC. ##
Speaker Audio	SP	. ##	SP. ##
Ethernet	DATA	. ##	DATA. ##
RS232 Serial Control	RS232	. ##	RS232. ##
RS485 Serial Control	RS485	. ##	RS485. ##
Infrared Control	IR	. ##	IR. ##
Relay / Dry Contact Control	RLY	. ##	RLY. ##
Crestron Cresnet	CRES	. ##	CRES. ##
GPIO Control	I/O	. ##	I/O. ##

(## = 2-digit number with leading zero for numbers less than 10)

C. Cable Labels:

1. Label Location: Affix at each end of the cable, not less than 1 inch or more than 3 inches from the connector, aligned such that the label is readable without adjusting the cable.
2. Include a clear vinyl adhesive wrapping applied over the label, in order to permanently affix the label to the cable and prevent smudges to label text. Using transparent tape to affix labels to cables is not acceptable.
3. Label Content: Labels shall be formatted all uppercase, with a dash between the item type and two-digit sequential number, and spaces between each segment, as follows:

[CABLE#] SOURCE –> DESTINATION

For example, the first RS232 control cable, connected to RS232 port #1 on Crestron Controller #1, to Video Switch #1 would be given the following label:

RS232.01 IC.01 –> SW.01

D. Cabling Color Scheme:
1. Use a consistent color scheme throughout the project, matching the existing scheme in the building.

E. Grounding/Bonding Conductors:
1. Label bonding conductors: “WARNING! BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!”

3.13 COMMISSIONING

A. General:
1. Provide a comprehensive verification of all A/V equipment and systems using a commissioning agent. Determine whether A/V systems meet the construction specifications, Contract Document requirements, standards, objectives, and manufacturer-listed performance guidelines.
2. Prior to beginning the commissioning process, the Contractor and commissioning agent shall hold a meeting with the Owner to review the commissioning requirements, commissioning process and required metrics.
3. Any shortcomings discovered during the commissioning process shall be resolved by the Contractor.
4. The Owner may conduct an independent commissioning process.

B. Commissioning Checklist – Commissioning agents shall use the InfoComm ASPVC as the basis of the commissioning checklist. The ASPVC check list can be found at:

http://www.infocomm.org/cps/rde/xbcr/infocomm/CAVSP_Checklist.pdf

C. Additional Commissioning Requirements – The following additions to the InfoComm ASPVC are required, listed below with references to each section of the ASPVC:

1. I AP Audio Performance:
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
2. II VP Video Performance:
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
   b. Verify that there is no pixel failure.

c. VP-102.1 Verify that keystoning has been avoided wherever possible.

3. III AVP Audio/Video Performance:
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
4. IV CABL Cable Management, Termination, and Labeling:
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
   b. IV CABL: CABL 117
5. V CON Control Performance:
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
   b. V CON: CON-106 Verify that Programming Code is well documented with detailed comments throughout all code.
   c. V CON: CON-107 Verify that all programming modules are unlocked and editable by the customer.
   d. V CON: CON-108 Verify that Layouts and Source Code have been delivered and accepted.
6. VI ELEC Electrical:
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
7. VII IT Information Technology:
   a. Perform all A/V IT commissioning as specified in the InfoComm CAVSP Checklist.
   b. Coordinate with the telecommunications contractor to perform all IT commissioning as specified in Section 27 15 00.
8. VIII OP Operational:
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
9. IX PHYSE Physical Environment:
   a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
10. X PHYSI Physical Installation:
    a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
11. XI SERV Serviceability:
    a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
12. XII WL Wireless:
    a. Perform commissioning as specified in the InfoComm CAVSP Checklist.
    b. XII WL: WL-103 Verify that wireless microphone frequencies are laid out so as to avoid interference.
    c. XII WL: WL-104 Verify that Wireless IP network has adequate coverage for up to three devices per person in each space.
13. XIII DOC Documentation:
    a. Perform commissioning as specified in the InfoComm CAVSP Checklist, as well as the following items.
14. Perform the following commissioning tasks to ensure that the system is consistent with existing campus infrastructure:
    a. Verify that all classroom equipment layouts conform to documentation and existing systems in use
    b. Verify that all touch panel and button panel layouts conform to documentation and existing systems in use. Look and feel shall be similar, but positioning shall be in the exact locations.

D. All functions and features shall be verified operational. Configure, program, adjust, and tune equipment such that it will perform as required.

E. Replace underperforming or non-performing equipment and cables.

3.14 WARRANTY REGISTRATION

A. Contractor-provided warranties on labor and workmanship shall commence on the date that the system is accepted by the Owner. Acceptance does not necessarily mean the date of Owner occupancy or Substantial Completion, but rather the date that the Owner accepts the audio/visual

systems as complete and operational. Warranty documentation showing effective start date and coverage period shall be provided to the Owner immediately upon Owner acceptance.

B. Manufacturer Warranty Registration:
   1. Equipment managed under Owner's Accounts:
      a. All equipment manufactured by Crestron shall be registered by the Owner's representatives. The Contractor shall provide an electronic document listing the installed location, model numbers, and serial numbers for each Crestron device that has been installed.
   2. All other equipment:
      a. Submit equipment manufacturer warranty registration forms and online warranty registration to the equipment manufacturers on behalf of the Owner, providing the Owner's name and contact information.
      b. Coordinate with the Owner to obtain appropriate contact information for the forms and documentation.
      c. Provide PDF documentation (scanned completed forms, and printed online applications) to the Owner to demonstrate that warranty registration has been completed for all equipment.
      d. Provide an electronic document listing all equipment (installed location, manufacturers, model numbers and serial numbers) along with the warranty start dates and coverage period for each device.

C. Warranty Coverage Periods:
   1. Provide extended warranties with 5-year coverage periods for all projectors, video panels, control systems, audio/visual switchers/matrices, digital signal processors, and other major equipment.

3.15 DELIVERABLES

A. All deliverables shall be provided to the Owner prior to Audio/Visual System Acceptance and shall include but not be limited to:
   1. Manufacturer user manuals shall be delivered to UVU in a single binder as well as in PDF form on USB flash drive.
   2. Wireless licensing documentation.
   3. Video and Audio system test reports shall be delivered to UVU in digital PDF format.
   4. All programs and modules loaded on A/V systems shall be delivered to the Owner. Programs shall be editable and executable. The Owner shall retain the rights and ability to edit programs, modules, and layouts.
   5. All software licensing shall be loaded and certificates delivered to the Owner
   6. All as-built drawings indicating all A/V devices, device locations, mounting detailed wiring schematics, and labeling.

3.16 DEMONSTRATION AND TRAINING

A. Provide 4 hours of demonstration and training to Owner's Representatives.

B. Demonstrate operation of each space to the A/V Engineer and the Owner's Representatives.

APPENDIX – MODEL NUMBERS

The following table lists manufacturers, model numbers, part numbers and other relevant information for the materials specified in Part II above.

END OF SECTION