KU INFORMATION TECHNOLOGY
The University of Kansas

DIVISION 27

TELECOMMUNICATIONS SYSTEMS

TRACT

Division 27 governs the infrastructure for the low-voltage information transport systems (ITS), which include voice, data, wireless, CATV systems and their pathways for all University buildings and structures

DIVISON 27

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Revision Date: May 1st, 2022

+Division 27 Addendum 9-8-25

27 Telecommunications Systems

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27 00 00 - Communications

PART 1 - GENERAL

The University of Kansas, Information Technology (KU IT) is the responsible unit for low-voltage telecommunications design, design oversight, and installation at the University of Kansas (KU). This responsibility includes but is not limited to any and all KU property and structures including hand-holes, maintenance holes, pull-boxes, pedestals, and enclosures as well as both inside and outside plant installations (ISP & OSP).

The University of Kansas Division 27 Standard is intended to communicate the design and installation requirements for the Telecommunications Systems at KU. It has been written for Architects, Engineers and Designers who are responsible for the design of new or remodeled facilities for KU where telecommunications infrastructure currently exists or will be installed. It is also intended for low voltage Telecommunications Contractors (TC or Contractors) installing telecommunications infrastructure at KU. Architects, Engineers and Designers shall verify that all applicable portions of these standards are incorporated into each project's design drawings, specifications and final construction. Contractors shall verify that all applicable portions of these standards are incorporated into the project's final construction.

1.1 SUMMARY

A. Division 27 governs the infrastructure for the low-voltage information transport systems (ITS), which include voice, data, and CATV systems and their pathways.

B. Life of Standard

1. This standard represents the minimum acceptable requirements for voice, data, video, and other general information transport systems at The University of Kansas. This standard is a living document. The criteria in this standard are subject to revisions and updating as warranted by advances in building construction techniques and telecommunications technology.
2. This standard is NOT to be used as the final specification or bid document for any project. This standard is a starting point in a process of collaboration between architect/design engineer, the occupant and KU IT. It also serves as a minimum or best practice for installation.

C. Description of Work:

1. Contractor shall furnish and install materials for the communications infrastructure as specified herein and as shown on the drawings. Upon completion, the systems shall be functioning systems in compliance with performance requirements specified.
2. The cabling specified and shown on the drawings is for complete, performance based, workable systems. Deviations from the cabling shown due to a particular manufacturer's requirements shall be made only with the written approval of the Architect, Designer, and KU IT, and at no additional cost to KU.

3. Unless otherwise indicated in the scope of work, drawings, or specifications, the TC shall provide all material required for a complete system, including the installation and termination of telecommunications cabling, telecommunications work area outlets and the termination of all cabling in the Telecommunications Spaces. If any cabling installed by the TC lacks proper service loops, the TC shall replace the entire cable at no cost to KU IT. The TC shall provide all splicing and grounding and bonding hardware and material.
4. In the event the scope of work requires demolition of KU IT equipment or cabling, KU IT shall have the first right of refusal for any items removed during demolition. Network electronics or similar equipment shall be returned to the KU IT Warehouse. Cabling shall be returned to the KU IT Warehouse unless otherwise approved or noted.

1.2 RELEATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections of The University of Kansas Design and Construction Standards apply to this standard. Refer also to the following sections of The University of Kansas Design and Construction Standards:
   1. Division 01 – General Requirements
   2. Division 02 – Sitework
   3. Division 06 – Woods and Plastics
   4. Division 11 – Equipment
   5. Division 13 – Special Construction
   6. Division 14 – Conveying Systems
   7. Division 26 – Electrical
B. The following codes, associations, acts and agencies, as required by law:
   1. Americans with Disabilities Act (ADA)
   2. Federal Communications Commission (FCC)
   3. NFPA-70, 2017 (National Electric Code)
   4. National Electrical Safety Code (NESC)
   5. Occupational Safety and Health Administration (OSHA)
C. The current edition of the following standards:
   1. National Electrical Manufacturers Association (NEMA)
   2. TIA-568-C.0, TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-568-C.4
   3. TIA-569-C
   4. TIA-606-C
   5. J-STD-607
D. The current edition of the following guidelines:
   1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
   2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)
   3. BICSI, Outside Plant Design Reference Manual (OSPDRM)
   4. BICSI/NECA-568

5. BICSI/NECA-607

E. When a discrepancy arises between the above mentioned codes, standards or guidelines and the standards contained in this document, it shall be brought to the attention of KU IT immediately for resolution. The more stringent of the two guidelines shall be implemented.

1.3 DEFINITIONS

A. Advanced System Warranty – an extended telecommunications warranty (20 years or greater) held by either the connectivity or cabling manufacturer directly with the KU for a project that guarantees product and performance of the entire cabling system for the warranty period. Refer to Warranty Requirements in Quality Assurance sub-section of this standard for additional information and requirements.

B. Asbestos Containing Material (ACM) - any material containing more than one percent (1%) asbestos.

C. Backbone (Riser) Cabling – The cabling that connects multiple Telecommunications Rooms to each other, to the Equipment Room and/or to the Entrance Facility.

D. Communications Outlet (Work Area Outlet) – Any point of connectivity for voice, data, or video services at the users end. (i.e. work area, desk, etc.)

E. Communications Pathways – Conduits, cable trays or other supports with the sole purpose of carrying communications cabling. Communications pathways shall not be used by other low-voltage systems, including but not limited to: fire alarm, security systems, and or building automation wiring or air/vacuum tubes.

F. Conveniently Accessible – being capable of being reached from the floor or with the use of an 8-foot step ladder without climbing or crawling over or under obstacles such as motors, pumps, belt guards, transformers, piping and/or duct work.

G. Design Engineer – the company as defined for sections referring to telecommunications work only, the Design Engineer shall be the design consultant employed by KU or sub-contracted with an Architect hired by KU for the purpose of designing the telecommunications systems and observing the work of the Communications Subcontractor(s). The Design Engineer shall have a staff member assigned to the project who is a Registered Communications Distribution Designer (RCDD). See RCDD-of-Record. Refer to this standard for required qualifications of this individual.

H. Entrance Facility (telecommunications, EF) – An entrance to a building for both public and private network service cables (including wireless) including the entrance point of the building and continuing to the entrance room or space. The location where the main telecommunications service enters a building from the outside; where the demarcation between the inter-building and intra-building cabling system occurs.

I. Equipment Room (telecommunications, ER) – An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect. The location which provides space and maintains a suitable operating environment for large telecommunications equipment. This space may be co-located with

the Entrance Facility and/or Telecommunications Room, provided the room is sized for all functions.

J. Horizontal Cabling – The cabling between the Telecommunications Room and the Work Area that carries voice, data and/or video signals.

K. Horizontal Cross-connect (HC) – A cross-connect of horizontal cabling to other cabling, e.g. horizontal, backbone, equipment. A connection facility that is cabled between the equipment outlet and the intermediate cross-connect in a hierarchical star topology (e.g. Telecommunications Room).

L. Inside Plant (ISP) Cabling – Communications cabling and terminations primarily located inside the building footprint including, but not limited to copper and optical fiber cabling, splicing and terminations, and work related to their construction.

M. Inside Plant (ISP) Pathways – Communications pathways primarily located inside the building footprint including but not limited to conduits, j-hooks, cable trays, enclosures, equipment racks and cabinets, and work related to their construction.

N. Intermediate Cross-connect (IC) – An intermediate connection facility that is cabled to the Main Cross-connect. An intermediate cross-connect typically services as the Telecommunications Equipment Room for a building.

O. KU IT Representatives – For each project KU IT will designate official representatives, one (1) each from KU IT Network Construction Management and KU IT Telecommunications Engineering. Design related questions shall be directed to KU IT Telecommunications Engineer for clarification and/or approval.

P. Lead Telecommunications Installer – acting as the project manager for the Telecommunications Subcontractor for all telecommunications work in the construction documents (T-series drawings and Division 27 project specifications and/or KU IT Division 27 standards), who shall be on-site at all times will Division 27 work is being performed. This individual shall attend all construction project meetings. The Lead Telecommunications Installer and Project RCDD may be the same person, but not necessarily. Refer to this standard for required qualifications of this individual.

Q. Main Cross-connect (MC) – The central connection facility in a hierarchical star topology. The University of Kansas has two (2) Main Cross-connect facilities, one located in the Computer Center and the second located in the Ellsworth Hall Annex.

R. Nationally Recognized Testing Laboratory (NRTL) – a testing facility recognized by the Occupational Safety and Health Administration (OSHA) as primarily private sector organizations that provide product safety testing and certification services to manufacturers.

S. Outside Plant (OSP) Cabling – Communications cabling and terminations primarily located outside the building footprint including, but not limited to copper and optical fiber cabling, splicing and terminations, lightning and electrical protection, and work related to their construction.

T. Outside Plant (OSP) Pathways – Communications pathways primarily located outside the building footprint including but not limited to conduits, maintenance holes, s and work related to their construction.

U. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system. Assume all spaces above suspended or accessible ceilings are a plenum.

V. Plenum-rated – listed by the Underwriters Laboratory as being suitable for installation into a plenum space. Communications cabling routed through plenum-rated space shall be plenum-rated and identified as Type CMP.

W. Project RCDD – The Registered Communications Distribution Designer (RCDD) on staff of the Telecommunications Subcontractor responsible for ensuring all telecommunications work meets or exceeds the construction documents (T-series drawings and Division 27 project specifications and/or KU IT Division 27 Standards) and the referenced codes, standards and guidelines. Refer to this standard for required qualifications of this individual.

X. RCDD-of-Record – The Registered Communications Distribution Designer (RCDD) on staff of the design engineering firm responsible for the design of the telecommunications systems. See Design Engineer. Refer to this standard for required qualifications of this individual.

Y. Substantial Completion – The stage in the progress of the Work where the Work or designated portion is sufficiently complete and KU IT can utilize the Work for its intended use. The point during construction at which the contractor is ready to turn the project over to KU IT for acceptance and final punch list. KU IT must receive and approve optical fiber and copper test results before any project may be deemed substantially complete.

Z. Telecommunications Room (TR) –The location where the connection between the horizontal cabling and the building backbone cabling occurs. This room also contains the electronic equipment that transitions between the data, voice and video building backbone and the end user's telecommunications equipment. This space may be co-located with the Entrance Facility and/or Equipment Room, provided the room is sized for all functions.

AA. Telecommunications Space – An area or room dedicated for use for the telecommunications infrastructure and equipment (e.g. Entrance Facility, Equipment Room, Telecommunications Room, Maintenance Hole, and hand hole.

BB. Telecommunications Subcontractor – the company responsible for all telecommunications work in the construction documents (T-series drawings and Division 27 project specifications and/or KU IT Division 27 Standards).

CC. Wet Location – Installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

DD. Furnish – To supply and deliver to the project site ready for instruction. This includes supplying and delivering to project site, ready for unloading, unpacking, assembly, installation, and similar operations. Note: KU IT Warehouse shall be defined as project site for KU IT furnished items. It shall be the contractor's responsibility to pick KU IT furnished items up from the KU IT Warehouse.

EE. Install – To place in position for service or use. This includes operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

FF. Provide – Furnish and install, complete and ready for the intended use.

1.4 QUALITY ASSURANCE

A. Telecommunications Design Engineer / Consultant Qualifications

1. The Telecommunications Design Engineer/Consultant shall be from the KU IT Pre-qualified Telecommunications Design pool or shall be evaluated and pre-qualified by KU IT on a project-by-project basis. This is done to ensure that design engineers are capable and experienced in successfully designing telecommunications systems according to the standards set forth in this document as well as industry codes, standards and best practices.
2. Telecommunications Design Engineer Pre-Qualification Requirements
   a. The Telecommunications Design Engineer candidate shall provide their company name and contact person (name, phone and email).
   b. The Telecommunications Design Engineer candidate shall provide a copy of the current Registered Communications Distribution Designer (RCDD) certificate for the RCDD completing the design and stamping the project documents (RCDD-of-Record).
   c. The Telecommunications Design Engineer candidate shall provide a resume for the RCDD-of-Record that identifies work experience.
   d. The Telecommunications Design Engineer candidate shall provide supporting documentation that identifies a minimum of five (5) projects for which the RCDD-of-Record has completed similar work (size and complexity) within the last five (5) years. This documentation shall include at minimum, a brief description of the systems designed, structured cabling products specified, gross square footage of the facility, number of telecommunications rooms/spaces within the facility and a reference for each project (name and phone number).
3. KU IT requires that the 100% Telecommunications Contract Documents (100% CD T-series drawings) be approved and stamped by the RCDD-of-Record prior to submitting the drawings to DCM for review by KU IT.
4. The Telecommunications Designer Engineer shall coordinate with the department/customer who will occupy the facility being designed to determine work area outlet locations and activation requirements. The information gathered shall be provided to KU IT with the submittal of 100% CD documents. This information shall include at minimum the locations of voice, data, wireless and CATV which the occupant needs to have activated upon completion of the project. This information shall be provided to KU IT in a separate drawing schedule or preferably an Excel spreadsheet.

5. RCDD-of-Record Requirements
   a. RCDD-of-Record shall be a current Registered Communications Distribution Designer as awarded by BICSI from time of bid through project's substantial completion.
   b. RCDD-of-Record shall be a full-time employee of the Design Engineer.
6. The Telecommunications Designer Engineer shall coordinate the final inspection with the KU IT Telecommunications Engineer, giving them the option to participate in all or part of the final inspection. KU IT shall be notified a minimum of five (5) business days in advance of the final inspection to give ample time to make accommodations to participate if so desired.

B. Telecommunications Subcontractor Qualifications
1. Telecommunications Subcontractors (TCs) shall have total responsibility for the coordination and installation of the work shown and described in the telecommunications drawings and specifications. The Telecommunications Subcontractor shall be a company specializing in the design, fabrication and installation of integrated telecommunications systems. The Telecommunications Subcontractor shall be a CommScope SYSTIMAX Authorized Business Partner or Implementation Partner and trained to install all SYSTIMAX products. Additionally, the TC shall be from the KU IT Pre-qualified Telecommunications Installation Pool or shall be evaluated and pre-qualified by KU IT on a project-by-project basis. This is done to ensure that bidders are capable and experienced in successfully completing installation of the telecommunications systems specified. Project qualification must be completed prior to bid opening. Bids from non-qualified TCs will not be opened.
2. Telecommunications Subcontractor Pre-qualification Requirements
   a. The Telecommunications Subcontractor candidate shall have a Registered Communications Distribution Designer (RCDD) on staff and provide a copy of the current RCDD certificate for the RCDD who will serve as the Project RCDD.
   b. The Telecommunications Subcontractor candidate shall provide a minimum of five (5) references for which the TC has completed similar work (i.e. number of drops and cost) within the last five (5) years.
   c. The Telecommunications Subcontractor candidate shall be a CommScope SYSTIMAX Authorized Business Partner or Implementation Partner and be certified and trained to install all Systimax products.
   d. The Telecommunications Subcontractor candidate shall certify in writing and provide supporting documentation to support that the Lead Telecommunication Installer is BICSI ITS Technician Certified and has a minimum of five (5) years of experience installing similar telecommunications structured cabling systems.
   e. If the scope of work requires outside cable plant installation (conduits and/or cabling), the contractor performing these tasks shall have five (5) years' experience and provide five (5) references for which the contractor has completed similar work within the last five (5) years.

3. Telecommunications Subcontractors involved in projects without a formal engineering and design process shall be fluent with and adhere to the requirements of this document and the codes, standards and guidelines referenced by this document.
4. The Telecommunications Subcontractor shall consistently demonstrate exceptional craftsmanship, communication, and professional integrity along with the items mentioned above to maintain their KU IT pre-qualified status. Failure to maintain the qualification requirements will result in removal from pre-qualification status.
5. The Telecommunications Subcontractor shall comply with all manufacturers recommended installation instructions/procedures for all installations unless otherwise noted in the scope of work, drawings or specifications.
6. The Telecommunications Subcontractor shall inspect each item, material or piece of equipment, upon receipt, prior to installation and reject damaged and defective items.
7. Project RCDD Requirements
   a. Project RCDD shall be a current Registered Communications Distribution Designer as awarded by BICSI from time of bid through project's substantial completion.
   b. Project RCDD shall be a full-time employee of the Telecommunications Subcontractor.
   c. Submit a copy of RCDD certificate with bid package.

8. Lead Telecommunications Installer Requirements
   a. Lead Telecommunications Installer shall be a current ITS Technician as awarded by BICSI from the time of bid through project's substantial completion.
   b. Submit a certificate of ITS Technician with bid package.
   c. Lead Telecommunications Installer shall be on-site at all times when Division 27 work is being completed.
   d. Lead Telecommunications Installer shall have an OSHA 30-hour Construction Card as evidence of completing an OSHA approved 30-hour training program. Submit a copy of the Lead Telecommunications Installer OSHA 30-hour Construction Card with bid.
9. General Telecommunications Installer Requirements
   a. For all work associated with Division 27, all installers are to have a minimum of BICSI ITS Installer 1 Training.
   b. Submit with bid package a list of names of all installers and appropriate copies of certificates verifying training.
   c. Advanced training from connectivity manufacturer may be submitted in lieu of BICSI ITS Installer 1 training. Submit manufacturer-training certificates for review by KU IT as substitution request as part of Pre-Bid questions. This training must be by the same manufacturer that will hold the Advanced System Warranty.
   d. General Telecommunications Installers shall have an OSHA 10-hour Construction Card as evidence of completing an OSHA approved 10-hour training program.

Submit a copy the OSHA 10-hour Construction Card for each individual on the list described above in item 9b.

C. Warranty Requirements
   1. Project Warranty
      a. Equipment and materials required for installation under these standards shall be the current model and new (less than one (1) year from date of manufacture), unused and without blemish or defect, and are to be guaranteed to be free from defect for a minimum of one (1) year from the date of project's substantial completion.
      b. When a defect or problem is observed within the first year after substantial completion, KU IT will notify the governing subcontractor through the proper channels. The appropriate subcontractor then will have 48 hours to fix the defect or furnish and install a replacement part/system, all at no cost to the project or KU.
   2. Advanced System Warranty
      a. An Advanced System Warranty shall be provided for all new buildings and major renovations which require significant rewiring or rework of the Structured Cabling Systems (SCS). This Warranty shall be the SYSTIMAX Network Infrastructure Solution 20-Year Extended Product Warranty and Application Assurance unless noted otherwise. KU IT Representative shall determine on a project-by-project basis whether an Advanced System Warranty will be required. This shall be disclosed in the bid documents prior to bid to allow Contractors to plan appropriately.
      b. SCS will be covered by a two-part certification program provided by a single manufacturer and that manufacturer's certified contractor/vendor. The Manufacturer shall administer a follow on program through the Contractor to provide support and service to KU. The first part is an assurance program, which provides that the certified system will support the applications for which it is designed, during the 20-year warranty of the certified system.
      c. The second portion of the certification is a 20-year warranty provided by the manufacturer and the vendor on all products within the system (cords, telecommunications outlet/connectors, cables, cross-connect, patch panels, etc.).
      d. In the event that the certified system ceases to support the certified application(s), whether at the time of cutover, during normal use or when upgrading, the manufacturer and vendor shall commit to promptly implement corrective action.
      e. Documentation proving the cabling system's compliance to the End-to-End Link Performance recommendations, as listed in ANSI TIA-568-C shall be provided by the Vendor prior to the SCS being installed.
      f. The cabling system must conform to the current issue of industry standard ANSI/TIA-568. All performance requirements of this document must be followed. As well, workmanship and installation methods used shall be equal to or better than that found in the BICSI (Building Industry Consulting Service International) ITSIM manual.

g. The warranty shall cover both material and labor for the full length of the warranty period.

1.5 COORDINATION

A. When articles, materials, operations or methods related to execution of communications work are noted, specified, or described in the specification or are indicated or reasonably implied on drawings and schedules, execute work as required or appropriate to provide complete and proper function, operation and installation.

B. The drawings utilize symbols and schematic diagrams to indicate items of work. These symbols and diagrams will not typically identify dimensions nor will they identify inclusion of specific accessories, appurtenances and related items necessary and appropriate for a complete and proper installation and operation. The Telecommunications Subcontractor shall install work complete and ready for proper operation, including related items not specifically identified, shown, indicated or expressed on the drawings, and in conformity with the dimensions indicated on architectural drawings and on shop drawings approved by the Design Engineers.

C. The drawings include details for various items, which are specific with regard to the dimensions and positioning of work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the Telecommunications Subcontractor.

D. The drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions.

1.6 EXISTING CONDITIONS

A. Prior to bid, Telecommunications Subcontractor is to visit the existing building and evaluate all existing conditions. Bring to the attention of KU IT and Design Team any cause for concern or conflicts with the contract documents as soon as practically possible.

1.7 SUBMITTALS

A. General Requirements

1. Provide Submittals in accordance with Division 01.
2. RCDD-of-Record and/or KU IT Representatives are to review and accept all submittals for work related to Division 27. This review includes, but is not limited to, relevant:
   a. Pre-bid questions
   b. Contractor and personnel qualifications with bid
   c. Voluntary alternates and unit pricings with bid
   d. Pre-construction product submittals and shop drawings
   e. Change order requests, requests for information (RFIs), design change directives (DCDs), and other changes as directed by the architect/engineer.
   f. Record drawings and warranty certificates/letters

3. Please allow a minimum of five (5) business days for the RCDD-of-Record/KU IT Representatives to review once delivered to the respective individual(s).

B. The following submittals are due at the Pre-Bid deadline for questions:
   1. Questions related to the drawings, specifications or design intent.
   2. Requests for product substitution.
      a. All products seeking approval either as "approved equivalent" or otherwise, shall be submitted as a product substitution request prior to bid. See form in appendix for KU IT projects. Failure to submit product substitution request in a timely manner (before pre-bid questions are due) may preclude product from being utilized on the project. Requests made with bid or post-bid will not be considered without a significant cost savings realized to KU.
      b. The burden of proof is on the contractor to provide documentation that equivalent product meets the specifications and project requirements. Include in the substitution request:
         i. Product being replaced
         ii. Reason for product substitution
         iii. Full manufacturer specification sheet clearly indicating that all requirements in project documents and/or this standard have been met.
      c. Failure to meet these requirements will result in the product substitution request being returned without review.
      d. All product substitution requests are to be reviewed and approved by the KU IT Representatives. Not all requests will be approved, and all decisions are final, without recourse.

C. The following submittals are due with the Bid:
   1. Proof of Telecommunications Subcontractor and personnel qualifications.
      a. Provide a typed list with the following information:
         i. Company name of Telecommunications Subcontractor
         ii. Proof of Bonding
         iii. Proof of Insurance
         iv. List of connectivity or cabling manufacturers that the Telecommunications Subcontractor is certified to install AND provide Advanced System Warranty.
         v. List of previous projects (minimum 5) of this scope and nature, including:
            (a) Project name and date of completion
            (b) Project size (square feet of building, total construction cost, total cost of telecommunications scope)
            (c) Name and contact information for building owner or IT Manager.
         vi. Name, contact information and a current BICSI RCDD Certificate for the Project RCDD.
         vii. Name, contact information and a current BICSI ITS Technician Certificate for Lead Telecommunications Installer, the de facto project manager on-site at all

times. (This may be the same person as the Project RCDD). Current copy of OSHA 30 Construction Card for Lead Telecommunications Installer.

viii. List of names and current BICSI ITS Installer 1, ITS Installer 2 Copper, ITS Installer 2 Fiber certificates for on-site Telecommunications Installation Personnel. Manufacturer advance training certificates may be submitted for approvals as a substitution for the BICSI ITS Installer certification requirements. Current copy of OSHA 10 Construction Card for each Telecommunications Installer.

(a) Provide certificates or letters from BICSI and manufacturers verifying by name these qualifications have been met.

(b) Refer to Quality Assurance subsection in this standard for additional requirements and qualifications.

2. Voluntary alternatives (that realize substantial cost savings)
3. Unit pricing for the following items:
   a. Cost to add typical telecommunications work area outlet (with two (2) cable drops) anywhere within the project/building footprint. This cost shall include electrical rough-in, cabling, faceplate, and modules at both ends for a complete and functioning outlet.

PART 2 – PRODUCTS

2.1 GENERAL

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

B. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer and part number.

C. All products and materials shall be new and unused prior to their installation as part of this project. Refurbished items are not allowed.

D. All products and materials shall be selected to allow for future growth. Examples: Conduits and cable trays shall be sized to allow for a minimum of 25% growth. Patch Panels shall be sized to allow for a minimum of 25% growth.

PART 3 – EXECUTION

3.1 RCDD-OF-RECORD

A. At a minimum, RCDD-of-Record shall at minimum perform the following inspections during construction to ensure the telecommunications installation meets the requirements and recommendations in the reference codes, standards, and guidelines. Refer to 3.4.F.4 below for further detail on these inspections.

1. Electrical Rough-in Complete; Electrical Rough-in Re-inspection(s) when scheduled;
2. Above Ceiling Inspection; Above-ceiling Re-inspection(s) when scheduled;
3. Final Inspection; Final Re-inspection(s) when scheduled.

B. The RCDD-of Record shall invite the Project RCDD and KU IT Representatives to each of these inspections.
C. Should any disparity be discovered by the RCDD-of-Record, Project RCDD, or KU IT Representative, contractor shall make necessary corrections without cost or time change to the project.
D. KU IT Representatives must be notified a minimum of five (5) business days prior of the occurrence and timing of inspections and/or punch lists to be able to provide timely input into the construction process.

3.2 PROJECT RCDD

A. At a minimum, Project RCDD shall participate in RCDD-of-Record inspections during construction.

3.3 GENERAL DESIGN REQUIREMENTS

A. General Design Engineer Drawing Requirements
   1. The Telecommunications Design Engineer contracted to create the Telecommunications System drawings and specifications shall comply with the requirements set forth in this standard, industry codes and standards, industry best practices, as well as The University of Kansas Design and Construction Standards.
   2. The drawings for the systems described in these standards shall be broken out from all other disciplines as “T-series” drawings.
   3. A complete set of project drawings shall be provided to the KU IT Representatives for design review following each design phase. Allow for the following lengths of time for KU IT to review design packages:
      a. Schematic Design – Five (5) business days
      b. Design Development – Eight (8) business days
      c. Contract Documents – Ten (10) business days
   4. The Telecommunications (T-Series) drawing set shall include the following at minimum:
      a. Cover Sheet
      b. Sheet List
      c. Site Map
      d. Symbol Schedule
      e. List of Abbreviations
      f. Plan Sheets
      g. Enlarged Plan Sheets (ERs, TRs, etc.)
      h. Rack and Wall Elevation Elevations
      i. Schematic/One-line/Riser Diagrams
      j. Typical Details
         1. Voice/Data Outlet Mounting Details
      k. Demolition

5. All plan sheets shall be scaled, shall indicate the scale and shall show a north arrow. All plan sheets shall show a key plan when the building or site is too large to fit on a single sheet.
6. Telecommunications infrastructure identifiers shall be shown on the drawings and diagrams.
7. The Designer shall coordinate equipment needs with KU IT during design to help determine electrical loads, UPS sizing and mechanical loads. Designer shall coordinate the electrical and mechanical loads with the appropriate Design engineers as early in the design process as possible.

B. The 100% Concept Design package shall include at minimum the following:
   1. Overall Floor Plans showing proposed telecommunications space locations and dimensions.

C. The 100% Schematic Design (SD) package shall include all items included in the 100% Concept Design package and at minimum the following:
   1. Overall Floor Plans showing proposed telecommunications space locations and dimensions as well as major raceways such as cable tray and/or conduits interconnecting telecommunications spaces horizontally and vertically.
   2. An enlarged room plan of the Telecommunications Equipment Room detailing:
      a. Proposed equipment rack locations
      b. Proposed telecommunications wall fields or wall equipment locations
   3. An enlarged room plan for a Typical Telecommunications Room detailing:
      a. Proposed equipment rack locations
      b. Proposed telecommunications wall fields or wall equipment locations
   4. A telecommunications cabling one-line/riser diagram detailing:
      a. Proposed multi-pair copper riser cable type and pair counts
      b. Proposed optical fiber riser cable type and strand counts
   5. An outline of specification sections related to the telecommunications infrastructure which will be issued for the project.

D. The 100% Design Development (DD) package shall at minimum include all items included in the 100% Schematic Design package and at minimum the following:
   1. Cover Sheet which shall include:
      a. Symbol Legend
      b. List of Abbreviations
      c. Outlet Mounting Height Information
      d. Drawing Index
   2. Plans which shall include:
      a. Telecommunications Outlet Locations
      b. Major Communication System Pathways
      c. Cable Tray – should be drawn on plans to scale.
      d. J-hook Pathways – major J-hook pathways shall be shown on plans.
      e. Conduits – 2-inches or larger shall be shown on plans.

f. Sleeves/Penetrations – 2-inches or larger shall be shown on plans.
g. Telecommunications Spaces – provide at minimum an outline around the entrance facility, equipment room, and telecommunications rooms and reference to enlarged room plans.

3. Risers/One-line Diagrams which shall include:
   a. Pathway Riser – show conduit's or sleeves required to connect telecommunications spaces. Provide information on conduit/sleeve size and quantities.
   b. Cabling Riser – show copper, optical fiber, and coaxial backbone cabling required to connect telecommunications spaces. Provide detail on cable types, strand/pair counts, and cable quantities.
   c. Grounding/Bonding Riser Diagram – show PBB location, SBB locations and TBB cabling connections. Provide information on Telecommunications Bonding Backbone conductor(s) size and quantities, Grounding Equalizer size and quantities, and Bonding Conductor for Telecommunications conductor size detailing tie to ac power system.
4. Enlarged Telecommunication Space Plans which shall include:
   a. Enlarged Plan shall be at minimum 1/4" = 1'-0" scale. Enlarged plan shall include:
   b. Equipment Racks locations and working clearances.
   c. Ground Bus Bar location.
   d. Cable Tray size and locations.
   e. Communications Equipment which will need wall space shown in plan view.
5. Equipment Rack Elevations which shall include:
   a. Optical Fiber Housings.
   b. Patch Panels.
   c. Cable Management.
   d. Network Equipment.
   e. Uninterruptable Power Supply.
   f. Other Communications Equipment which will need rack space.
6. A draft copy of all specification sections related to the telecommunications infrastructure.

E. The 100% Construction Document (CD) drawings shall at minimum include the following sheet(s) and details:
   1. Cover Sheet which shall include:
   2. Symbol Legend
   3. List of Abbreviations
   4. Outlet Mounting Height Information
   5. Drawing Index
   6. Plans which shall include:
      a. Telecommunications Outlet Locations and Labels
      b. Major Communication System Pathways
      c. Cable Tray – should be drawn on plans to scale.

d. J-hook Pathways – major J-hook pathways shall be shown on plans.
e. Conduits – 2-inches or larger shall be shown on plans.
f. Sleeves/Penetrations – 2-inches or larger shall be shown on plans.
g. Fire Wall Penetrations – provide reference to detail showing fire-stopping system which shall be required for penetration.
h. Telecommunications Spaces – provide at minimum an outline around the entrance facility, equipment room, and telecommunications rooms and reference to enlarged room plans.

7. Risers/One-line Diagrams which shall include:
   a. Pathway Riser – show conduit's or sleeves required to connect telecommunications spaces. Provide information on conduit/sleeve size and quantities.
   b. Cabling Riser – show copper, optical fiber, and coaxial backbone cabling required to connect telecommunications spaces. Provide detail on cable types, strand/pair counts, and cable quantities.
   c. Grounding/Bonding Riser Diagram – show PBB location, SBB locations and TBB cabling connections. Provide information on Telecommunications Bonding Backbone conductor(s) size and quantities, Grounding Equalizer size and quantities, and Bonding Conductor for Telecommunications conductor size detailing tie to ac power system.
8. Enlarged Telecommunication Space Plans which shall include:
   a. Enlarged Plan shall be at minimum 1/4" = 1'-0" scale. Enlarged plan shall include:
   b. Equipment Racks locations and working clearances.
   c. Ground Bus Bar location.
   d. Cable Tray size and locations.
   e. Wall Elevations which shall include:
   f. Equipment Rack locations when applicable.
   g. Communications Block Field Layouts.
   h. Other Communications Equipment which will need wall space.
9. Equipment Rack Elevations which shall include:
   a. Optical Fiber Housings.
   b. Patch Panels.
   c. Cable Management.
   d. Network Equipment.
   e. Uninterruptable Power Supply.
   f. Other Communications Equipment which will need rack space.
10. Details which shall include:
   a. Typical communications outlet detail.
   b. Labeling details.
   c. Block field layout details.
   d. Fire-stopping details.
   e. Other typical details as required to further clarify drawings.

11. Schedules which shall include:
    a. Activation Schedule as gathered by the Telecom Consultant.
12. Final Specifications for all sections related to the telecommunications infrastructure.

F. Outside Plant Telecommunications Site Plan Drawings
1. For projects which include outside plant cabling or infrastructure, provide drawings showing a scaled telecommunications distribution site plan. These drawings shall include the following:
    a. Maintenance Hole or locations labeled with their identifiers.
    b. Maintenance Hole or butterfly diagram detailing racking and duct entrance locations.
    c. Complete duct bank routing, details, and elevations.
    d. Conduit sizes, quantities, and arrangements.
    e. Section cuts
    f. Existing and new surface conditions
    g. Outside plant copper telecommunications cabling, including pair counts
    h. Outside plant optical fiber telecommunications cabling, including optical fiber type and strand counts
    i. Locations of buildings, roads, poles, existing underground utilities and other obstructions.
2. These sheets should also identify coordination arrangements where conflicts with site work for other disciplines could possibly arise, in particular indicating the separation distances between telecommunications and power or water. The sequencing of site work also should be shown, if applicable.
3. The site plan shall show the cabling from the service providers and shall indicate the requirements for owner-provided maintenance holes or s and pathway to the point of demarcation.

3.4 GENERAL CONSTRUCTION

A. Coordinate with all other trades prior to installation.
1. Telecommunications Subcontractor shall meet with Electrical and General Contractors prior to construction to identify pathway and infrastructure space requirements.
    a. At a minimum, the following items shall be discussed:
        1. Cable tray locations and clearance space above (12-inches if possible, with proper coordination)
    b. Failure to coordinate sufficient space for telecommunications shall result in relocation of various systems by the contractor at no additional cost to KU IT.
2. Prior to the start of work, the Telecommunications Subcontractors shall carefully inspect the installed work of other trades and verify that such work is complete to the point where Division 27 work may properly commence. Start of work indicates acceptance of conditions.

3. Coordinate location of equipment and conduit with other trades to minimize interference.
    a. Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base building. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the Design Engineer as required by limited working space.
    b. Holes shall be located so as not to affect structural sections such as ribs, beams or tensioning cables.
    c. Holes shall be laid out in advance. The Design Engineer shall be advised prior to drilling through structural sections, for determination of proper layout.
    d. Structural Penetrations: Where conduits, cable tray and other raceways pass through fire partitions, fire walls or walls and floors, provide an effective barrier against the spread of fire, smoke and gases.

B. Follow all manufacturers' instructions and install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.
    1. In the event of discrepancy, immediately notify the Design Engineer through the proper channels. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

C. Protection of Systems and Equipment
    1. Asbestos Survey: Prior to the disturbance of any building materials, construction personnel must know the results of an asbestos survey. Coordinate with The University of Kansas Department of Environmental Health and Safety (EHS).
    2. Lead Survey: Prior to the disturbance of any building materials, construction personnel must know the results of a lead survey. Coordinate with The University of Kansas Department of Environmental Health and Safety (EHS).
    3. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.
    4. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on sides with securely fastened protective rigid or flexible waterproof coverings.
    5. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum-cleaned both inside (as appropriate) and outside before testing, operating or painting.
    6. As determined by the Design Engineer, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Design Engineer shall be final.
    7. Painted surfaces shall be protected with removable heavy Kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.

8. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer.

D. Access to Equipment
1. Equipment shall be installed in a location and manner that will allow convenient access for maintenance and inspection.
2. Working spaces shall not be less than specified in the NEC for voltages specified.
3. Where the Design Engineer determines that the Telecommunications Subcontractor has installed equipment in a manner that is not "conveniently accessible" for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the Design Engineer, at no additional cost to KU.

E. Cleaning
1. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by communications work.
2. Remove dust and debris from interiors and exteriors of telecommunications equipment (including electrical rough-in). Clean accessible current carrying equipment prior to being energized.
3. The Telecommunications Subcontractor shall remove, on a daily basis, all debris in associated work areas left as a result of the installation of the telecommunications systems. Where communication equipment and related materials are installed in new, existing or renovated KU IT telecommunications Rooms or other affected spaces, remove all communication related construction debris, cable scrap and accumulated dust from the floor and surfaces of the newly installed communication equipment, materials and rooms of the building.

F. Completion
1. General:
   a. Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.
2. Results Expected:
   a. Systems shall be complete and operational and controls shall be set and calibrated.
   b. Testing, start-up and cleaning work shall be complete.
   c. Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Standard shall be delivered to KU IT.
3. Testing and Verification – General Requirements
   a. Refer to individual sections for additional testing and verification requirements.
   b. The Telecommunications Subcontractor shall verify that requirements of the Standard are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.
   c. Verification by Inspection: Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the specifications. Inspection may require moving or partially

disassembling the item to accomplish the verification, included as part of the work at no additional cost to the Owner.

d. Verification by Test and Demonstration: The Telecommunications Subcontractors shall verify by formal demonstrations or tests that the requirements of this Standard and the specifications have been met. The Telecommunications Subcontractor shall demonstrate that the communications systems components and subsystems meet specification requirements in the "as-installed" operating environment during the "System Operation Test". Even though no formal environmental testing is required, the communications Subcontractor shall measure and record temperature, humidity and other environmental parameters and the environmental conditions, which were encountered during the "System Operation Test".

e. Perform commissioning and pretest prior to enclosure of walls.

f. Perform system operation tests after full enclosure of walls.

4. Commissioning

a. Commissioning of the telecommunications systems is to be completed by the Design Engineer for each system.

b. There shall be three (3) phases of commissioning:

1. Rough-in inspection
2. Above-ceiling inspection (after cables are placed)
3. Final Inspection

c. Once electrical rough-in and pathways have been installed, but prior to walls and ceilings being installed, contractor shall request of the design team, in writing, for the official rough-in inspection to take place. The Design Engineer shall then schedule a time to be on-site to conduct this inspection; the Design Engineer shall also invite the KU IT Representatives to attend this inspection. If the KU IT Representatives are unavailable at that time, they may request another KU IT employee attend in their place.

1. At a minimum, the Design Engineer shall check the following items:

a) Accurate location and height above finished floor for all outlet boxes.
b) Accurate dimensions (particularly depth) of all outlet boxes and diameter of in-wall conduit serving outlet boxes.
c) Cable tray size, location, and clearance.
d) Location and size of all other communications conduits or pathways.
e) That power receptacles within the communications rooms meet the design standards.

2. The Design Engineer is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the Telecommunications Subcontractor and all items are to be addressed. This report is not necessarily all-inclusive; should issues be discovered later in the project, the Telecommunications Subcontractor is still responsible for corrections/repairs.

d. Once all communication cabling has been installed and properly supported and walls have been painted, but prior to the installation of ceiling tiles/material, contractor shall request of the design team, in writing, for the official above-ceiling inspection. The Design Engineer shall then schedule a time to be on-site to conduct this inspection; the Design Engineer shall also invite the KU IT Representatives to attend this inspection. If the KU IT Representatives are unavailable at that time, they may request another KU IT employee attend in their place.
    1. At a minimum, the Design Engineer shall check the following items:
        a) That all items from the previous inspection have been corrected.
        b) That communications cabling is routed correctly and adequately supported.
        c) That communications cabling is not painted or over sprayed.
        d) That the installed communications cabling matches what was specified/submitted.
        e) That there are no kinks, splices, or other damage to the installed communications cabling.
    2. The Design Engineer is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the Telecommunications Subcontractor and all items are to be addressed. This report is not necessarily all-inclusive; should issues be discovered later in the project, the Telecommunications Subcontractor is still responsible for corrections/repairs.

e. Once all communications work has been completed, contractor shall request of the design team, in writing, for the official final inspection. This request shall be made three (3) weeks before substantial completion. The Design Engineer shall then schedule a time to be on-site to conduct this inspection; the Design Engineer shall also invite the KU IT Representatives to attend this inspection. If the KU IT Representatives are unavailable at that time, they may request another KU IT employee attend in their place.
    1. At a minimum, the Design Engineer shall check the following items:
        a) That all items from the previous inspections have been corrected.
        b) That all faceplates are installed, with the correct modules, quantity of modules, and approved labeling scheme.
        c) That all equipment and cabling within communications rooms is installed per the contract documents, including all patch panels and wall blocks (with specified spare capacity), horizontal and backbone cabling labeling, and telecommunications grounding.
        d) And all other items necessary to guarantee contract documents are met and complete and functioning communications systems are installed.
    2. The Design Engineer is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the Telecommunications Subcontractor and all

items are to be addressed prior to substantial completion. This report is not necessarily all-inclusive; should issues be discovered within one year after substantial completion, the Telecommunications subcontractor is still responsible for corrections/repairs.

END OF SECTION 27 00 00

27 05 26 – Grounding and Bonding for Communications Systems

PART 1 – GENERAL

1.1 SUMMARY

A. Grounding and bonding systems are an integral part of the signal or telecommunications cabling system. In addition to helping protect personnel and equipment from hazardous voltages, a proper grounding and bonding system will improve the electromagnetic compatibility performance of the cabling system. Improper grounding and bonding can allow induced voltages and conducted noise, which can disrupt signal transmission. The telecommunications grounding and bonding system shall conform to local codes and J-STD-607-B requirements.

B. Description of work:

1. Furnish and install a complete and fully-functioning grounding and bonding system. All cables, terminations, support hardware, and grounding and bonding hardware shall be furnished, installed, tested, labeled, and documented by the telecommunications subcontractor.

a. Coordinate with electrical contractor including pathways, termination points, busbar locations, and connections to the main electrical service ground and electrical distribution panels.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 270000 “Communications” including all referenced codes, standards and guidelines.

1.3 DEFINITIONS

A. BCT: Bonding Conductor for Telecommunications. A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground.

B. Bonding: The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

C. EMT: Electrical metallic tubing.

D. GE: Grounding equalizer. The conductor that interconnects elements of the telecommunications grounding infrastructure. For example, a bonding conductor that interconnects SBBs on the same floor.

E. Ground: A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

F. RGC: Rack Bonding Conductor. A bonding conductor used to connect an equipment rack directly to the PBB or SBB.
G. RBB: Rack Bonding Busbar. A busbar that is vertically mounted on an equipment rack.
H. TBB: Telecommunications bonding backbone. A conductor that interconnects the telecommunications main grounding busbar (PBB) to the telecommunications grounding busbar (SBB) located on the floor farthest away.
A. SBB: Telecommunications grounding busbar. A common point of connect for telecommunication systems and equipment bonding to ground and located in the telecommunications rooms (TR) and equipment room (ER).
B. PBB: Telecommunications main grounding busbar. A busbar placed in a convenient and accessible location and bonded, by means of the BCT, to the building ac service equipment (power) ground.

1.4 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 270000 “Communications”:
   1. Product Information
      a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
      b. Provide manufacturer’s product information cut-sheet or specifications sheet with the specific product number identified.
   2. Shop Drawings
      a. Provide scaled drawings (floor plans not less than 1/16” = 1’-0”) indicating the location and size, dimensions, type of connection (e.g. mechanical, exothermic weld of each bonding busbar (e.g., PBB,SBB), conductor (e.g., BCT, GE, TBB), connections (e.g., lugs), and splice points.
      b. Provide scaled plan and elevation drawings of telecommunications rooms (not less than 1/4” = 1’-0”) indicating locations of busbars (e.g. PBB, SBB, RBB).
      c. Bonding and Grounding shall have its own separate drawing(s).
B. The following submittals are due at the Post-Construction Phase, in accordance with submittal requirements in Section 270000 “Communications”:
   1. Record Drawings
      a. Provide scaled drawings (floor plans not less than 1/16” = 1’-0”) indicating actual location and size/length of PBB, SBBs, BCT, GE and TBB conductors and all splice points.
      b. Provide scaled plan and elevation drawings of telecommunications rooms (not less than 1/4” = 1’-0”) indicating actual locations of PBB and SBBs.
      c. Bonding and Grounding shall have its own separate drawing(s).Provide manufacturer’s product information cut-sheet or specifications sheet with the specific product number identified.

2. A letter from the contractors Project RCDD stating that the grounding system has been installed in accordance with the project documents and the referenced codes, standards, and guidelines. This letter is to also specifically acknowledge that the telecommunications grounding system has been fully tested according to these specifications.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
   2. Field Inspector: Currently registered by BICSI as a Registered Communications Distribution Designer (RCDD) to perform the on-site inspection

PART 2 – PRODUCTS

2.1 GENERAL

A. All components shall be Listed by a NRTL.
B. Telecommunications grounding systems at the University of Kansas shall conform to J-STD-607-B and the following guidelines, whichever is more stringent.

2.2 CONDUCTORS

A. Conductors shall be copper. Bare and insulated conductors are permitted. The NEC specifies criteria for mechanical protection.
B. Conductors shall comply with UL 486A-486B.
C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
   1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
   2. Cable Tray Equipment Grounding Wire: No. 6 AWG
D. Cable Tray Grounding Jumper:
   1. Not smaller than No. 6 AWG and no longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.
E. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.
   4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor

6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 COMPRESSION LUGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following or an approved equal:
   1. Harger Lightning and Grounding
   2. Hubbell
B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
C. Compression Type
D. Two holes with various hole spacing's to fit the busbar.
E. Long barrel that will allow a minimum of two crimps with standard industry colors.
F. An inspection window to verify that the conductor is fully seated in the lug.
G. Crimped according to manufacturer's recommendation.

2.4 TAPS

A. Manufacturers: Subject to compliance with requirements, provide products by the following or an approved equal:
   1. Harger Lightning and Grounding
   2. Hubbell
B. Connections to the conductor shall be made with irreversible compression connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
C. Shall be able to accept 6 AWG to 3/0.
D. Shall require a minimum of two (2) crimps for C Tap and H Tap, one (1) crimp for I-Beam and busbar Tap.
E. Crimp according to manufacturer's recommendation.
F. C Tap
   1. Main Run 6-4 AWG - Tap 6 AWG
      a. Hubbell Part Number HYC4C6
   2. Main Run 6-4 AWG – Tap 4 AWG
      a. Hubbell Part Number HYC4C4
   3. Main Run 2 AWG – Tap 8-4 AWG
      a. Hubbell Part Number HYC2C4
   4. Main Run 2 AWG – Tap 2 AWG
      a. Hubbell Part Number HYC2C2
   5. Main Run 1/0-2/0 AWG – Tap 8-2 AWG
      a. Hubbell Part Number HYC26C2

6. Main Run 1/0-2/0 AWG – Tap 1/0-2/0 AWG
   a. Hubbell Part Number HYC26C26

G. H Tap
1. Main Run 4/0-2 AWG - Tap 2-8 AWG
   a. Hubbell Part Number HYH292C
2. Main Run 2-8 AWG – Tap 2-8 AWG
   a. Hubbell Part Number HYH2C2C
3. Main Run 6-10 AWG – Tap 6 AWG
   a. Hubbell Part Number HYH6C6C

H. Busbar Tap
1. Busbar thickness 0.25”, Main Run 2 AWG - Tap 6 AWG
   a. Hubbell Part Number HYG14B2TC2C6C
2. Busbar thickness 0.25”, Main Run 2 AWG – Tap 2 AWG
   a. Hubbell Part Number HYG14B2TC2C2C
3. Busbar thickness 0.25”, Main Run 4/0 – 1/0 AWG
   a. Hubbell Part Number HYGBTC28

2.5 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, provide products by the following or an approved equal:
1. Harger Lightning and Grounding.
2. Hubbell

B. PBB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4-inch by 4- inches in cross section and at minimum 20-inches long. Increase length as necessary to provide all connections with 25% spare capacity. The busbar shall be NRTL listed for use as PBB and shall comply with J-STD-607-B (Harger P/N GBI14420TMGBKT or equal).
1. A PBB shall be provided at the telecommunications service entrance (or as indicated on the drawings).
2. Predrilling shall be with holes for use with lugs specified in this section.
3. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
4. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for us in 600-V switchboards, impulse tested at 5000V.

C. SBB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4-inch by 2-inches in cross section and at minimum 12-inches long. Increase length as necessary to provide all connections with 25% spare capacity. The busbar shall be NRTL listed for use as SBB and shall comply with J-STD-607-B (Harger P/N GBI14212TGBKT or equal).
1. A SBB shall be provided in each telecommunications room.
2. Predrilling shall be with holes for use with lugs specified in this section.
3. Mounting Hardware: Stand-off brackets that provide a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.

4. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for us in 600-V switchboards, impulse tested at 5000V.

D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-B. Predrilling shall be with holes for use with lugs specified in this section.

1. Rack-Mounted Vertical Busbar: Minimum 36-inches long with stainless-steel or copper plated hardware for attachment to the rack.

2.6 GROUND RODS

A. Ground Rods: Copper-clad Stainless-steel; 3/4 inch in diameter by 10 feet in length minimum.

2.7 LADDER RACK BONDING CONDUCTORS

A. Ground cord assembly
1. Stranded THHN
2. Color: green
3. #6 AWG insulated bonding jumper
4. Length: 9” - 12”.
5. Each end terminated with a two hole compression lug or listing approved terminal
6. Hubbell Part Number HGRKTD12D, HGRKTKA9KA5, HGRKTKLU9KLU5

B. Braided Jumper
1. 0.94” Braid width
2. Hole diameter 0.375”
3. Hole Spacing 1.25”
4. Length: 12”
5. Hubbell Part Number HGBBD12

2.8 BASKET TRAY CONDUCTORS

A. Mounts to the basket tray metal runner
B. Accepts #6 AWG cable that spans the gaps between sections of basket tray
C. Hubbell Part Number HGBKS17, HGRKTWC45, HGRKTWB5

2.9 RAISED FLOOR GROUNDING CLAMP

A. Ability to do both parallel and grid configurations
1. Hubbell Part Number HGBGXP1828RF - Grid or Parallel
2. Hubbell Part Number HGBGP1526G1 - Parallel
3. Hubbell Part Number HGBGRF4C3 – Parallel

B. Attached to the stringer of the raised floor
1. Hubbell Part Number HGBGXP1828RF - 0.75”-1.5” Round or Square
2. Hubbell Part Number HGBGP1526G1 - 1.0”-1.25” Round

3. Hubbell Part Number HGBGRF4C3 - 0.75”-1.0” Round or Square

C. Wire Range.
1. Hubbell Part Number HGBGXP1828RF 6 – 4/0 AWG
2. Hubbell Part Number HGBGP1526G1 4 – 2/0 AWG
3. Hubbell Part Number HGBGRF4C3 8 – 2 AWG

2.10 LABELING

A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8-inch. Overlay shall provide weatherproof and UV-resistant seal for label.
C. Label the grounding conductor destination. For example: In the EF or MDF, label the conductor: i.e., (To 1B); or, (To structural steel, room 112); or (To electrical power ground, room 115).

PART 3 – EXECUTION

3.1 GENERAL

A. Locate PBB and SBBs so that they are accessible to telecommunications personnel.
B. At a minimum, follow all manufacturer instructions. In case of discrepancy between manufacturer and contractor requirements, the more stringent shall apply. In the case of conflicting instructions, report any discrepancy to the Design Engineer in a timely fashion so as not to impact the construction timeline.
C. At a minimum, provide exothermic welds as identified on the drawings or required in the specifications. For all other connections, irreversible compression connections are sufficient.

3.2 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
B. Comply with NECA 1
C. Comply with J-STD-607-B

3.4 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
B. Underground Grounding Conductors: Install bare-copper conductor, No. 2 AWG minimum.
C. Conductor Terminations and Connections:
    1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
    2. Underground Connections: Welded connectors except at test wells and otherwise indicated.
    3. Connections to Ground Rods at Test Wells: Bolted connectors.
    4. Connections to Structural Steel: Welded connectors.
D. Conductor Support:
    1. Secure grounding and bonding conductors at intervals of no more than 36 inches.
E. Grounding and Bonding Conductors:
    1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend shall exceed 90 degrees.
    2. Install without splices.
    3. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room, supporting the 3/4-inch PVC at intervals of no more than 36 inches. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
        a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 “Pathways for Communications Systems,” and bond both ends of the conduit to a SBB.

3.5 GROUNDING ELECTRODE SYSTEM

A. The BCT between the PBB and the ac service equipment ground shall not be smaller than No. 1/0 AWG. The BCT shall be, as a minimum, the same size as the largest TBB.
B. The TBB between the PBB and the farthest SBB shall be a continuous copper conductor that should be sized no less than 6 AWG to a maximum 3/0 AWG. This conductor shall be sized per Table 1 below:

TBB Conductor Size vs. Length	
TBB/GE linear length (ft.)	TBB/GE size (AWG)
Less than 4	6
14-20	4
21-26	3
27-33	2
34-41	1
42-52	1/0
53-66	2/0
Greater than 66	3/0

Table 1 - TBB Conductor Size vs. Length

C. The GE between SBBs on the same floor on the first, top, and every third floor in a multistory building shall be a continuous copper conductor that should be size no less than 6 AWG. The GE shall be, as a minimum, the same size as the largest TBB.
D. The Telecommunications Equipment Bonding Conductor (TEBC) shall be a continuous copper conductor that should be sized no less than 6 AWG.

3.6 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, in insulated spacers 2 inches minimum from wall, 12 inches minimum above finished floor unless otherwise indicated.
B. The PBB shall be installed at the bottom of the backboard near the building entrance conduits in the EF.
C. Each SBB shall be installed at the bottom of the backboard near where the TBB enters or passes through each TR.
D. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.7 CONNECTIONS

A. Bond metallic equipment in a telecommunications entrance facility, equipment room and telecommunications rooms to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with the manufacturer's written instructions and as follows:
   1. Use crimping tool and the die specific to the connector.
   2. Pre-twist the conductor.
   3. Apply an antioxidant compound to all bolted and compression connections.
D. Primary Protector: Bond to the PBB with insulated bonding conductor.
E. Interconnections: Interconnect all SBBs with the PBB with the telecommunications bonding backbone conductor. If more than one PBB is installed, interconnect PBBs using grounding equalizer conductor. The telecommunications bonding backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install vertical rack equipment grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the SBB using No. 2 AWG bonding conductors.
G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each SBB and PBB to the vertical steel of the building frame.
H. Electrical Power Panel-boards: Where an electrical panel-board for telecommunications equipment is located in the same room or space, bond each SBB to the ground bar of the panel-board.
I. Shielded Cable: Bond the shield of shielded cable to the SBB in telecommunications rooms and spaces. Comply with TIA-568-C.0 when grounding screened, balanced, twisted pair cables.
J. Rack- and Cabinet-Mounted Equipment: bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as supplement to bonding requirements in this Section.
K. Access Floors: Bond all metal parts of access floors to the SBB.
L. Equipment room Signal Reference Grid: Provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.
   1. Install the conductors in grid pattern on 4-foot centers, allowing bonding of one pedestal from each access floor tile.
   2. Bond the SBB of the equipment room to the reference grid at two or more locations.
   3. Bond all conduits and piping entering the equipment room to the SBB at the perimeter of the room.
M. Cable runways and Cable Trays: In order to achieve the objectives of potential equalization, ensure that the all cable runway and cable tray sections are bonded together and bonded back to the PBB/SBB using two-hole compression lugs or ground terminal blocks.

Listed split bolts suitable for the application can be used for bonding sections of cable runways or trays. Cable runway/tray bonding conductors shall be installed between every splice junction of runway/tray to ensure electrical continuity. Consult cable runway/tray manufacturer's for recommended grounding and bonding requirements.

3.8 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

B. Comply with IEEE C2 grounding requirements.

C. Grounding Maintenance holes and Hand holes: Install a driven ground rod through manhole or hand-hole floor, close to wall, and set rod depth so 4 inches extends above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

D. Grounding Connections to Manhole Components: bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders and cable shields within each manhole or hand-hole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect grounding conductors to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.9 IDENTIFICATION

A. Refer to Section 270553 "Identification for Communications Systems" for identification requirements.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections. Tests shall be performed by the contractor and the designer/consultant shall perform the inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

2. Test the bonding connections of the system using an AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a PBB or a SBB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms (0.1 ohm).
b. A copy of the test results shall be provided to KU IT prior to any telecommunication services being activated.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
   a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the PBB and in each SBB. Maximum acceptable ac current level is 1.0 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify KU IT promptly and include recommendations to reduce ground resistance.
D. Grounding system will be considered defective if it does not pass tests and inspections.
E. Prepare test and inspection reports and provide to KU IT.

END OF SECTION 27 05 26

27 05 28 – Pathways for Communications Systems

PART 1 – GENERAL

1.1 SUMMARY

1. This section governs the products and installation of pathways for communications systems

A. Related Requirements:
   1. Section 270000 "Communications" including all referenced codes, standards and guidelines.

1.2 DEFINITIONS

A. ARC: Aluminum rigid conduit.
B. GRC: Galvanized rigid steel conduit.
C. IMC: Intermediate metal conduit.
D. EMT: Electrical Metallic Tubing

1.3 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 270000 "Communications":
   1. Product Information
      a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
      b. Provide manufacturer's product information cut sheet or specifications sheet with the specific product number identified or filled out.
   2. Shop Drawings
      a. Provide scaled drawings (not less than 1/8" – 1'-0") indicating routing of conduits and locations of all pull points (to include pull boxes, communications LB, etc.). These locations are to be fully coordinated with all other trades.
B. The following submittals are due Post-Construction, in accordance with submittal requirements in Section 270000 "Communications":
   1. Record Drawings
      a. Provide scaled drawings (not less than 1/8" = 1'-0") indicating actual installed routing of conduits and locations of all pull points. Design or shop drawings modified in the field will not be accepted.
   2. Keys for any pull boxes, enclosures and/or cabinets (if applicable).

PART 2 – PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. General Requirements for Metal Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-C.

B. GRC: Comply with ANSI C80.1 and UL 6.

C. ARC: Comply with ANSI C80.5 and UL 6A.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. PVC-Coated Steel Conduit:
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.

F. EMT: Comply with ANSI C80.3 and UL 797.

G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
   2. Fittings for EMT:
      a. Material: Steel.
      b. Type: Setscrew or compression.
   3. Expansion Fittings: PVS or steel to match conduit type, complying with UL 467, rated for environmental conditions where-installed, and including flexible external bonding jumper.
   4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

H. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. General Requirements for Nonmetallic Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-C.

B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

C. Rigid HDPE: Comply with UL 651A.

D. Continuous HDPE: Comply with UL 651B.

E. Fittings for RNC: comply with NEMA TC 3; match to conduit or tubing type and material.

F. Solvent Cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway, approved for plenum installation unless otherwise indicated.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-C.

2.4 SURFACE PATHWAYS

1. Comply with Section 270539 "Surface Raceways for Communications Systems."

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Hoffman; a Pentair company.
   2. Hubbell Incorporated; Killark Division.
   3. RACO; a Hubbell company.
   4. Wiremold / Legrand.
B. General Requirements for Boxes, Enclosures, and Cabinets.
   1. Comply with TIA-569-C.
   2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
D. Box extensions used to accommodate new building finishes shall be of the same material as recessed box.
E. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.
F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
G. Device Box Dimensions: Refer to Section 270553 "Conduits and Back-boxes."
H. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 12 for indoor use only, Type 3R or Type 4x for outdoor use only, with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Nonmetallic Enclosures: Material: Plastic
   3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

PART 3 – EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC, RNC, Type EPC-40-PVC
   2. Concealed Conduit, Aboveground: GRC, RNC, Type EPC-40-PVC

3. Underground Conduit: RNC, Type EPC-40-PVC, Smooth-wall HDPE.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT
2. Exposed, Not Subject to Severe Physical Damage: EMT
3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:
   a. Loading Dock
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Gymnasiums
4. Concealed in Ceilings and Interior Walls and Partitions: EMT
5. Damp or Wet Locations: GRC
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway or EMT for non-plenum rated cabling.
7. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 1-1/4 inch trade size.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealants recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg. F.

H. All pathways shall be sized to allow for a minimum of 25% growth.

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-C for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Comply with requirements for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius elbows for all optical-fiber cables.
G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
H. Support conduit within 12 inches of enclosures to which attached.
I. Pathways Embedded in Slabs:
    1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
    2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
    3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.
    4. Do not embed thread-less fittings in concrete.
    5. Change from ENT to GRC before rising above floor.
J. Stub-ups to Above Recessed Ceilings:
    1. Use EMT for pathways.
    2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
L. Coat field-cut threads on PVC-coated pathways with corrosion-preventing conductive compound prior to assembly.
M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
N. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus ¼ turn more.
O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures with locknuts. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
P. Cut conduit perpendicular to the length. For conduits of 2-inch trade size or larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
Q. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
R. Surface Pathways: Refer to Section 270539 "Surface Raceways."
S. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 3/4-inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet. Prior approval shall be obtained to use 3/4-inch Trade Size and Smaller pathways.
2. 1-inch Trade Size and Smaller: Install pathways in maximum lengths of 75 feet. Prior approval shall be obtained to use 1-inch Trade Size and Smaller pathways.
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

T. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, 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 pathway sealing fittings according to NFPA 70.

U. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service pathway enters a building structure.
   3. Where otherwise required by NFPA 70.

V. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

W. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

X. Horizontally separate boxes mounted on opposite sides of walls so that they are not in the same vertical channel.

Y. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

Z. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

AA. Set metal floor boxes level and flush with finished floor surface.

BB. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENTRATIONS

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

3.4 FIRE-STOPPING

A. Install fire-stopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in **Section 270545 "Penetration Fire-stopping for Communications Systems."**

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.
   1. Repair damage to galvanized finishes with zinc-rich pant recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

27 05 29 – Hangers and Supports for Communications Systems

PART 1 - GENERAL

Cable hooks (J-hooks) are a suitable alternative to cable tray ONLY when the planned capacity of the pathway system is fifty (50) cables or fewer.

1.1 SUMMARY

A. This section shall govern the products and installation of hangers and supports for communications systems.

B. Section Includes:

1. Non-Continuous Cable Support (J-Hooks) Systems.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 270000 “Communications” including all referenced codes, standards and guidelines.

1.3 SUBMITTALS

A. The following submittals are due at the Pre-construction Phase, in accordance with submittal requirements in Section 270000 “Communications”.

1. Product Information

a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.

b. Provide manufacturer’s product information cut-sheet or specifications sheet with the specific product number identified or filled out.

2. Shop Drawings

a. In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8” = 1’-0”) indicating routing of cable and means of support (where supported by cable tray vs. j-hooks).

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

a. Include scaled j-hook layout and relationships between components and adjacent structural, electrical, and mechanical elements.

b. Vertical and horizontal offsets and transitions.

c. Clearances for access above and to side of j-hooks.

d. Vertical elevation of j-hooks above the floor or below bottom of ceiling structure.

e. These locations shall be fully coordinated with all other trades.

B. The following submittals are due at the Post-construction Phase, in accordance with submittal requirements in Section 270000 “Communications”.

1. Record Drawings

a. In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8” = 1’-0”) indicating routing of cable and means of support. Design drawings or shop drawings modified in the field will not be accepted.

2. Manufacturer and Maintenance Manuals for all installed equipment
   a. Provide manufacturer’s product information cut-sheet or specifications sheet with the specific product number identified or filled out.

PART 2 - PRODUCTS

2.1 NON-CONTINUOUS CABLE SUPPORT (J-HOOK) SYSTEMS

A. Non-continuous cable supports
   1. J-hooks shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables and be UL Listed.
   2. J-hooks shall have flared edges to prevent damage while installing cables.
   3. J-hooks shall have the manufacturer’s name and part number stamped on the part for identification.
   4. J-hooks sized 1-5/16-inches and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable, reusable, and suitable for use in air handling spaces.
   5. J-hooks shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
      6. J-hooks shall be ERICO CADDY CAT LINKS models CAT32HP, CAT48HP, CAT64HP or B-Line Systems models BCH21 or 1-5/16”, BCH32, BCH64 or approved equals.
   7. The minimum size for the main J-hook pathway shall be 4”. Where cabling is installed within and is intended for an individual room or area, the minimum size J-hook shall be 2”. The size or dimension of this J-hook pathway shall not be reduced based on any factors.
   8. 1-5/16-inch J-hooks shall only be installed to support the excess cable slack for wireless access point locations or other similar uses as approved by KU IT.

PART 3 - EXECUTION

3.1 J-HOOK SYSTEM INSTALLATION

A. Installation and configuration shall comply with TIA-569-C, NPFA 70, and the manufacturer’s installation instructions.
B. Install cables using techniques, practices, and methods which are consistent with Category 6A and optical fiber cabling and that supports their performance of completed and linked signal paths end-to-end.
C. J-hooks shall be located at intervals of 60-inches or less.
D. J-hooks shall be selected to accommodate the immediate and anticipated future quantity and weight of cables. Size j-hooks to allow for a maximum of 25% future capacity.

E. Structural steel, wood, masonry, independent (minimum 3/8” rods), or other structural parts of the building shall be used for cable support attachment points up to the total weight for which the fastener is approved. Rods that are currently employed for other functions (e.g. suspended ceiling grid support) shall not be utilized as attachment points for j-hooks. Support clips or support wires shall not be used in any fashion to secure, support or attach J-hooks to building structure.
F. Cable hooks shall be installed such that cable slack between supports is a minimum of 6-inches above ceilings.
G. Provide adequate j-hooks to ensure telecommunications cabling is a minimum of 6-inches from light fixtures and power conduits.
H. Where telecommunications cabling is being supported by j-hooks, provide a cable hook at every change in direction.
I. J-hooks shall be installed in a conveniently accessible location.
J. Route cabling such that a minimum of 48-inches is provided between cabling and electric motors or generators.

END OF SECTION 270529

27 05 33 – Conduits and Back boxes for Communications Systems

PART 1 - GENERAL

1.1 SUMMARY

A. This section governs the products and installation of conduits, back boxes, and additional accessories, connections, fittings, and equipment required for in-building communications systems, otherwise known as "Electrical Rough-in".

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Section 270000 "Communications" including all referenced codes, standards and guidelines.
C. Section 270528 "Pathways for Communications Systems."

1.3 DEFINITIONS

A. Conveniently Accessible – being capable of being reached from the floor or use of 8-foot step ladder without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, and duct work.
B. IMC – Intermediate Metal Conduit
C. Listed Communications Cable – A cable listed by a Nationally Recognized Testing Laboratory (NRTL) and acceptable to the local Authority Having Jurisdiction (AHJ) as having met appropriate designated standards or has been tested and found suitable for installation in specific spaces. Refer to NEC Articles 725, 770, and 800 for listing types and additional requirements. Assume Outside Plant (OSP) Cables being supplied are not Listed.
D. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
E. Plenum-rated – A product that is Listed by a NRTL as being suitable for installation into a plenum space. Communications cabling shall be Listed and identified as type CMP.
F. Point of Entrance (Building Entrance) – The point within a building at which the OSP communications wire or cable emerges from an external wall, from a concrete floor slab, or from a rigid metal conduit (Type RMC) or an intermediate metal conduit (Type IMC) connected by a grounding conductor to an electrode in accordance with the NEC.
G. RMC – Rigid Metal Conduit
H. UL – Underwriters Laboratory

1.4 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 270000 "Communications":
    1. Product Information

a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
b. Provide manufacturer's product information cut sheet or specifications sheet with the specific product number identified or filled out.

2. Shop Drawings
   a. Provide scaled drawings (not less than 1/8" – 1'-0") indicating routing of conduits and locations of all pull points (to include pull boxes, communications LB, etc.). These locations are to be fully coordinated with all other trades.

B. The following submittals are due Post-Construction, in accordance with submittal requirements in Section 270000 "Communications":
   1. Record Drawings
      a. Provide scaled drawings (not less than 1/8" = 1'-0") indicating actual installed routing of conduits and locations of all pull points. Design or shop drawings modified in the field will not be accepted.
   2. Keys for any pull boxes (if applicable)

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to Electrical specifications for additional information.

2.2 CONDUIT

A. Refer to execution section for sizing and installation requirements.
B. Refer to Electrical specifications for list of approved manufacturers.
C. The minimum conduit trade size for telecommunications shall be 1-1/4-inch.

2.3 BACKBOXES

A. At minimum, the typical communications back-box shall be 4-11/16-inch square by 2-1/8-inch deep with 1-1/4-inch knockouts and a 4-11/16-inch Square Mud-Ring for one (1) device (single-gang) unless noted otherwise.
   1. For outlets in stud wall, Manufacturer shall be:
      a. RACO/Hubbell Electrical Products – 4-11/16-inch Square Box, 2-1/8-inch Deep, 1-1/4-inch Side Knockouts. (P/N RACO259) with 4-11/16-inch Square Mud-Ring for one (1) device (verify appropriate Mud-Ring depth).
      b. Randl Industries, Inc. – 5-square Telecommunications Outlet Box (P/N T55017) with appropriate mud-ring.
      c. Or approved equivalent.
   2. For outlets in CMU wall, submit appropriate back-box for application.
   3. For in-slab or poke-through outlet locations, submit appropriate back-box for application. For installations in up to two hour rated floors, the Legrand Evolution™ Series Poke-Thru Device is recommended. Available in 4", 6", 8" and 10" configurations.

With the variety of available termination plates, the Evolution series Poke-Thru allows for a wide range of CommScope jack termination options.

4. For outlets above ceiling for applications such as Wireless Access Points
   a. CommScope Ceiling Connector Cat 6A item: 760235591.

2.4 PULLBOXES

A. Material shall be aluminum or steel.
B. The following manufacturers are conditionally-approved:
   1. Hoffman
   2. Or approved equivalent
C. Refer to execution section for sizing and installation requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall follow all manufacturer's instructions.
B. Coordinate with all other trades prior to installation.
C. The contractor's Project RCDD shall perform weekly inspections during construction to verify the conduits, back boxes, and other electrical rough-in meet these specifications and referenced documents. Each week of rough-in installation, the contractor's Project RCDD shall invite the Design Engineer and KU IT Representatives to weekly inspections.
   1. Should any disparity between construction and these specifications be discovered by the contractor's Project RCDD, Design Engineer, or KU IT Representatives at any point during the course of construction, contractor shall make necessary corrections without cost or schedule change to the project.

3.2 CONDUIT

A. Conduit size to telecommunications outlets shall be minimum trade size 1-1/4-inch unless otherwise noted.
B. Conduits which enter Telecommunications Spaces shall extend:
   1. 4-inches above finished floor, or
   2. 3-inches below finished ceiling, or
   3. 3-inches through wall
C. Conduits shall be reamed and bushed.
D. Telecommunications building entrance conduits shall be RMC or IMC construction and shall extend to within 50-feet cable length from the location reserved for Building Entrance Protection in the Entrance Facility.
E. Minimum Bend Radius
   1. For trade size conduits 2-inches or less, maintain a minimum bend radius of six (6) times the actual inside diameter of the conduit.

2. For trade size conduits greater than 2-inches, maintain a minimum bend radius of ten (10) times the actual inside diameter of the conduit.

F. No continuous section of conduit may exceed 100-feet. Utilize pull boxes as necessary.

G. No continuous section of conduit may include more than two (2) 90 degree bends (or equivalent).

H. Conduit to Floor Boxes in Slab-on-Grade
   1. Slab-on-grade conduits shall not be installed.

I. Flexible Conduit
   1. As defined by the NEC.
   2. To be utilized only at specific locations identified on the drawings and previously approved by KU IT prior to installation.
   3. Sections are to be limited to a maximum of 20-feet in length and the trade-size shall be increased by one. The minimum trade size shall be 1-1/2-inch unless otherwise noted and approved.

3.3 BACKBOXES

A. Back boxes installed into fire-rated walls shall include appropriate fire-stopping system.

B. Where back-to-back with outlet on opposite side of wall, off-set one of the back boxes and conduits to adjacent stud cavity or masonry block.

C. With the exception of Wireless Access cable terminations; all in-room cabling must terminate on a jack within an application-approved back-box.

D. Where communication cables serve a podium, kiosk, cubicle(s), connected desks or other. It is assumed the cables will enter from the floor below. These cable shall terminate on CommScope Jacks in a *(previously-approved)*, floor box or poke through device rated for the intended application or placement. Devices installed shall meet or exceed the fire rating integrity of the membrane it is installed within. See section PART 2 – PRODUCTS, 2.3 BACK BOXES A3 in this section for additional information. “See Poke-Thru example on page 53”.

3.4 PULLBOXES

A. Angle, U-pulls, or Directional changes within a pull box shall not be allowed.

B. Straight Pulls. In straight pulls, the length of the box shall not be less than eight (8) times the trade size of the largest conduit.

C. For Straight Pulls, size pull boxes according to the following table:

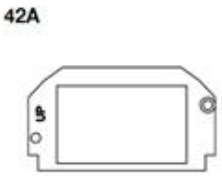
Conduit Trade Size	Min. Width	Min. Length	Min. Depth	Width Increase for Additional Conduit
1”	4”	8”	3”	2”
1-1/4”	6”	10”	3”	3”

1-1/2”	8”	12”	4”	4”
2”	8”	16”	4”	5”
2-1/2”	10”	20”	6”	6”
3”	12”	24”	6”	6”
4”	16”	32”	8”	6”

D. Install pull boxes in conveniently accessible locations.

E. Where identified on drawings as lockable, key all pull boxes the same. The KU IT AB1 key is typical for lockable boxes, enclosures and/or cabinets. Verity the key type with KU IT prior to specifying or ordering the lock cylinders.

POKE THRU DEVICE EXAMPLE:



Device Mounting Plate – Device plate that will accept up to two (2) ports of communication devices. Designed to fit into one (1) gang of the 4AT Series poke-thru. Communications devices supplied by others.

The interior of the Evolution™ Series 4" Poke-Thru Device.

END OF SECTION 270533

27 05 36 – Cable Trays for Communications Systems

PART 1 - GENERAL

1.1 SUMMARY

A. This section governs the products and installation of cable trays and additional accessories, connections, fittings, and equipment required for in-building communications systems, otherwise known as "Electrical Rough-in."

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 270000 "Communications" including all referenced codes, standards and guidelines.

1.3 QUALITY ASSURANCE

A. All cable trays, including all parts, pieces and connections, shall be certified from a NRTL for the intended purpose.

1.4 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 270000 "Communications".

1. Product Information
   a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
   b. Provide manufacturer's product information cut sheet or specifications sheet with the specific product number identified or filled out.
   c. Include documentation from manufacturer that the cable tray system has been UL-tested to be continuously grounded.
   d. Where the desired distance between cable tray supports is greater than 5-feet, provide calculations indicating maximum distance given the worst case load factor for the area with the greatest density of cables.
2. Shop Drawings
   a. In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8"=1'-0") indicating routing of cable and means of support (where supported by cable tray versus j-hooks). These locations are to be fully coordinated with other trades.
   b. Where submitted locations of cable trays differ from those in the contract documents, note the shop drawings with the reason for the relocation.

B. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 270000 "Communications".

1. Record Drawings
   a. In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8" = 1'-0") indicating routing of cable and means of support. Design drawings or shop drawings modified in the field will not be accepted.
2. Manufacturer and Maintenance Manuals for all installed equipment.
   a. Provide manufacturer's product information cut sheet or specifications sheet with the specific product number identified or filled out.
   b. List of bill of materials, including all parts, pieces and connectors required for installation of the cable tray system.

PART 2 - PRODUCTS

2.1 GENERAL

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
   1. Source Limitations: Obtain cable trays and components from single manufacturer.

I. Sizes and Configurations: See the Cable Tray Schedule on the Drawings or in the Scope of Work for specific requirements for types, materials, sizes, and configurations. All cable trays shall be sized based on a max fill of 50% and to allow for a minimum of 25% growth.

B. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
   1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
   2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
   3. Load and Safety Factors: Applicable to both side rails and run capacities.

C. The cable tray system shall be Listed for its location and intended purpose.

D. The cable tray system shall be Listed to allow for continuous grounding. Refer to execution section for additional grounding requirements.

2.3 LADDER CABLE TRAYS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Chalfant Manufacturing Company.
   2. Cooper B-Line, Inc.
   3. Mono-Systems, Inc.
   4. MP Husky.

B. Description:
   1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
   2. Rung Spacing: 9 inches on center.
   3. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.

4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
5. No portion of the rungs shall protrude below the bottom plane of side rails.
6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
7. Minimum Useable Load Depth: 3 inches minimum.
8. Straight Section Lengths: 10 feet except where shorter lengths are required to facilitate tray assembly.
9. Width: 12 inches unless otherwise indicated on Drawings.
10. Fitting Minimum Radius: 12-inches
11. Splicing Assemblies: Bolted type using serrated flange locknuts.
12. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316 or Steel, zinc plated according to ASTM B 633
13. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.4 WIRE-BASKET CABLE TRAYS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Cablofil/Legrand.
   2. Cooper B-Line, Inc.
B. Description:
   1. Configuration: Wires are formed into standard 2-by-4-inch wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
   2. Materials: High-strength-steel longitudinal wires with no bends.
   3. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.
   4. Sizes:
      a. Straight sections shall be furnished in standard 10-feet lengths.
      b. Wire-Basket Depth: 2-inch usable loading depth by 6 inches, 12 inches, 18 inches or 24 inches wide.
      c. Wire-Basket Depth: 4-inch usable loading depth by 12 inches, 18 inches or 24 inches wide.
   5. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
   6. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
   7. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316 or Steel, zinc plated according to ASTM B 633

2.5 SINGLE-RAIL CABLE TRAYS

A. Single-Rail Cable Trays are prohibited.

2.6 TROUGH CABLE TRAYS

A. Trough Cable Trays are prohibited unless otherwise noted.

2.7 FIBERGLASS CABLE TRAY

A. Fiberglass Cable Trays are prohibited.

2.8 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
B. Covers: Covers are not required unless otherwise indicated.
C. Barrier Strips: Same materials and finishes as for cable tray.
D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.
E. At all 90 degree changes in direction, install a Cablofil Radius Tee 90 degree Kit (RADT90KIT).

2.9 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE1.

PART 3 - EXECUTION

3.1 GENERAL

A. Minimum clearances for cable tray:
    1. Maintain as much separation from EMI sources as practical. At minimum, cable tray shall be installed at least:
        a. 6-inches away from fluorescent light fixtures.
        b. 6-inches away from power lines (circuits) enclosed in a grounded metal conduit.
        c. 48-inches away from electrical motors and transformers.
    2. Install a minimum of 3-inches above accessible ceiling T-bars. If possible, install 6-inches above accessible ceiling T-bars.
    3. Install with 12-inches of open space above and to one side of the tray to allow access for installing and maintain cable.
        a. Coordination with other trades is imperative. It shall be the contractors responsibility to coordinate and ensure all ductwork, piping, etc. of other trades is installed to allow successful installation of cable tray.
    4. Where minimum clearances are not possible, project must reroute cable tray at no cost to KU.

a. Cable tray may be relocated at the contractors discretion, provided that it is within the footprint of the same room(s) as indicated on the construction drawings, and the contractor notes the new routing on the Record Drawings.
b. Where cable tray needs to be relocated above different room(s) than indicated on the construction drawings, contractor shall submit an RFI with proposed new location.

3.2 CABLE TRAY INSTALLATION

A. Install cable trays in all corridors and hallways.
B. Cable trays shall not be installed above individual offices, conference rooms or restrooms.
C. Install cable trays according to NEMA VE 2.
D. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
E. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
F. Remove burrs and sharp edges from cable trays.
G. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.
H. Fasten cable tray supports to building structure.
I. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb.
J. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
K. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
L. Support bus assembly to prevent twisting from eccentric loading.
M. Center-hung supports are prohibited.
N. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
O. Support wire-basket cable trays with trapeze hangers or wall brackets as required by application.
P. Support trapeze hangers for wire-basket trays with 3/8-inch diameter rods.
Q. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
R. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

S. Make changes in direction and elevation using manufacturer's recommended fittings.
T. Make cable tray connections using manufacturer's recommended fittings.
U. Seal penetrations through fire and smoke barriers. Comply from requirements in Section 270545 "Penetration Fire-stopping for Communications Systems."
V. Install capped metal sleeves for future cables through fire-stop-sealed cable tray penetrations of fire and smoke barriers.
W. Install cable trays with enough workspace to permit access for installing cables.
X. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15000 V.
Y. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
Z. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

3.3 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."
B. Cable trays with communications cable shall be bonded together with splice plates listed from grounding purposes or with listed bonding jumpers.
C. Cable trays with control conductors shall be bonded together with splice plates listed from grounding purposes or with listed bonding jumpers.
D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.4 CABLE INSTALLATION

A. Install cables only when each cable tray has been completed and inspected.
B. Fasten cables on horizontal runs with Velcro ties. Tighten Velcro only enough to secure the cable, without indenting the cable jacket.
C. Fasten cables on vertical runs to cable trays every 36 inches.
D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. Install cable waterfalls when cables exit the tray. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.
E. In existing construction, remove inactive or dead cables from cable trays.

3.5 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after all connections are completed.
B. Connect pathways to cable trays according to requirements in NEMA VE 2.

3.6 FIELD QUALITY CONTROL

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

3.7 PROTECTION

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

END OF SECTION 270536

27 05 39 – Surface Raceways for Communications Systems

PART 1 – GENERAL

1.1 SUMMARY

A. This section shall govern the products and installation of all necessary parts, pieces and accessories of a surface raceway system for communications cabling.

B. Surface raceways and surface mounted device boxes SHALL NOT be permitted for new construction.

C. Surface raceways and surface mounted device boxes may be permissible for existing construction and renovations in areas where no suitable alternatives exist. Design Engineer and/or Telecommunications Subcontractor shall obtain prior written approval from KU IT Representatives during design and/or prior to installation.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections, apply to this section.

B. Section 270000 “Communications” including all referenced codes, standards and guidelines.

C. Section 270528 “Pathways for Communications Systems”

1.3 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 270000 “Communications”.

1. Product Information

a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.

b. Provide manufacturer’s product information cut sheet or specifications sheet with the specific product number identified or filled out.

B. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 27 00 00 Communications:

1. Manufacturer and Maintenance Manuals for all installed equipment.

a. Provide manufacturer’s product information cut-sheet or specifications sheet with the specific product number identified or filled out.

b. List of bill of materials, including all parts, pieces and connectors required for installation of the surface raceway.

2. Deliver to owner any special tools produced by the manufacturer required to install or uninstall the surface raceway and/or raceway cover.

PART 2 – PRODUCTS

2.1 METALLIC RACEWAY

A. Size according to Execution section.

B. Manufacturer shall be:

1. Wiremold/Legrand.

C. Materials
   1. The raceway and all system components must be US/C Listed. The base and cover shall be manufactured of steel, finish in ivory ScuffCoat™ (a polyester topcoat over an ivory base) and suitable for field repainting.
D. The raceway shall be a two-piece design with a raceway base and snap-on cover. The minimum size model shall be Wiremold V2400. The raceway base shall be available in 10-foot lengths and the cover shall be available in 5-foot lengths.

2.2 FITTINGS

A. A full complement of fittings shall be available including, but not limited to, couplings, flat, internal and external elbows, entrance end fittings, blank end fittings, cover clips and wire clips. The fitting covers shall be manufactured of steel and be painted with an enamel finish or a rigid plastic compound that exhibits nonflammable self-extinguishing characteristics tested to comparable specifications of UL94V-0. All fittings shall be supplied with a base where applicable. Transition fittings shall be available to adapt to smaller or larger raceway.

2.3 SURFACE OUTLET BOXES

A. Single-gang
   1. Minimum of 2-3/4 – inches deep.
   2. Manufacturer shall be:
      a. Wiremold/Legrand
B. Double-gang
   1. Minimum of 2-3/4 – inches deep.
   2. Manufacturer shall be:
      a. Wiremold/Legrand

PART 3 – EXECUTION

3.1 GENERAL

A. Follow all manufacturers' recommended installation instructions.
B. Coordinate will all other trades prior to installation.
C. Delivery, Storage, and Handling
   1. Store products in manufacturer's unopened packaging until ready for installation.
   2. Store and handle in strict compliance with manufacturer's written instructions and recommendations.
   3. Protect from damage due to weather, excessive temperature, and construction operations.
D. Verify routing locations of raceway prior to installation.
E. Surface raceways shall be sized to accommodate 1 square inch of space per work area.
F. Do not begin installation until substrates have been properly prepared. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
G. Clean surfaces thoroughly prior to installation.

H. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
I. Install all components necessary to make a complete, code-compliant installation.
J. Sections of surface raceway less than 7' in length shall be a single piece of raceway.

3.2 INSTALLATION

A. Prior to and during installation, refer to system layout drawing containing all elements of the system. Installer shall comply with detailed manufacturer's instruction sheets which accompany system components as well as complete system instruction sheets, whichever is applicable.
B. Install surface pathways for surface telecommunications outlet boxes only where indicated on Drawings.
C. Install surface pathway with a minimum 2-inch radius control at bend points.
D. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are NOT acceptable support methods.
E. Mechanical Security – All raceway systems shall be mechanically continuous and connected to all telecommunications outlets, boxes, cabinets, in accordance with manufacturer's installation sheets.
F. Electrical Security – All steel raceway shall be electrically continuous and bonded in accordance with the National Electric Code for proper grounding.
G. Completeness – All raceway systems shall be installed complete, including insulating bushings and inserts where required by manufacturer's installation sheets. All unused raceway openings shall be closed.
H. File, sand or remove any burrs or sharp edges created by cutting the surface raceway. There shall be no sharp edges or surfaces on the interior or exterior of the installed surface raceway system.

END OF SECTION 27 05 39.

27 05 43 – Underground Ducts and Raceways for Communications Systems

PART 1 – GENERAL

1.1 SUMMARY

A. This section shall govern the products and installation of all necessary parts, pieces and accessories of an underground duct and raceway system for communications cabling including manholes and hand-holes.

B. Underground Ducts and Raceways are used to interconnect spaces such as buildings, pedestals, cabinets, maintenance holes and hand-holes. All pathways shall be underground or direct buried. Aerial pathways shall be prohibited.

C. Underground Ducts and Raceways shall be specified to support the initial and anticipated telecommunications needs. In determining the total number of pathways required, the Design Engineer shall consider:

1. Type and use of building;
2. Growth;
3. Difficulty of adding pathways in the future;
4. Alternate/diverse entrances;
5. Type and size of cable likely to be installed.

D. At minimum, four (4) 4-inch ducts shall be installed in all primary or trunk duct banks. Two (2) 4-inch, 3-cell MaxCell textile innerducts shall be installed in two (2) of the four (4) ducts. One (1) of the four (4) textile innerducts shall be detectable. Each of the textile innerducts shall have a different color identifier.

E. At minimum, two (2) 4-inch ducts shall be installed in all secondary or branch duct banks, including those duct banks which feed each building. Two (2) 4-inch, 3-cell MaxCell textile innerducts shall be installed in one (1) of the two (2) ducts. One (1) of the two(2) textile innerducts shall be detectable. Each of the textile innerducts shall have a different color identifier.

F. Site requirements and building type may drive the need for more ducts or diverse pathways. These needs shall be coordinated with KU IT Representatives by the Design Engineer prior to completion of Contract Documents.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections, apply to this section.

B. Division 02 “Sitework”

C. Section 270000 “Communications” including all referenced codes, standards and guidelines.

D. Section 270526 “Grounding and Bonding for Communications Systems”

E. Section 270528 “Pathways for Communications Systems”

1.3 DEFINITIONS

A. Telecommunications Underground Ducts and Raceways – a portion of KU IT's communication infrastructure which includes products provided for the routing, segregation, and support of telecommunications cabling both inside and outside of facilities.

1.4 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:
   1. Product Information: For the following:
      a. Maintenance Hole and Hardware.
      b. Duct-bank materials, including spacers and miscellaneous components.
      c. Warning tape.
      d. Grounding and bonding.
   2. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
   3. Provide manufacturer's product information cut sheet or specifications sheet with the specific product number identified or filled out.

B. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 27 00 00 Communications:
   1. Record Drawings
      a. Provide scaled drawings indicating routing of pathway and cable as well as locations of telecommunications spaces such as maintenance holes or hand-holes. Design drawings or shop drawings modified in the field will not be accepted.
   2. Manufacturer and Maintenance Manuals for all installed equipment.
      a. Provide manufacturer's product information cut sheet or specifications sheet with the specific product number identified or filled out.
      b. List of bill of materials, including all parts, pieces and connectors required for installation of the underground duct and raceway including manholes and hand-holes.
   3. Deliver to owner any special tools produced by the manufacturer required to install or uninstall any component of the system.

1.5 QUALITY ASSURANCE

A. Devices and Accessories (including conduits for communications): Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver conduits to Project site with ends capped. Store nonmetallic conduits with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate layout and installation of conduits and manholes with final arrangement of other utilities and site grading, as determined in the field.

B. Coordinate elevations of conduits and duct bank entrances into manholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and to ensure conduit runs drain to manholes and as approved by Design Engineer and KU IT Representatives.

PART 2 – PRODUCTS

2.1 GENERAL

A. All Ducts/Raceway:

1. The number, size, raceway duct material and arrangement shall be as indicated on Drawings and or as specified herein.
2. May be non-metallic Schedule 40 PVC (heavy wall), galvanized rigid conduit (GRC) or Smoothwall HDPE as indicated on Drawings and/or as specified herein.
3. Shall be capped with manufactured caps (duct plugs) when installation is temporarily discontinued or installed for future use.
4. Shall be 4-inch nominal trade size, unless otherwise noted and approved in writing by KU IT Representatives.
5. Shall be checked by pulling a round wood or steel test mandrel, sized for each duct from both directions to remove obstructions.
6. Shall be cleaned by passing a wire brush mandrel and/or rubber duct swab (or approved alternative) of appropriate size back and forth until all foreign materials and water are removed.
7. Shall be encased by a concrete envelope in road crossings or heavy traffic areas only, minimum 3” cover on all sides or flowable backfill as specified on the drawings.
8. Shall be installed using long radius sweeps to minimize pulling tensions, unless otherwise noted on Drawings or in specifications. No more than 180 degrees of total bends in any one section of conduit.
9. Shall be installed with minimum of 3-inches fall per 100-foot run toward manholes and away from buildings.
10. Each conduit shall have a one-half inch pre-lubricated, woven, 1130lb. minimum polyester tape made from low friction, high abrasion resistant yarns placed with in the

conduit and secured at each end. Tape shall be printed with sequential footage markings for accurate measurements.

11. Provide a minimum of 12” separation between electric power and telecommunications ducts.
12. A minimum of 30-inches bury depth (measured from top of duct or concrete encasement to finished grade) is required. Exceptions may be granted to avoid interference’s with approval of KU IT Representatives.
13. The distance between telecommunications manholes shall be no greater than 500-feet.

2.2 CONDUIT

A. Non-Metallic Raceways

1. Manufacturers: Subject to compliance with requirements, provide products by the following or an approved equal:
   a. Carlon
2. Product: Shall be PVC Schedule 40 Conduit for application underground, encased or exposed applications in accordance with NFPA 70.
3. Requirements:
   a. Conduit shall be rated for used with 90°C conductors, UL Listed or approved equal. Material shall comply with NEMA Specification TC-2 (Conduit), TC-3 (Fittings) and UL 651 (Conduit) and 514b (Fittings).
   b. Conduit and fittings shall carry a UL label (Conduit – on each 10 foot length; Fittings – stamped or molded on each fitting).
   c. Conduit and fittings shall be identified for type and manufacturer and shall be traceable to location of plant and date manufactured. The marking shall be legible and permanent.
   d. The Conduit shall be made from polyvinyl chloride compound (recognized by UL) which includes inert modifiers to improve longevity and resist heat distortion. Clean rework material, generated by the manufacturer’s own conduit production, may be used by the same manufacturer, provided the end products meet the requirements of this specification.
   e. The conduit and fittings shall be homogeneous plastic material free from visible cracks, holes or foreign inclusions. The conduit bore shall be smooth and free of blisters, nicks or other imperfections which could mar conductors or cables.
   f. Conduit, fittings and cement shall be produced by the same manufacturer to assure system integrity
4. All underground conduits shall be at minimum, 4-inch nominal trade size, unless otherwise noted and approved in writing by KU IT Representatives.
5. All bends shall be factory made and be ten (10) times the diameter of the conduit.
6. Provide bushings on all conduit terminations.
7. Splice conduits with fittings approved by the conduit manufacturer for the specified applications.

B. High Density Polyethylene (HDPE)
   1. HDPE may be used if given prior approval by KU IT Representatives.
   2. HDPE shall be at minimum 4-inch nominal trade size, unless otherwise noted and approved in writing by KU IT Representatives.
   3. HDPE shall be smooth-walled interior and exterior configuration with call construction of SDR 13.5. (Note: Directional drilling installations shall utilize SDR 11).

2.3 TEXTILE/FABRIC INNERDUCT

A. Manufacturer shall be MaxCell Group/TVC Communications
   1. Substitutions will not be acceptable.
B. Standard Outdoor Textile Innerduct: 4-inch, 3-cell polyester/nylon textile innerduct, each cell containing 250-pount polyester flat woven pull tape printed with accurate sequential footage marks and color coded.
C. Detectable Outdoor Textile Innerduct: 4-inch, 3-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape, and a solid copper, polyvinyl color coated conductor (19AWG minimum) for tracing and rated for a minimum of 6 amps and 600 volts. Conductor shall be placed in the sidewall edge fold of the textile sleeve.
D. Size and cell count may vary dependent upon duct size. 4-inch, 3-cell shall be the default standard. Any variances from this standard shall require prior written approval by KU IT Representatives.

2.4 TEXTILE/FABRIC INNERDUCT FITTINGS

A. Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 4-inch inside diameter conduit, e.g.:
   1. 4-inch plug with nine holes for cables in a 3 pack (9-cell) configuration
B. Termination Bags: Inflation-type bags for sealing and securing around one or more textile innerducts and cables within 2-inch outside diameter or larger conduit.

2.5 COMMUNICATIONS MAINTENANCE HOLES

A. Manufacturers: Subject to compliance with requirements, provide products by the following or an approved equal:
   1. Oldcastle Precast
B. Description:
   1. Precast Units: ASTM 478, with interlocking mating sections, complete with accessories, hardware, and features as indicated. Include concrete knockout panels for conduit entrance and sleeve for ground rod. The size shall be at minimum 6-feet wide x 8-feet long by 7-feet high (interior dimensions) with a 30-inch manhole.
   2. The lid (cover) for all maintenance holes shall be rated to support heavy vehicular traffic (e.g. Type B, SB). Lid shall be lettered “Communications” and number as assigned by KU IT Representatives.

3. Maintenance holes shall be constructed of reinforced pre-cast concrete, 4500 psi and designed for truck loading.
4. Manholes shall be used to accommodate cable, splice closures and racking systems. Maintenance holes shall contain a French drain and be installed on a gravel base of sufficient depth to allow for drainage and stability.
5. Maintenance holes shall be used to facilitate placing and splicing of cables. New maintenance holes shall be equipped with: corrosion-resistant cable racks and permanent ladders, which are grounded; pulling irons; and a sump pit and floor drainage system to drain water.
6. Telecommunications maintenance holes shall not be shared with electrical installations other than those needed for telecommunications equipment.
7. Maintenance holes shall meet the following requirements of this section unless otherwise approved by KU IT Representatives.
8. Conduits shall enter and exit the maintenance hole in a straight line method. The remaining parallel shall remain free of conduit entrances to allow cable support and splicing operations.
9. Pulling irons shall be provided on opposite sides of the ducts, rated at 10,000 pounds pulling tension.
10. Cable racks shall be installed into the walls, arms and insulators must be provided with cable supports.
11. All manhole hardware shall have rubberized or hot dipped galvanized finish.
12. Provide manhole signage within collar/chimney: to include manhole/hand-hole designator, measured distance to the next manhole/hand-hole, access point or building, North designation and direction to adjoining maintenance holes and building entrance points. Signage shall be stamped metal attached to the chimney.
13. Identify the end-destination of installed conduits. i.e.; “To Green Hall”

2.6 COMMUNICATIONS HANDHOLES

A. Manufacturers: Subject to compliance with requirements, provide products by the following or an approved equal:
   1. Quazite
   2. Oldcastle DUO MOLD®
B. Description:
   1. Hand-hole enclosures shall be at minimum, Quazite Pre-cast Polymer Concrete 30-inch wide x 48-inch long x 24-inch deep PG style (Stackable) assembly with no base, Quazite P/N PG3048BA24 and cover PG3048HA00 or as specified on drawings. Larger dimensions may be required dependent upon quantity and size of incoming ducts, outgoing ducts, and for locations housing splices.
   2. Boxes and hand-holes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.

3. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Comply with TIA-569-C.
5. Polymer-Concrete Hand-holes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
6. Standard: Comply with SCTE 77
7. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
8. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with the enclosure and hand-hole location. Hand-hole covers shall be heavy-duty type, suitable for occasional heavy vehicles.
9. Cover Finish: Nonskid finish.
10. Cover Legend: Molded lettering, "COMMUNICATIONS."
11. Hand-holes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
12. Fiberglass Hand-holes and Boxes are prohibited.

2.7 ACCESSORIES

A. Conduit Spacers: Rigid PVC interlocking spaces, selected to provide minimum conduit spacing and cover depths indicated while supporting conduits during concreting and backfilling; produced by the same manufacturer as the conduits.
B. Manhole Frames and Covers: Rated for Heavy Vehicular Traffic.
   1. Provide cast iron covers with the engraved word "Communications" and number as assigned by KU IT Representatives, as required.
   2. Manhole Frames: ASTM A 48, Class 30B gray cast iron, 30-inch size with pick holes, machine-finished with flat bearing surfaces.
C. Sump Frame and Grate: ASTM A 48
D. Pulling Eyes in Walls: Eyebolt with reinforcing-bar fastening insert 2-inch- diameter eye and 1-1/4-inch bolt.
   1. Working Load Embedded in 6-inch, 4000-psi Concrete: 13,000-lbf minimum tension.
E. Pulling and Lifting Irons in Floor: 7/8-inch diameter, hot-dip-galvanized, bent steel rod; stress relieved after forming; and fastened to reinforced rod. Exposed triangular opening.
   1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
F. Bolting Inserts for Cable Stanchions: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4-inches deep, flared to 1-1/4-inches minimum at base.
   1. Tested Ultimate Pullout Strength; 12,000 lbf. minimum.
G. Cable Stanchions: Hot-rolled, hot-dip-galvanized, T-section steel; 2-1/4-inch size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.

H. Cable Arms: 3/16-inch thick, hot-rolled, hot-dip-galvanized, steel sheet pressed to channel shape; 12-inches wide by 14-inches long and arranged for secure mounting in horizontal position at any location on cable stanchions.

I. Cable-Support Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

J. Grounding Materials: Comply with Section 270526 "Grounding and Bonding for Communications Systems".

K. Ladder: UL-listed, hot-rolled, hot-dip galvanized steel ladder specifically designed for manhole use. Minimum length equal to the distance from the manhole floor to grade. Each manhole shall contain its own ladder.

L. Conduit-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg. F. Capable of withstanding temperatures of 300 deg. F without slump and of adhering to clean surfaces of plastic conduits, metallic conduits, conduit coatings, concrete, masonry, lead cable sheaths, cable jackets, insulation materials, and common metals.

M. Conduit Duct Plugs:
   1. Duct plugs shall be manufactured from high impact plastic components and shall be corrosion proof.
   2. Duct plugs shall contain a durable elastic compressible gasket which will make it effective as long term or temporary seal. They shall be removable and reusable.
   3. They shall meet or exceed the following mechanical requirements:
      a. Air Pressure: 7.5 psi
      b. Water Head: 15 ft.
      c. Pull Out: 100 Kgf.
   4. Duct plugs shall be equipped with a rope tie device on the back compression plate to allow the securing of a pull rope. This will allow excess rope slack to be stored within the conduit.
   5. Refer to 2.4 for MaxCell Textile Innerduct, duct plug requirements.

PART 3 – EXECUTION

3.1 GENERAL

A. The exact number of building entrance conduits shall be determined by Design Engineer after considering the site and building requirements and approved in writing by KU IT Representatives. Provide typically two (2) 4-inch Schedule 40 PVC building entrance conduits from the building entrance facility to the nearest telecommunications manhole or connection point, with the exception of boring applications. One (1) of the 4-inch conduits shall contain two (2) 4-inch, 3-cell MaxCell Textile Innerducts of which, one (1) of the two (2) shall be detectable. Exact building entrance conduit requirements shall be approved in writing by KU IT Representatives prior to installation.

B. The exact backbone conduit requirements shall be determined by Design Engineer and approved in writing by KU IT Representatives. Outside plant backbone pathways shall typically comprise of four (4) 4-inch Schedule 40 PVC conduits. Two (2) of the 4-inch conduits shall contain two (2) 4-inch, 3-cell MaxCell Textile Innerducts for a total of four (4). One (1) of the four (4) shall be detectable. Exact backbone conduit requirements shall be approved in writing by KU IT Representatives prior to installation.
C. All bends shall be manufactured factory long, sweeping bends, ten times the internal diameter of conduits larger than 4-inches.
D. In underground raceways, angle couplings and bends alone or in combination with straight sections shall be used for direction changes. Direction changes made by skewing straight sections of conduits will not be permitted. Direction changes made in manholes or hand-holes will not be permitted.
E. Orange caution tape shall be installed 12-inches above all underground conduits.
F. Conduits shall be Schedule 40 PVC. Use of HDPE may be allowed but shall require prior written approval from KU IT Representatives.
G. Conduits shall be capped with manufactured caps (duct plugs) when installation is temporarily discontinued.
H. Conduits shall be cleaned by passing a wire brush mandrel and/or rubber duct swab of appropriate size back and forth until all foreign materials and water are removed.
I. Conduits shall be checked by pulling a round test mandrel, 1/4-inch less than the conduit's size for each duct from both directions to remove obstructions.
J. Conduits shall be provided with continuous 1250 pound tensile strength conduit measuring pull tape in each duct terminated to prevent pullout.
K. Installed underground conduit or HDPE pathways shall contain an un-spliced length of green-jacketed, #10 THHN copper tracer wire.
L. No section of conduit shall have more than 180° of bends without a manhole or hand-hole installed for an access point.
M. No conduit run shall extend more than 500 feet without a manhole or hand-hole installed as an access point.
N. Conduit connections from buildings to manholes shall be installed with a minimum of 3 inch fall per 100 feet of conduit towards the manhole and sloping away from the building
O. Conduits shall be inspected and approved for correct formations and tied to prevent ducts from floating when concrete is poured.
P. The minimum separation from other utilizes is a follows
    1. Power up to one KVA:
        a. 12 inches of well- packed earth
        b. 4 inches of masonry
        c. 3 inches of concrete
    2. Gas, Oil, Water, etc.:
        a. 12 inches when parallel
        b. 6 in. when crossing

Q. A minimum of 30 inches bury depth (measured from top of conduit or concrete encasement to finished grade) is required.
   1. Install a 6” orange warning tape labeled fiber optics. Install tape 12 inches above the entire conduit or duct bank.

R. Requirements for Non-metallic Raceways
   1. Install for all raceways except where rigid conduit is required.
   2. Install only manufacturer approved system components and methods.
   3. Typical nonmetallic conduits installation consists of a minimum of PVC Type Schedule 40.
   4. Provide minimum of 30 inches bury depth measured from the top conduit to finished grade.
   5. Bond PVC duct with couplings using manufacturer approved adhesives.
   6. Install metallic threaded adapter when attached to rigid conduit.
   7. Protect from deformation during stockpiling. Maintain circular shape. Other configurations will not be permitted.
   8. Comply with the manufacturers requirements for bending and cutting.
   9. All joints shall be wrapped with 1.5” or larger Scotch #88 tape as temporary concrete seal.
   10. Provide with end bells flush with inside wall of manhole or vault.
   11. Install a 6” orange warning tape labeled “Communications”. Install tape 12-inches above the entire conduit or duct bank.
   12. Cover with select compactable soil, free of stones and debris.

3.2 CONDUIT INSTALLATION

A. Slope: Pitch conduits a minimum of 3-inches fall per 100-foot run down toward manholes, hand-holes and away from buildings and equipment. Slope conduits from high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use manufactured long sweep bends with a minimum radius of 24-inches.

C. Use solvent-cement joints in conduits and fittings and make watertight according to manufacturer’s written instructions. Stagger couplings so those of adjacent conduits do not lie in the same plane.

D. Conduit Entrances to Manholes: Space end bells approximately 8-inches on center for 4-inch conduits and vary proportionately for other conduit sizes. Change from regular spacing to end-bell spacing 10-feet from the end bell without reducing conduit line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.

E. Building Entrances: Make a transition from underground PVC to right galvanized steel conduit 5-feet from exterior wall of the building. Use fittings manufactured for this purpose. Follow the appropriate installation instructions below:

1. Concrete-Encased Conduit: Install reinforcement in conduit banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
2. Waterproofed Wall and Floor Penetrations: Install a watertight entrance sealing device with sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

F. Concrete-Encased, Nonmetallic conduits: Support conduits on spacers, spaced as recommended by manufacturer and coordinated with conduit size, conduit spacing, and outdoor temperature. Install as follows:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 “Earth Moving” for pipe less than 6-inches in nominal diameter.
2. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrance through floor.
   a. Couple steel conduits to duct with adapters designed for this purpose, and encase coupling with 3-inches of concrete for a minimum of 12 inches on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60-inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
3. Underground Warning Tape: Bury detectable warning tape labeled “FIBER OPTIC” OR “TELECOMMUNICATIONS” 12-inches to 18-inches above direct buried conduits, but at minimum of 6-inches below grade. Align warning tape along centerline of conduit.
4. Separator installation: Space separators close enough to prevent sagging and deforming of conduits and secure separators to earth and to conduits to prevent floating during backfilling. Stagger spacers approximately 6-inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around conduits or conduit groups.
5. Concreting: Space concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto conduits. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Pour each run of envelop between manholes or other terminations in one continuous operation. If more than one pour is necessary, terminate each pour in a vertical plan and install 3/4-inch reinforcing rod dowels extending 18-inches into concrete on both sides of joint near corners of envelope.

6. Reinforcement: Reinforce duct banks where they cross disturbed earth and where indicated.
7. Forms: use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise use forms.
8. Minimum Clearances between Conduits: 3-inches between conduits and exterior envelope wall, 3-inches between conduits for like services, and 4-inches between power and signal conduits.
9. Depth: Install top of duct bank at least 30-inches below finished grade in non-traffic areas and at least 36-inches below finished grade in vehicular traffic areas, unless otherwise indicated. If depth cannot be met, contact Design Engineer and KU IT Representative for variance before proceeding.

G. Non-Metallic Conduits – No Encasement - Support conduits on spacers, spaced as recommended by manufacturer and coordinated with conduit size, conduit spacing, and outdoor temperature. Install as follows:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 “Earth Moving” for pipe less than 6-inches in nominal diameter.
2. Install backfill as specified in Section 312000 “Earth Moving.”
3. Backfilling: Spade backfill carefully to prevent voids under and between conduits and exterior surface of envelope. Do not allow a heavy mass of backfill to fall directly onto conduits.
4. After installing conduit, backfill and compact. Start at the tie-in point and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12-inches of finished grade make final conduit connect at end of run and complete backfilling with normal compaction as specified in Section 312000 “Earth Moving.”
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrance through floor.
   a. Couple steel conduits to duct with adapters designed for this purpose, and encase coupling with 3-inchs of concrete for a minimum of 12 inches on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60-inches from edge of foundation or equipment base. Install insulated grounding bushing on terminations at equipment.
6. Underground Warning Tape: Bury detectable warning tape labeled “FIBER OPTIC” OR “TELECOMMUNICATIONS” 12-inches to 18-inches above direct buried conduits, but a minimum of 6-inches below grade. Align warning tape along centerline of conduit.

7. Separator installation: Space separators close enough to prevent sagging and deforming of conduits and secure separators to earth and to conduits to prevent floating during backfilling. Stagger spacers approximately 6-inches between tiers. Continue…
   Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around conduits or conduit groups.
8. Backfilling: Spade backfill carefully to prevent voids under and between conduits and exterior surface of envelope. Do not allow a heavy mass of backfill to fall directly onto conduits. Comply with "Earthwork Section", but do not use heavy-duty hydraulic-operated compaction equipment.
9. Reinforcement: Reinforce duct banks where they cross disturbed earth and where indicated.
10. Forms: use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise use forms.
11. Minimum Clearances between Conduits: 3-inches between conduits and exterior envelope wall, 3-inches between conduits for like services, and 4-inches between power and signal conduits.
12. Depth: Install top of duct bank at least 30-inches below finished grade in non-traffic areas and at least 36-inches below finished grade in vehicular traffic areas, unless otherwise indicated. If depth cannot be met, contact Design Engineer and KU IT Representative for variance before proceeding.

H. Sealing: Provide temporary closure at terminations of conduits and innerducts that have cables pulled. Seal spare conduits and innerducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

3.3 TEXTILE INNERDUCT INSTALLATION

A. Provide textile innerduct in conduit and wire ways using continuous non-spliced lengths of textile innerduct between maintenance holes, pull boxes, and/or termination points as indicated on the drawings.
B. Make a 2" incision, approximately 18" from the end of textile innerduct. Pull out and cut off approximately 2 feet of pull-tape. Thus allowing the pull tape ends to retract back into the cells.
C. Using approximately 6 feet of pull tape, tie a non-slip knot to the incision. Then tie 3 to 6 half-hitch knots down to the end of textile innerduct. Apply black vinyl tape over all knots and the end of textile innerduct. Using a Bow Line knot tie a SWIVEL to the end of 3 feet pull tape. For multi-pack installations one swivel is sufficient, but stagger each textile innerduct.
D. Using a Bow Line knot, attach the pull rope located in the rigid conduit to the other end of the swivel. Install textile innerduct – ensuring that no twist is introduced to the innerduct.
E. Provide suitable textile innerduct slack in the maintenance holes, hand holes, pull boxes, and at turns to ensure there is no kinking or binding of the product.
F. Textile Innerduct Mountings, Hangers and Attachments: When exposed indoors or in maintenance holes, hold firmly in place using independent support.

1. Design & install hangers and other similar fittings adequate to support loads and so as to not damage innerduct.
2. Do not fasten textile innerduct to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires
3. When appropriate, use the following cable ties to secure textile innerduct through previously created incisions:
   a. Plenum areas: plenum-rated plastic or stainless steel
   b. Non plenum areas: Conventional flame-retardant nylon ties
   c. Underground locations : Conventional plastic cable ties

G. Maintenance Hole and Hand Hole Installation:
1. At locations where textile innerduct will be continuous through a manhole or hand hole, allow sufficient slack so that the innerduct may be secured to the side of the vault maintaining the minimum bend radius.
2. At maintenance holes serving as the junction location, pull the exposed end of the innerduct to the far end of the vault, install termination bag, and secure to the vault.

H. Penetrations
1. Seal all conduit and textile innerduct entering structures at the first box or outlet to prevent entrance into the structure of gases, liquids, insects or rodents.
2. Inspect fire stopping installation by others between building structure and conduit, wire way, and cable tray to verify integrity of installation.
3. Exposed Textile Innerduct Penetrations: Install conduit sleeves or fire barrier sealing systems in all openings where open and exposed textile innerduct passes through fire-rated walls and floors. After installation, install intumescent fire barrier penetration sealing material (Hilti system) between textile innerduct and sleeves or fire barrier system.
4. Raceway Penetrations: After textile innerduct installation, install intumescent fire barrier penetration sealing material (Hilti system) between textile innerduct and conduit or wire way at all exposed penetration locations.
5. Inflation bags for MaxCell 4” Plug kit shall be used to seal conduits in maintenance holes or hand-holes.
6. Protect adjacent surfaces from damage during water seal or fire stop installation. Repair any damage.
7. Document entire installation process for future referral.

3.4 MAINTENANCE HOLE INSTALLATION

A. Elevation: Install manholes with rooftop at least 13-inches below finished grade.
B. Drainage: Install drains in bottom of units where indicated. Coordinate drainage provisions indicated.
C. Access: Install cast-iron frame and cover.

1. Install precast collars and rings to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to collar.
2. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1-inch above finished grade.

D. Damp Proofing: Apply damp proofing to exterior surfaces of units after concrete has cured at least three days. Apply bituminous damp proofing. After conduits have been connected and grouted, and before backfilling, damp proof joints and connections and touch up abrasions and scrapes. Damp proof exterior of manhole and hand-hole chimneys after mortar has cured at least three days.

E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables, conductors and as indicated.

F. Field-Installed Bolting Anchors: Do not drill deeper than 3-7/8-inches for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

G. Grounding: Install an 8ft copper ground rod through floor in each structure with top protruding a minimum of 4-inches above MH floor. Seal floor opening against water penetration with waterproof non-shrink grout. Ground exposed metal components and hardware with #10 bare-copper ground conductors. Train conductors neatly around corners. Use appropriate sized copper cable clamps secured with expansion anchors to attach ground conductors.

H. Precast Concrete Manhole Installation: Unless otherwise indicated, comply with ASTM C 891.
   1. Install units level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
   2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as undisturbed earth.

3.5 UNDERGROUND HANDHOLE AND BOX INSTALLATION

A. Install hand-holes and boxes level and plumb with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1-inch above finished grade.

D. Install hand-holes with bottom below frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as

indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate clearance in enclosure.

F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. Install a 4 ft., 5/8" Diameter, copper bonded steel ground rod, connecting conduit tracer wires with NVENT ERICO CP58 or equivalent 5/8" ground rod clamps.

3.6 CONCRETE ENCASEMENT

A. Provide as shown on drawing and in accordance with these specifications. Duct banks shall not receive less than 3 inches of concrete cover all around and 1-1/2-inches between raceways.

B. Conduits entering or leaving maintenance holes shall be encased in concrete or flowable fill 5-feet beyond maintenance holes. The concrete or flowable fill shall be pinned to the side of the maintenance holes to keep the ducts from shearing.

C. Provide with a fine sand cover for initial curing except where waived by KU IT in writing.

D. Rebar reinforcement is required where duct banks will cross roadways, railways or similar heavily traffic areas.

E. Install a 6-inch orange warning tape labeled fiber optics. Install tape 12-inches above the entire conduit or duct bank.

F. Protect against rain, flooding, freezing, etc., during curing.

G. Ensure no honeycombing occurs and be properly vibrated with small vibrator. Do not vibrate between ducts.

H. Concrete for the duct bank shall be placed in such a way that the duct bank will not be disturbed and that the sides of the trench do not crumble, using splash boards, proper placement, etc. The vertical drop of concrete from chute shall not exceed 30-inches.

I. Concrete shall be poured continuous from manhole to manhole. No pours shall originate between manholes.

J. Interval between base or intermediate spacers shall not exceed 8 feet with a minimum of two supports per length of duct.

K. Make provisions, such as nylon ties, to prevent the ducts from floating when concrete is poured.

L. Color top layer of concrete encasement by using "ORANGE" (for telecommunications) chalk dust while still wet, or dye the concrete.

3.7 BACKFILL

A. Per Division 31 00 00 Earthwork (excavation, backfill, compaction, etc.).

3.8 DIRECTIONAL BORING

A. Boring Depths - Coil-able duct shall be directionally bored at standard burial depths of 36" of cover for ducts housing primary cables and 24"-36" of cover for ducts housing secondary

cables. KU IT Representatives shall approve any exceptions in writing to the specified burial depths, up to a maximum 60” of cover from final grade.

B. Duct Joining - Sections of coil- able duct shall be joined using fusion couplings. Where the coil-able duct is to be joined with PVC conduit, the Contractor is to fuse a 24” straight piece of matching size PVC conduit to the coil-able duct. Prior to fusing, the Contractor shall make circumferential scores around the outside of the PVC conduit at the end that is to be installed into the fusion coupling. This will allow the fusion coupling to adhere to the… dissimilar PVC conduit. A special epoxy is also available that joins the coil-able duct with standard PVC couplings. The epoxy and it application shall be approved with KU IT prior to installation.

C. Connections into Vaults and Manholes - Bored coil-able duct shall end 4’-5’ from a new vault or manhole. This coil-able duct shall then be transitioned to the same size PVC before connecting into the structure. The transition to PVC shall be made using the techniques described in duct joining.

D. Contractor shall be responsible for marking location and depth on surface for University of Kansas Facilities Planning and Development use. Contractor shall contact Facilities Planning and Development Office 864-4770, prior to commencement of work to allow them the opportunity to be present while work is being completed. And, to survey and establish locations and depths of directionally bored utilities.

3.9 MAINTENANCE HOLE CABLE SUPPORT

A. The cable supports described on the drawings or herein are intended to assist the Contractor in obtaining a satisfactory job and shall be altered to fit job conditions.

B. In general, all cables in manholes shall be supported on 4 feet maximum centers for straight runs, on each side of splices, and within 2 feet of cable entering or exiting a duct or termination.

C. Do not install supports so that cables will block or cross ducts.

3.10 EXCAVATION

A. Coordinate excavation with other trades, disciplines, specifications and drawing before starting work.

B. Verify all elevations and arrangements are correct and there are no conflicts with other utilities. Verify that the entryways into manholes, buildings and other structures meet KU IT Standards. It will be the responsibility of the Contractor and Design Team to ensure KU IT requirements are met. All corrections needed to meet KU IT Standards are the responsibility of the Contractor.

C. Verify all utilities shave been located. Contractor shall call Kansas One Call (1-800-DIG-SAFE; 1-800-344-7233) or (811), to request a utility locate ticket prior to beginning any excavation work, for onsite assistance in locating known underground utilities in the area of work. Complete all requirements of Kansas One Call before excavating. Report any conflicts or omitted utility locates to KU IT.

D. If soil conditions are such that because of the depth or any other reasons the trench/excavation cannot conform to the size of the duct bank, provide forms and bracing as required.
E. Contractor shall open entire length of trench and establish proper grades before beginning installation of any portion of connecting duct runs.
F. Coordinate and comply with the requirements of Division 310000 - Earthwork and Division 020000 and all related sections of the project specifications for Excavation, Backfill, Concrete, Asphalt Repairs and Related Work.
G. Depth of excavation shall be such that the required bury depths (top of concrete encasement) are met. KU IT prior to installation shall approve any deviation from required depths. It is the responsibility of the contractor to call for a KU IT inspection before closing any work.
H. Using GPS equipment, record depths of open-trench conduit pathways at 20ft intervals; where other utilities crosses over or under; at angle points and change of elevation.

3.11 REINFORCING:

A. Reinforcing shall be installed when the following conditions are present and as specified in the project documents and References listed with this section.
   1. Where noted on drawings and /or as specified herein.
   2. Where connected to buildings and manhole walls, anchor there using projecting re-bars.
   3. Where crossing trenches for other work.
   4. At conduit joints.
   5. If continuous pour is impractical, provide (4) #4 reinforcing bars extending 6 feet into first and second pour.
   6. Where trenches cross roadways and railways.
   7. Reinforcing shall be supported from bottom of trench at least one inch and is not required if conduits are supported by saddles.

3.12 BACKFILL

A. Contractor shall contact University of Kansas Facilities Planning and Development Office, (785-864-5620) prior to backfilling any underground utility lines and shall allow adequate time during normal business hours for personnel to observe depths of all lines.
B. Shall not be installed until after concrete has reached initial set.
C. Cover with select fill void of stones and debris.
D. Meet all requirements of the University Standards for excavation, backfill, compaction, and restoration.
E. The Contractor shall restore landscape to its original condition or as specified by the project documents.

3.13 WARRANTY & AS-BUILTS

A. The Contractor shall provide a 5 year warranty on materials and labor for all work associated with duct banks, manholes, hand-holes, associated apparatus and all other infrastructure components associated with this section. A certificate of warranty shall be provided to KU IT as part of closeout prior to final invoice.
B. The Contractor shall provide as-built drawings and documentation to KU IT prior to final payment for this work.
C. As-built information shall be in electronic form; (AutoCAD) drawing and .csv file. Indicate location of all underground routes within the work area.
D. If construction drawings are not utilized, Contractor shall provide all telecommunications location information on an accurate scaled AutoCAD formatted site plans.

END OF SECTION 270543

27 05 44 – Sleeves and Sleeve Seals for Communications Systems

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification and Standard Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   3. Sleeve-seal fittings.
   4. Grout.
   5. Silicone Sealants.

1.3 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 270000 “Communications”.
   1. Product Information
      a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
      b. Provide manufacturer’s product information cut sheet or specifications sheet with the specific product number identified or filled out.

B. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 270000 “Communications”.
   1. Manufacturer and Maintenance Manuals for all installed equipment.
      a. Provide manufacturer’s product information cut sheet or specifications sheet with the specific product number identified or filled out.
   2. Deliver to owner any special tools produced by the manufacturer required to install or uninstall any component of the system.

PART 2 – PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
   1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
   2. Cast-Iron Pipe Sleeves: Cast or fabricated “wall pipe,” equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6 mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw fastening the sleeve to the board.
C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
E. Molded-PE or –PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
F. Sleeves for Rectangular Openings:
   1. Material: Galvanized-steel sheet
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Advance Products & Systems, Inc.
      b. CALPICO, Inc.
      c. Metraflex Company (The).
      d. Pipeline Seal and Insulator, Inc.
      e. Proco Products, Inc.
   2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Stainless Steel.
   4. Connecting bolts and Nuts: Stainless Steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. https://www.gptindustries.com/en/products/link-seal

2.4 GROUT

A. Description: No shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicon Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floor s and other horizontal surfaces that are not fire rated.
   2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 – EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED COMMUNICATIONS PENETRATIONS

A. Comply with NECA 1.
B. Comply with NEMA VE 2 for cable tray and cable penetrations.
C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint.
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surface smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4" annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls if possible. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed though walls 2-inches away from wall on each side. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors if possible.
D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work and approved by manufacturer of roof/roofing material so as to not void roof warranty.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure mailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 270544

27 05 45 – Penetration Fire-stopping for Communications Systems

PART 1 – GENERAL

1.1 SUMMARY

A. This section shall govern the products and installation of all necessary parts, pieces and accessories of a UL Listed penetration fire-stopping system for communication systems.

B. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications and Standard Sections, apply to this section.

1.3 REFERENCES

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 Penetration Fire-stop Systems”.
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 Fire-stops”.
G. Underwriters Laboratories Inc. (UL) – Fire Resistance Directory
H. National Fire Protection Association (NFPA) – NFPA 101: Life Safety Code.
I. National Fire Protection Association (NFPA) – NFPA 70: National Electrical Code.

1.4 PERFORMANCE REQUIREMENTS

A. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur, such devices shall:

1. Meet the hourly rating of the floor or wall penetrated.
2. Permit the allowable cable load to range from 0% to 100% visual fill thereby eliminating the need to calculate allowable fill ratios.
3. Not require any additional action on the part of the installer to open or close the pathway device or activate the internal smoke and fire seal, such as, but not limited to:
   a. Opening or closing of doors.
   b. Twisting an inner liner.
   c. Removal or replacement of any material such as, but not limited to, sealant, caulk, putty, pillows, bags, foam plugs, foam blocks, or any other material.
4. Permit multiple devices to be ganged together to increase overall cable capacity.
5. Allow for retrofit to install around existing cables.

6. Include an optional means to lengthen the device to facilitate installation in thicker barriers without degrading fire or smoke sealing properties or inhibiting ability of device to permit cable moves, add-ons, or changes.

B. Where single cables (up to 0.27 in. (7 mm) diameter) penetrate gypsum board/stud wall assemblies, a fire-rated cable grommet may be substituted. Acceptable products shall be molded from plenum-grade polymer and conform to the outer diameter of the cable forming a tight seal for fire and smoke. Additionally, acceptable products shall lock into the barrier to secure cable penetration.

C. Where non- mechanical products are utilized, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction.

D. Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.

E. Cable trays shall terminate at each barrier and resume on the opposite side such that cables pass independently through fire-rated pathway devices. Cable tray shall be rigidly supported independent from fire-rated pathway devices on each side of barrier.

F. It shall be assumed that all wall penetrations require at a minimum a fire-stop system which provides a 1-hour rating. It shall also be assumed that any existing penetration used by a contractor for cabling is “owned” by that contractor. They shall be responsible for providing the appropriate fire-stopping materials to fire-stop the penetration regardless of whether fire-stopping existed at the beginning. Any fire-stopping material removed during cable installation shall be replaced with like material.

1.5 SUBMITTAL

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:

1. Product Information
   a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
   b. Provide manufacturer’s standard catalog data for specified products demonstrating compliance with referenced standards and listing numbers of systems in which each product is to be used.
   c. Provide manufacturer’s product information cut sheet or specifications sheet with the specific product number identified or filled out.
2. Product Schedule: For each penetration fire-stopping system. Include location and design designation of qualified testing and inspecting agency.
   a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration fire-stopping condition, submit illustration, with modifications marked, approved by penetration fire-stopping

manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

B. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 27 00 00 Communications:
   1. Record Drawings
      a. In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8” = 1’-0”) indicating the location of fire-stop penetrations. Design drawings or shop drawings modified in the field will not be accepted.
      b. Installer Certificates: From Installer indicating penetration fire-stopping has been installed in compliance with requirements and manufacturer’s written recommendations.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing penetration fire-stopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration fire-stopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

B. Fire-Test-Response Characteristics: Penetration fire-stopping shall comply with the following requirements:
   1. Penetration fire-stopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
   2. Penetration fire-stopping is identical to those tested per testing standard referenced in "Penetration Fire-stopping" Article. Provide rated systems complying with the following requirements:
      a. Penetration fire-stopping products bear classification marking of qualified testing and inspecting agency.
      b. Classification markings on penetration fire-stopping correspond to designations listed by the following:
         i. UL in its "Fire Resistance Directory."
         ii. Intertek ETL SEMKO in its "Directory of Listed Building Products."
         iii. FM Global in its "Building Materials Approval Guide."

1.7 DELIEVERY, STORAGE, AND HANDLING

A. Delivery:
   1. Manufacturer’s original, unopened, undamaged containers, identification labels intact identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable; qualified testing and inspection agency’s classification marking; and mixing instruction for multicomponent products.

2. Handle and store products according to manufacturer's recommendations published in technical materials. Leave products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.

B. Storage and Protection:
1. Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.8 PROJECT CONDITIONS

A. Do not install fire-stopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer.
B. Do not install fire-stopping products when substrates are wet due to rain, frost, condensation, or other causes.
C. Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.
D. Do not use materials that contain flammable solvents.
E. Coordinate construction of openings and penetrating items to ensure that through-penetration fire-stop systems are installed according to specified requirements.
F. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire-stop systems.
G. Schedule installation of fire-stopping after completion of penetrating item installation but prior to covering or concealing of openings.

PART 2 – PRODUCTS

2.1 MANUFACTUERS

A. Subject to compliance with requirements, provide products by one of the following:
1. Specified Technologies, Inc.
B. Substitutions: No substitutions shall be allowed for Fire Rated Cable Pathways.

2.2 MATERIALS

A. General: Use only fire-stopping products that have been tested for specific fire resistance rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.
B. Fire-stop Sealants: STI SpecSeal® Brand single component latex formulations that upon cure do not re-emulsify during exposure to moisture. Fire-stop Sealants shall be used to fill annular space around between wall substrate and sleeve. The following products are acceptable:
1. Specified Technologies Inc. (STI) SpecSeal® Series SSS Sealant
2. Specified Technologies Inc. (STI) SpecSeal® Series LCI Sealant
C. Fire-stop Putty: STI SpecSeal® Brand intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds. Fire-stop Putty shall be used

to seal through-penetrations such as traditional conduit sleeves. The following products are acceptable:

1. Specified Technologies Inc. (STI) SpecSeal® Series SSP Putty

D. Fire-stop Pillows: STI SpecSeal® Brand re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag. Fire-stop Pillows shall be used to seal large through penetrations such as those created to allow cable trays to pass through fire rated walls. The following products are acceptable:

1. Specified Technologies Inc. (STI) SpecSeal® Series SSB Pillows

E. Fire Rated Cable Pathways: STI EZ-PATH™ Brand device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill. STI EZ-PATH shall be used for sleeves into Telecommunications Spaces and shall be the base standard for penetrations into classrooms/labs/offices, etc. that require a fire-stopped penetration. At minimum, each telecommunications space shall have two (2) SERIES 44+ sleeves from the telecommunications space to the adjacent accessible corridor. At minimum each stacked telecommunications space shall have one (1) EZ-PATH Pathway Module (EZD444MBS) installed between floors. Coordinate penetration with Architect and Structural Engineer during design. At minimum, one (1) EZ-PATH Series 22 Fire Rated Pathway shall be used to enter classrooms/labs/offices that require a fire-stopped penetration. The following products are acceptable:

1. Specified Technologies Inc. (STI) EZ-PATH™ Fire Rated Pathway

F. Fire-stop Plugs: Re-enterable, foam rubber plug impregnated with intumescent material for use in blank openings and cable sleeves. Fire-stop Plugs shall only be used for existing 2-inch or 4-inch penetrations that require fire-stopping. The following products are acceptable:

1. Specified Technologies, Inc. (STI) SpecSeal Series FP Fire-stop Plug

G. Fire-Rated Cable Grommet: Molded two-piece grommet made from plenum grade polymer with a foam inner core for sealing individual cable penetrations up to 0.27 in. (7 mm) diameter. Fire-Rated Cable Grommets shall be prohibited without prior approval by KU IT Representatives. If approved, the following products are acceptable:

1. Specified Technologies, Inc. (STI) Ready Fire-stop Grommet

PART 3 – EXECUTION

3.1 EXAMINATION

A. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of fire-stopping in accordance with manufacturer's installation instructions and technical bulletins.

B. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion.

C. Provide masking and temporary covering to protect adjacent surfaces.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install through-penetration fire-stop systems and fire-resistive joint systems in accordance with the required performance requirements and in accordance with the conditions of testing and classification as specified in the published design.

B. Comply with manufacturer's instructions for installation of fire-stopping products and the following.
   1. Seal all openings or voids made by penetrations to ensure an air and water resistant seal.
   2. Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of through-penetration fire-stop systems that might hamper the performance of fire dampers as it pertains to duct work.
   3. Protect materials from damage on surfaces subjected to traffic.
   4. Apply a suitable bond-breaker to prevent three-sided adhesion in applications where this condition might occur such as the intersection of a gypsum wallboard/steel stud wall to floor or roof assembly where the joint is backed by a steel ceiling runner or track.
   5. Where joint application is exposed to the elements, fire-resistive joint sealant must be approved by manufacturer for use in exterior applications and shall comply with ASTM C-920, "Specification for Elastomeric Joint Sealants".

C. Perimeter Containment: Comply with manufacturer's instructions for installation of perimeter fire containment system products.
   1. Seal all slab-edge openings to ensure an air and water resistant seal.
   2. Curtain wall insulation that is an integral component of the perimeter fire containment system shall be installed in accordance with the conditions of testing and classification as specified in the published design and shall comply with thermal insulation requirements as specified in Section 07210 Building Insulation.
   3. Safing insulation shall be installed with the grain oriented vertically to maintain effective compression between edge of floor assembly and curtain wall.

3.3 IDENTIFICATION

A. Comply with Section 270553 “Identification for Communications Systems”

B. A fire-stop identification label shall be applied to the wall substrate adjacent to the through penetration or joint fire-stop system.

C. At minimum, the label shall contain the following information:
   1. Fire-stop Identification per Section 270553
   2. Fire-stop product/system used
   3. Installation Company
   4. Penetration Hour Rating
   5. Installation Date

3.4 FIELD QUALITY CONTROL

A. Inspections: Owner shall engage a qualified independent inspection agency to inspect through-penetration fire-stop systems.
B. Keep areas of work accessible until inspection by authorities having jurisdiction.
C. Where deficiencies are found, repair or fire-stopping products so they comply with requirements.

3.5 ADJUSTING AND CLEANING

A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.
B. Clean all surfaces adjacent to sealed openings to be free of excess fire-stopping materials and soiling as work progresses.

END OF SECTION 270545

27 05 53 – Identification for Communications Systems

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

A. Section Includes:
   1. Cabling identification products.

PART 2 – PRODUCTS

2.1 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-A and UL969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
B. The size, color, and contrast of all labels should be selected to ensure that the identifiers are easily read. Labels should be visible during normal maintenance of the infrastructure.
C. Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light), and should have a design life equal to or greater than that of the labeled component.
D. The text on labels shall be machine generated.

PART 3 – EXECUTION

3.1 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-A.
   1. Administration Class: 4
B. Labels for equipment identification shall comply with TIA-606-A for Class 4 level of administration including the following optional identification requirements of these standards:
   1. Outdoor Telecommunication Spaces
   2. Outside plant pathways
C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project to KU IT.
D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone cables, entrance cables, terminal hardware and positions, horizontal cables, work

areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:
   1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
   3. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
      a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with a name and number of particular device as shown.
      b. Label each unit and field within distribution racks and frames.
   4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA-606-A, for the following:
   1. Cables use flexible vinyl or polyester that flexes as cables are bent.

G. The alphabetical letters “I”, “O”, and “Q” shall be excluded from use in all labels.

3.2 CAMPUS OR SITE IDENTIFIER

A. A unique campus or site identifier shall be assigned to each campus or site.
   1. The campus or site identifier shall be coordinated with KU IT and should comply with TIA-606-A.
   2. The campus or site identifier shall have the format:

c	where c is a one or more alphanumeric characters identifying a campus or site. The following identifiers shall be used for the University of Kansas:
LMC	Lawrence Main Campus
LAW	Remote buildings throughout Lawrence
KUEC	University of Kansas Edwards Campus in Overland Park, KS
KUMC	University of Kansas Medical Center in Kansas City, KS
LETC	Law Enforcement Training Center in Hutchinson, KS

   3. There are no labeling requirements for the campus or site identifier. It may however, be used as part of other identifiers.

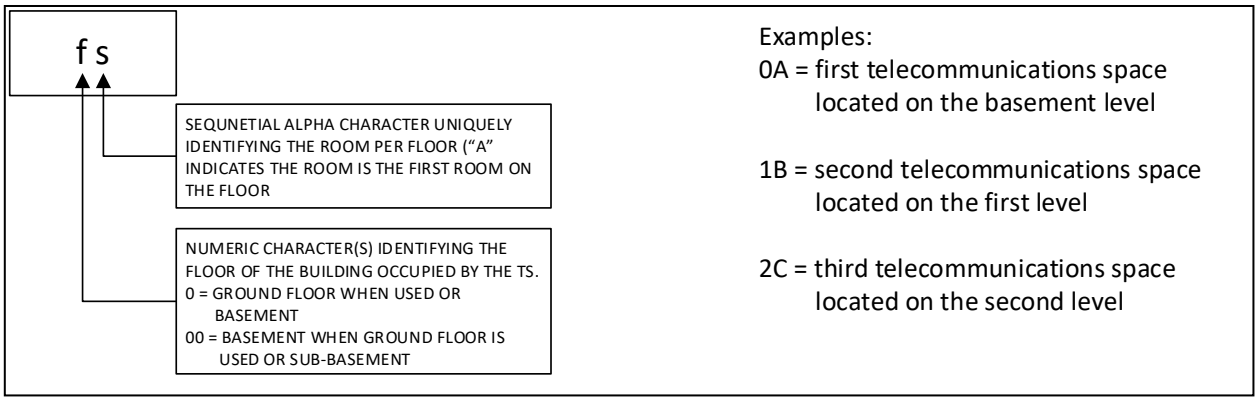
3.3 BUILDING IDENTIFIER

A. A unique building identifier has been assigned to each building.

1. The building identifier shall be coordinated with KU IT and should comply with TIA-606-A.
2. The building identifier shall have the format:
   b where b is four numeric characters identifying the building
3. There are no labeling requirements for the building identifier. It may however, be used as part of other identifiers.

3.4 TELECOMMUNICATIONS SPACE IDENTIFIER

A. Labels shall be preprinted or computer-printed type.
   1. The TS identifier shall be coordinated with KU IT and should comply with TIA-606-A.
   2. The TS identifier shall have the format:
      fs
      Where:
      f numeric character(s) identifying the floor of the building occupied by the TS
      s alpha character(s) uniquely identifying the TS on floor "*f*", or the building area in which the space is located.



   3. For buildings with non-numeric floors, alpha-numeric characters may be used in the "f" format and shall be consistent with the floor naming convention used within the building.
   4. All TS identifiers in a single infrastructure should have the same format where possible.
   5. The TS shall be labeled with the TS identifier inside the room so as to be visible to someone working in that room.

3.5 OUTDOOR TELECOMMUNICATIONS SPACE IDENTIFIERS

A. Labels shall be preprinted or computer-printed type.
   1. The outdoor telecommunications space identifier shall be coordinated with KU IT and should comply with TIA-606-A.
   2. The outdoor telecommunications space identifier shall have the format:
      c-T
      Where:

c optional campus identifier
T identifier of outside space (e.g. PMH0101 for maintenance hole #101)
PMH Maintenance Hole
PHH Hand Hole
PTN Tunnel Access/Entrance Point
PPB Pull-box
PPE Pedestal

3. Outdoor telecommunications spaces shall be labeled on the maintenance hole lid, lid or pedestal lid.
4. Labeling shall be accomplished via machine printed labels. Text on labels should be a font without serifs, upper case and large enough to be easily read. Labels shall be durably affixed to the lids.

3.6 OUTSIDE PLANT PATHWAY IDENTIFIERS

A. Labels shall be preprinted or computer-printed type.
1. The outside plant pathway identifiers shall be coordinated with KU IT and should comply with TIA-606-A.
2. The outside plant pathway identifier shall have the format:

c_1-b_1-f_1s_1 /c_2-b_2-f_2s_2-UUU.n.d(q)

Where:

c_1-b_1-f_1s_1 origin telecommunication space identifier
c_2-b_2-f_2s_2 destination telecommunication space identifier
UUU Element identifier (e.g. PCN for pathway conduit, where existing only, PCC for pathway clay cell)
n numeric characters identify the pathway system sequence number – for example, conduit number in a multiple conduit duct bank. If there is only one element, n shall be 1.
d alpha characters identify the sub-duct sequence number – for example, conduit number 1 has three innerducts, the first innerduct shall be a, second shall be b, etc.
q conduit trade size(e.g. 4”)

NOTE: Outdoor telecommunications space identifiers may be used in place of the building space identifier within the outside plant pathway identifier.

3. The space closest to the main distributor of the campus or administration system cabling system hierarchy shall be listed first. For pathways between wire centers, the following hierarchy shall be followed: 1. Ellsworth Annex, 2. Computer Center, 3. Memorial Stadium, 4. McCollum Laboratory.
4. Outside plant pathways should be permanently labeled on both ends with their pathway identifiers. The labels should be on the exterior of the pathway so as not to be obscured when a cable is placed in the pathway. The label shall be permanent and legible to someone installing a cable in the pathway.

3.7 CABINET AND RACK IDENTIFIERS

A. Labels shall be preprinted or computer-printed type.

1. The Cabinet/Rack identifier shall be coordinated with KU IT and should comply with TIA-606-A.
2. The Cabinet/Rack identifier shall have the format:

   fs.xy

   Where:

fs	telecommunications space identifier
x	two alpha character(s) designating the cabinet/rack row identifier. Shall start at AA.
Y	two numeric characters designating the cabinet/rack location within the row. Shall start at 01.

3. Row position identifiers should be sequential, shall be unique, and shall use the same format for all rows within a room.
4. Wall spaces in rooms that do not use grids should have identifiers for each wall on which telecommunications equipment is mounted. The wall space should be divided into sections (corresponding to frame or cabinet numbers); the sections may either be the width of a typical block, cabinet or rack, or be the distance from the left edge of the wall in feet (rounded up to the nearest integer).
5. Each cabinet and rack shall be labeled on the front and rear, both top and bottom, in plain view with its identifier. Text on labels should be a font without serifs, upper case, and large enough to be easily read while standing near the cabinet or rack. Text on labels shall be machine printed, and the label color shall contrast with the background upon which they are affixed.

3.8 PATCH PANEL AND TERMINATION BLOCK IDENTIFIER

A. Labels shall be preprinted or computer-printed type.

1. The Patch Panel and Termination Block Identifier shall be coordinated with KU IT and should comply with TIA-606-A.
2. Patch panels mounted in cabinets and racks in a single vertical column shall have identifiers with the following formant

   $fs.x_1y_1\text{-}r_1$

   Where:

$fs.x_1y_1$	cabinet, rack, frame or wall segment identifier.
r_1	one or more alpha character(s) designating the patch panel location within the cabinet or rack beginning at the top. Horizontal cable managers are not included when sequencing patch panels.

3. Patch panels mounted where they are not in a single vertical column such as on frames and walls shall have identifiers with the following formant

   $fs.x_1y_1\text{-}r_1_r_2$

Where:

$fs.x_1y_1$ cabinet, rack, frame or wall segment identifier.

r_1 one or more alpha character(s) designating the vertical termination block or patch panel location, within the frame or wall section.

r_2 two numeric character(s) designating the horizontal termination block or patch panel location, within the frame or wall section.

Note that the underscore "_" character separates the vertical and horizontal coordinates.

4. Patch panels shall be labeled with their identifiers on the front, top, and center portion of the panel. For brevity, the building and room name does not need to be included for patch panels and/or other equipment mounted in each cabinet or rack.

3.9 PATCH PANEL PORT AND TERMINATION BLOCK POSITION IDENTIFIERS

A. Labels shall be preprinted or computer-printed type.

1. The following format shall be used to identify patch panel ports and termination block IDC connectors. The colon ":" is used between the characters designating the patch panel/termination block and the characters designating the port:

$fs.x_1y_1\text{-}r_1{:}P_1$

Where:

$fs.x_1y_1\text{-}r_1$ patch panel or termination block identifier.

P_1 two to three numeric characters designating the port on the patch panel or termination position on the termination block.

For patch panels that include subpanels (e.g. optical fiber patch panel):

P_1 = pn,

Where:

p one to two alphabetic characters that identifies the subpanel located within the patch panel starting sequentially from "A" and excluding "I", "O", and "Q".

n two numeric characters corresponding to the port number within the subpanel.

2. All ports on patch panels and all positions on termination blocks not already labeled from the factory shall be labeled with the corresponding port number or position number.
3. All subpanels not already labeled from the factory shall be labeled with their subpanel identifier.

3.10 INTER-BUILDING CABLE

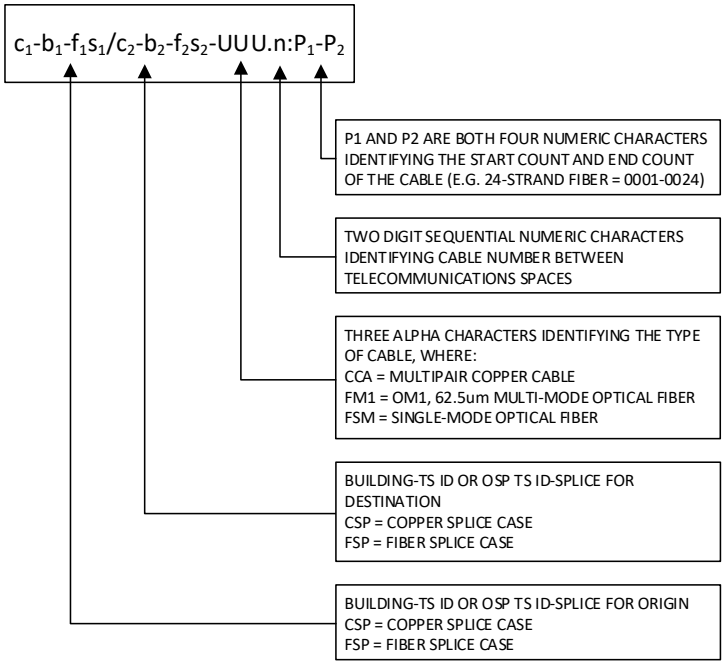
A. A unique identifier shall be assigned to each inter-building cable segment.

1. The inter-building identifier shall be coordinated with KU IT and should comply with TIA-606-A.
2. The inter-building identifier shall have the format:

   c_1-b_1-f_1s_1/c_2-b_2-f_2s_2-UUU.n:P_1-P_2

   Where:

c_1-b_1-f_1s_1	Campus identifier, building identifier and TS identifier for the origin space of the inter-building cable (c_1 = campus is optional).
c_2-b_2-f_2s_2	Campus identifier, building identifier and TS identifier for the destination space of the inter-building cable (c_2 = campus is optional).
UUU	Cable type identifier where: CCA = multi-pair copper cable FM1 = 62.5 µm multi-mode optical fiber (OM1) FSM = single-mode optical fiber (OS1/OS2)
n	two numeric characters identifying a single cable with one end terminated in the TS designated f_1s_1 and the other end terminated in the TS designated f_2s_2
P_1-P_2	P1 and P2 are both four numeric characters identifying the start count and end count of the cable (e.g. 24-strand fiber = 0001-0024)



Examples:
089A-FOT/PMH0081-FSP.FSM.01:0001-0288 = first single-mode optical fiber between building 89A, FOT and maintenance hole 81 fiber splice, 288 strand

PMH0081-FSP/PMH0179-FSP.FSM.02:0001-0096 = second single-mode optical fiber between maintenance hole 81 and maintenance hole 179, 96-strands

3. The campus identifier, building identifier and TS identifier may need to be replaced by the outdoor telecommunications space identifier for cables, which originate or splice/terminate in an outdoor telecommunications space (e.g. maintenance hole).

a. For Example: c-T where c is the campus identifier and T is the outside space identifier (e.g. PMH0101 for maintenance hole #101).

4. The termination closest to the main cross-connect in the telecommunications cabling hierarchy shall be listed first.
5. Cables shall be labeled on both ends and at within 12-inches of each entrance and exit of a maintenance hole, hand-hole, or splice case.
6. Cable labeling shall be accomplished via machine printed labels. Text on labels should be a font without serifs, upper case and large enough to be easily read. Labels shall be durably affixed to both ends of each cable conspicuously displayed prior to each cable being routed into the terminate device and within 12-inches of the end of the cable jacket.

3.11 BUILDING BACKBONE/RISER LINK IDENTIFIER

A. A unique building backbone link identifier shall be assigned to each backbone cable and to its elements.

B. Labels shall be preprinted or computer-printed type.

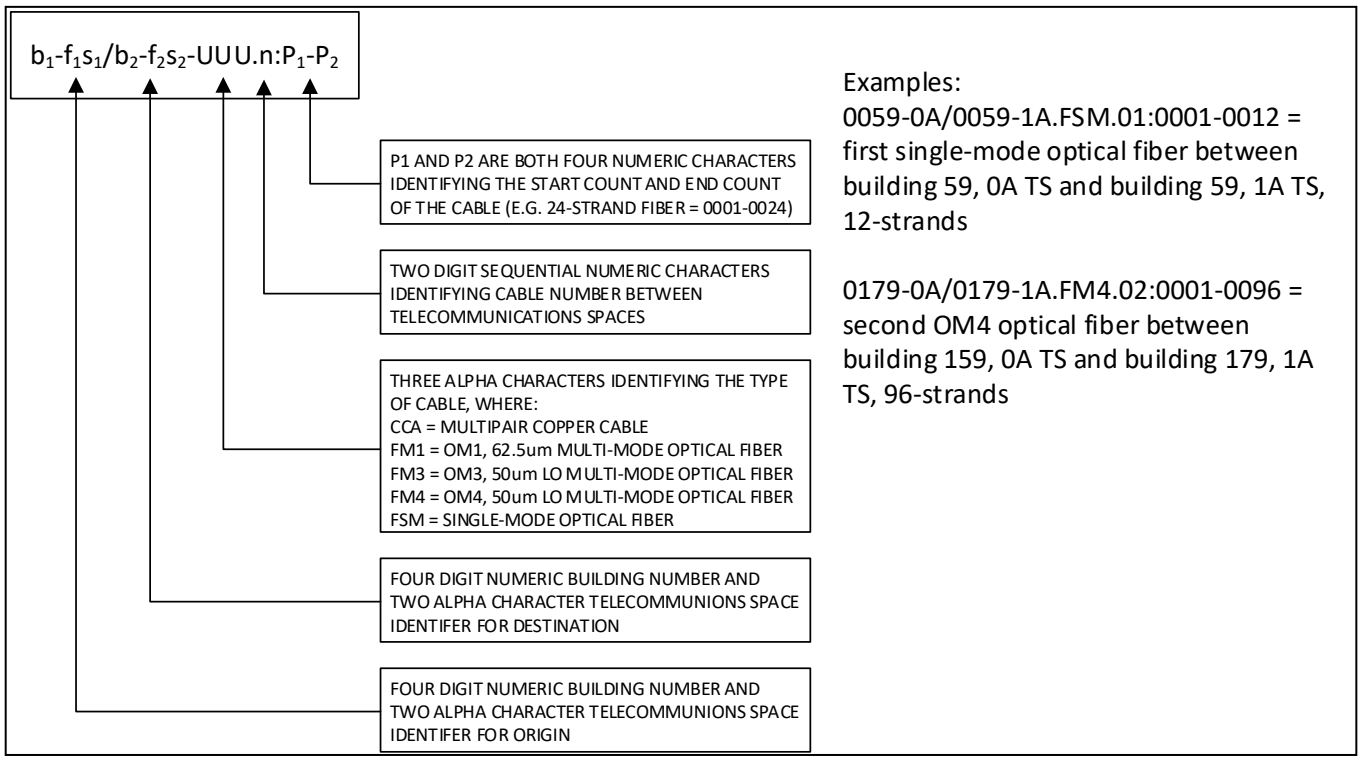
1. The building backbone link identifier shall have the format:

   $b\text{-}f_1s_1/b\text{-}f_2s_2\text{-}UUU.n{:}P_1\text{-}P_2$

   Where:

$b\text{-}f_1s_1$	Building identifier and TS identifier for the origin space of the building backbone link (cable).
$b\text{-}f_2s_2$	Building identifier and TS identifier for the destination space of the building backbone link (cable)
UUU	Cable type identifier where: CCA = multi-pair copper cable FM3 = 50 µm 300m laser-optimized multi-mode optical fiber (OM3) FM4 = 50 µm 550m laser-optimized multi-mode optical fiber (OM4) FM5 = 50 µm WideBand Multimode Fiber (WBMMF) FSM = single-mode optical fiber (OS1/OS2)
n	two numeric characters identifying a single cable with one end terminated in the TS designated f_1s_1 and the other end terminated in the TS designated f_2s_2
$P_1\text{-}P_2$	P1 and P2 are both four numeric characters identifying the start count and end count of the cable (e.g. 24-strand fiber = 0001-0024)

2. The termination closest to the main cross-connect in the telecommunications cabling hierarchy shall be listed first.



3. Cables shall be labeled on both ends.
4. Cable labeling shall be accomplished via machine printed labels. Text on labels should be a font without serifs, upper case and large enough to be easily read. Labels shall be durably affixed to both ends of each cable conspicuously displayed prior to each cable being routed into the terminate device and within 12-inches of the end of the cable jacket.

3.12 HORIZONTAL LINK IDENTIFIER

A. A horizontal link identifier, unique within the administration system, shall be assigned to each horizontal cable and to its elements.

B. Labels shall be preprinted or computer-printed type.

1. The horizontal link identifier shall have the format:

   fs-x1y1pp

   Where:

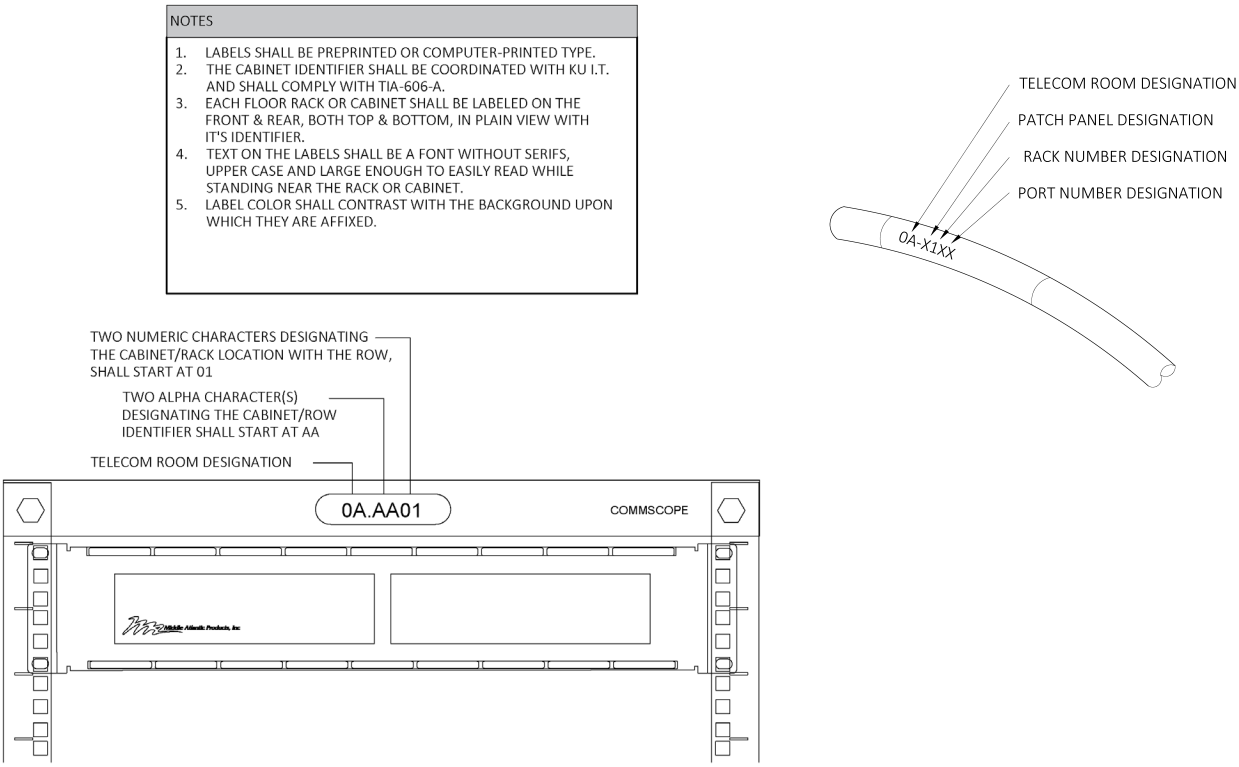
fs	telecommunications space identifier
x_1y_1	x_1 = row/patch panel rack position, y_1 = column/rack number
pp	two numeric characters designating the port on the patch panel or the termination block.

B. The horizontal link consists of the following elements:

1. The connecting hardware (e.g. patch panel port or the position of a termination block terminating a four-pair cable).
2. A four-pair horizontal cable.
3. An information/equipment outlet terminating a four-pair horizontal cable in the work area.

C. All elements of the horizontal link shall be labeled at the time they are installed with the horizontal link identifier.

D. Each end of a horizontal cable shall be labeled within 12-inches of the end of the cable jacket with the horizontal link identifier, which shall be visible on the exposed part of the cable jacket. This shall include each cable end in the TS and at the work area.



3.13 GROUNDING AND BONDING LABELING

A. PBB (primary bonding busbar) Identifier
   1. The PBB identifier is used to identify the single PBB present in a building.
   2. Label PBB(s) with “fs-PBB,” where “fs” is the telecommunications space identifier for the space containing the PBB.

B. SBB (secondary bonding busbar) Identifier
   1. The SBB identifier is used to identify SBBs in the bonding and grounding system. A unique SBB identifier shall be assigned to each SBB.
   2. Label SBB(s) with “fs-SBB,” where “fs” is the telecommunications space identifier for the space containing the SBB.

C. TBC (telecommunications bonding conductor) Identifier
   1. The TBC identifier is used to identify the TBC in the telecommunications bonding and grounding system. This identifier shall be unique.
   2. Label the TBC and each telecommunications backbone conductor at its attachment point on each end of the conductor: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"
   3. Label the TBC $f_m s_m/f_e s_e$=TCB where "$f_m s_m$" is the TS identifier for the space containing the PBB and "$f_e s_e$" is the TS identifier for the space, typically the electrical entrance facility, that contains the service equipment (power) ground to which the TBC is attached.
   4. Each TBC shall be labeled with its identifier on both ends. The labels shall be durably affixed to both ends conspicuously display just prior to the conductor being routed into its termination.
D. TBB (telecom bonding backbone) Identifier
   1. The TBB identifier is used to identify a TBB in the bonding and grounding system. The TBB is identified by the names of the telecommunications grounding busbars on either end of the TBB. This identifier shall be unique.
   2. The TBB identifier shall have the format:

      $f_m s_m$-PBB/$f_2 s_2$-SBB

      Where:

      $f_m s_m$-PBB = the identifier for primary bonding busbar;

      $f_2 s_2$-SBB = the identifier for the secondary bonding busbar.
   3. Each TBB shall be labeled with its identifier on both ends. The labels shall be durably affixed to both ends conspicuously display just prior to the conductor being routed into its termination.
E. BBC (backbone bonding conductor) Identifier
   1. The BBC identifier is used to identify a BBC in the bonding and grounding system. The This identifier shall be unique.
   2. The BBC identifier shall have the format:

      $f_m s_m$-PBB/$f_2 s_2$-BBC

      Where:

      $f_m s_m$-PBB = the identifier for primary bonding busbar

      $f_2 s_2$-SBB = the identifier for the secondary bonding busbar
   3. Each BBC shall be labeled with its identifier on both ends. The labels shall be durably affixed to both ends conspicuously display just prior to the conductor being routed into its termination.
F. Identifier for bonding conductor attached to PBB
   1. Labels shall be preprinted or computer-printed type and have the format:

      fs-PBB/object

      Where:

      Fs-PBB the identifier of the PBB

Object — the identifier of an object to which the bonding conductor is attached. It can be the identifier of a cabinet/rack, electrical panel, pathway, building steel (e.g. 'bldgsteel'), a cable tray system (e.g. cable trays) or the identifier of equipment such as a LAN switch.

2. All bonding conductors attached to a PBB shall be labeled with its identifier on both ends. The labels shall be durably affixed to both ends conspicuously display just prior to the conductor being routed into its termination.

G. Identifier for bonding conductor attached to SBB

1. Labels shall be preprinted or computer-printed type and have the format:

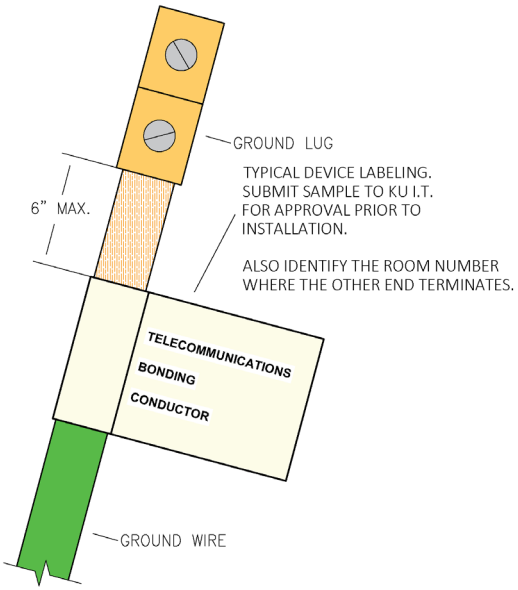
   fs-SBB/object

   Where:

   Fs-SBB — the identifier of the SBB

   Object — the identifier of an object to which the bonding conductor is attached. It can be the identifier of a cabinet/rack, electrical panel, pathway, building steel (e.g. 'bldgsteel'), a cable tray system (e.g. cable trays) or the identifier of equipment such as a LAN switch.

2. All bonding conductors attached to a SBB shall be labeled with its identifier on both ends. The labels shall be durably affixed to both ends conspicuously displayed just prior to the conductor being routed into its termination.



GROUND WIRE LABEL
NO SCALE

3.14 FIRE-STOPPING LOCATION IDENTIFIER

A. A fire-stopping location identifier shall identify each installation of fire-stopping material.

B. Labels shall be preprinted or computer-printed type.

1. The fire-stopping location identifier shall have the format:

b-f-FSLn(h)

Where:

b	three numeric characters identifying the building location
f	two numeric characters identifying the floor of the fire-stopping location
FSL	the letters 'FSL' that designate the element as being a fire-stopping Location
n	three numeric characters identifying one fire-stopping location
h	one numeric character to specify hour rating of the fire-stop system

C. Each fire-stopping location shall be labeled at each location where fire-stopping is installed, on each side of the penetrated fire barrier, within 12-inches of the fire-stopping material.

END OF SECTION 270553

27 08 13 – Copper Testing

PART 1 – GENERAL

1.1 SUMMARY

A. Test measurements shall be taken for all balanced-twisted pair cabling, including horizontal and backbone copper cables and wall-to-rack cables. Test all category cables in accordance with current TIA measurement specifications for that category of cabling with a field-test instrument meeting or exceeding Level IV accuracy. Provide test measurement results (in electronic format) a minimum of three weeks prior to substantial completion.

1.2 RELATED DOCMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions of Division 01 Specifications Sections, apply to this section.
B. Section 270000 “Communications” including all referenced codes, standards and guidelines.
C. Section 271300 “Communications Backbone Cabling”
D. Section 271500 “Communications Horizontal Cabling”

1.3 QUALITY ASSURANCE

A. All testing procedures and field-test instruments shall comply with applicable requirements of :
   1. ANSI/TIA-568-C.2
   2. ANSI/TIA-1152
B. Test measurements shall be performed by trained technicians who have successfully attended manufacturer training or BICSI Installer 2 Copper training.
C. The KU IT Representatives shall be invited to witness, review or both witness and review field-testing.
   1. Notify KU IT Representatives and Design Engineer of the testing start date at minimum five (5) business days before testing commences.
   2. After final test measurements have been completed and submitted, the KU IT Representatives or Design Engineer may select a random sample of up to 10% of the installed links that the telecommunications contractor is to retest at no cost to KU. If more than 2% of the sample results differ in terms of the pass/fail determination, the contractor, under supervision of KU IT Representatives, shall repeat 100% of the testing at no cost to KU.

1.4 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:
   1. Names of individuals that will be performing the testing and their training certificates (from BICSI or manufacturer).

2. Manufacturer's cut sheet or specifications sheet for the field-test instrument to be used, along with calibration data sheet.
3. Sample Test Report, which shall show that the field-test instrument software and firmware is up-to-date (the most recent version). This sample test report shall also show all required test parameters as required by the referenced standards.

B. The following submittals are due a minimum of three weeks prior to substantial completion, in accordance with the submittal requirements in Section 27 00 00 Communications:
1. Complete test measurement results indicating that all cable permanent links have passed. Submit electronic versions in their native format to the KU IT Representatives and the Design Engineer.
   a. Test measurement results in their native format and the manufacturer's PC software to read test results.

PART 2 – PRODUCTS

2.1 FIELD-TEST INSTRUMENT

A. Manufacturer shall be:
1. Fluke
2. JDSU
3. Or Approved Equivalent

B. The field-test instrument shall:
1. Be within the calibration period recommended by the manufacturer. The calibration date shall be included and/or printed on each test result.
2. Contain the most recent software and firmware provided by the manufacturer prior to testing.
3. Be a Level IV accuracy (or greater).
4. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.

C. Administration
1. The test measurement result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.
2. The test result records saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records

PART 3 – EXECUTION

3.1 GENERAL

A. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any test measurements performed on incomplete systems shall be redone upon completion of the work.

B. The records for each cable test measurement shall be provided to the owner a minimum of three weeks prior to substantial completion in the native format to the field-test instrument..

C. The installed twisted-pair links shall be tested from the telecommunications room to the telecommunication wall outlet in the work area for compliance with the "Permanent Link" performance specification.

D. If the Telecommunications Contractor is provisioning service, they shall test from the from the termination block/patch cord in the telecommunications room to the station cord/work area cord for compliance with the "Channel" performance specification for all activated outlets.

E. One hundred percent of the installed cabling links shall pass the requirements of the referenced standards. Any failing link shall be diagnosed and corrected. The corrective action shall be noted and followed with a new test measurement to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test measurements results documentation.

F. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. The test equipment (tester) shall comply with the accuracy requirements for Level IV field-test instruments as defined in ANSI/TIA-1152. The field test instrument, including the appropriate interface adapter, shall meet Level IV accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 2 of ANSI/TIA-1152 (Table 2 in this TIA document also specifies the accuracy requirements for the Channel configuration).

G. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests. Any Fail, Fail* or Pass* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass. The "*" shall not be turned off on the test instrument.

H. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester.

3.2 PERFORMANCE TEST PARAMETERS

A. Category 6 Installation UTP Performance Tests:

1. General Requirements

a. Every cabling link in the installation shall be tested in accordance with the field test specifications defined in TIA-568-C.2 "Commercial Twisted-Pair Telecommunications

Cabling and Components Standard." This document will be referred to as the "Category 6 Standard." Every cabling link in the installation shall be tested for:

i. Wire map.
ii. Length.
iii. Insertion loss.
iv. NEXT loss.
v. PS NEXT loss.
vi. ACR-F loss
vii. PS ACR-F loss
viii. Return loss
ix. Propagation delay.
x. Delay skew.

b. The installed twisted-pair horizontal links shall be tested from the telecommunications room to the telecommunication outlet in the work area for compliance with the "Permanent Link" performance specification as defined in the Category 6 Standard.
c. The RJ45 test plug shall fall within the values specified in TIA-568-C Annex C for NEXT, FEXT and Return Loss.

B. Performance Test Parameters – The test parameters are defined in the Category 6 Standard. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test, all measurements at each frequency in the range from 1 MHz through 250 MHz must meet or exceed the value determined in the above-mentioned standard.

1. Wire Map – The field tester shall report Pass if the wiring of each wire-pair from end to end is determined to be correct.
2. Length – The field tester shall be capable of measuring length of a basic link or channel based on the propagation delay measurement and the average value for Nominal Velocity of Propagation (NVP). The physical length shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (295 feet) plus 10% to allow for the variation and uncertainty of NVP.
3. Insertion Loss (Attenuation) – Insertion Loss is a measure of signal loss in the permanent link or channel. The term "Attenuation" has been used to designate "Insertion Loss." Insertion Loss shall be tested from 1 MHz through 250 MHz in a maximum step size of 1 MHz. It is preferred to measure Insertion Loss at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter. Minimum test results documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs, and the test limit value at this frequency.

4. NEXT Loss – Pair-to-pair near-end crosstalk loss (NEXT) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through 250 MHz. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the Category 6 Standard. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin and the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
5. PS NEXT Loss – Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link under-test (a total of eight results). PS NEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 through 250 MHz and the step size may not exceed the maximum step size defined in the Category 6 Standard. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS NEXT. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
6. ACR-F Loss, pair-to-pair – Attenuation Crosstalk Ratio Far-end is calculated from the pair-to-pair FEXT Loss. It shall be measured for each wire-pair combination from both ends of the link under-test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ACR-F Loss that must be evaluated and reported in the test results. ACR-F measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ACR-F is to be measured from 1 through 250 MHz and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the standard. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR-F. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
7. PS ACR-F Loss – Power Sum Attenuation Crosstalk Ratio Far-end is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields eight wire-pair combinations. Each wire-pair is evaluated from 1 through 250 MHz in frequency increments that do not exceed the maximum step

size defined in the standard. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

8. Return Loss – Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through 250 MHz in frequency increments that do not exceed the maximum step size defined in the Category 6 Standard. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
9. Propagation Delay – Propagation delay is the time required for the signal to travel from one end of the link to the other. This measurement is to be performed for each of the four wire pairs. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.
10. Delay Skew – This parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.

C. Category 6A Installation UTP Performance Tests
   1. General Requirements
      a. Every cabling link in the installation shall be tested in accordance with the field test specifications defined in ANSI/TIA-568-C.2 “Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard”. This document will be referred to as the “TIA Category 6A Standard.” Every cabling link in the installation shall be tested for:
         i. Wire Map
         ii. Length
         iii. Insertion Loss
         iv. NEXT Loss
         v. PS NEXT Loss
         vi. ACR-F Loss
         vii. PS ACR-F Loss
         viii. Return Loss
         ix. Propagation Delay
         x. Delay Skew

b. In addition to testing the “In-link” performance parameters detailed in above, Alien Crosstalk testing or “Between-link’ testing shall be carried out in accordance with Section 4.7 of ANSI/TIA-1152. Alien crosstalk testing includes the PS ANEXT and PS AACR-F (Power sum alien attenuation-to-crosstalk ratio from the far end) performance parameters. The standards refer to the link-under-test for Alien Crosstalk as the disturbed link.
c. PS ANEXT and PS AACR-F shall meet or exceed the limits defined in Section 6 of the TIA Category 6A Standard.
d. Selection of disturbed (victim) links:
e. Choose short, medium and long links equally.
f. Selection of disturber links. Select all of the links that are in the same cable bundle and the most consistently positioned relative to the disturbed link as disturbing links.
g. If the margin of PS ANEXT and PS AACR-F exceeds 5 dB for the first three short, medium and long links (nine in total), further alien crosstalk testing can be discontinued.
h. The installed twisted-pair horizontal links shall be tested from the IDF in the telecommunications room to the telecommunication wall outlet in the work area for compliance with the “Permanent Link” performance specification as defined in the TIA Cat 6A Standard.

2. Performance Test Parameters - The test parameters for Cat 6A are defined in the TIA Cat 6A standard. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test, all measurements (at each frequency in the range from 1 MHz through 500 MHz) must meet or exceed the limit value determined in the above-mentioned standard.
   a. Wire Map - Shall report Pass if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.
   b. Length - The field tester shall be capable of measuring length of all pairs of a basic link or channel based on the propagation delay measurement and the average value for NVP (1). The physical length of the link shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10% to allow for the variation and uncertainty of NVP.
   c. Insertion Loss (Attenuation) – Insertion Loss is a measure of signal loss in the permanent link or channel. The term “Attenuation” has been used to designate “Insertion Loss.” Insertion Loss shall be tested from 1 MHz through 500 MHz in maximum step size of 1 MHz. It is preferred to measure insertion loss at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter. Minimum test results

documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs, and the test limit value at this frequency.

d. NEXT Loss – Pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through 500 MHz. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the standard. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin (2) and the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

e. PS NEXT Loss – Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link under-test (a total of eight results). PS NEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 through 500 MHz and the step size may not exceed the maximum step size defined in the standard. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS NEXT. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

f. ACR-F, pair-to-pair – Attenuation Crosstalk Ratio Far-end is calculated from the pair-to-pair FEXT Loss. It shall be measured for each wire-pair combination from both ends of the link under-test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ACR-F Loss that must be evaluated and reported in the test results. ACR-F measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ACR-F is to be measured from 1 through 500 MHz and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the standard. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR-F. These wire pairs must be identified for the tests performed

from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

g. PS ACR-F Loss – Power Sum Attenuation Crosstalk Ratio Far-end is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields eight wire-pair combinations. Each wire-pair is evaluated from 1 through 500 MHz in frequency increments that do not exceed the maximum step size defined in the standard. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

h. Return Loss – Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through 500 MHz in frequency increments that do not exceed the maximum step size defined in the standard. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

i. Propagation Delay – Propagation delay is the time required for the signal to travel from one end of the link to the other. This measurement is to be performed for each of the four wire pairs. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.

j. Delay Skew [as defined in the TIA Cat 6A Standard; Section 6.2.19] - This parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.

k. PS ANEXT - Pair-to-pair Alien NEXT (ANEXT) contributions is measured by applying the stimulus signal at the near end to one wire pair of a disturbing link and measuring the coupled signal at the near end of a wire pair in a disturbed link. This process is repeated for every wire pair in a disturbing link. The PS ANEXT for each wire pair in a disturbed link is obtained by the power sum addition of all the pair-to-pair ANEXT results to that wire pair from all wire pairs in disturbing links. All the links that are bundles with the disturbed link need to be included as disturbing links. In addition, links that are terminated in adjacent positions in a patch panel or interconnect panel should also be included as disturbing links in this test. Minimum test results documentation (summary results): Identify the wire pair that exhibits

the worst-case margin and the wire pair that exhibits the worst value for PS ANEXT. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

l. PS AACR-F - The pair-to-pair Alien Far End crosstalk (AFEXT) contributions is measured by applying the signal at the near end to one wire pair of a disturbing channel or permanent link and measuring the coupled signal at the far end of a wire pair in a disturbed channel or permanent link. This process is repeated for every wire pair in a disturbing link and for all links in close proximity. A normalization, which is dependent on the relative length of disturbing and disturbed link, is applied to each pair-to-pair alien FEXT measurement. Then the PS Alien Attenuation-to-Crosstalk Ratio from the Far end (PS AACR-F) for each wire pair in a disturbed channel or permanent link is obtained by the power sum addition of all the normalized pair-to-pair far end alien crosstalk results to that wire pair from all wire pairs in disturbing links in close proximity. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS AACR-F. if the link or channel connects two patch panels (data center), these wire pairs must be identified for the tests performed from both ends. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

3. Test Result Documentation
   a. The test results/measurements shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time.
   b. The database for the completed job shall be stored and delivered on CD-ROM or DVD including the software tools required to view, inspect, and print any selection of test reports.
   c. The test results shall also be published in a PDF format and provided to KU IT electronically so they may be reviewed without the need of special software.
   d. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information
   e. The identification of the link in accordance with the naming convention defined in the overall system documentation
   f. The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number
   g. The date and time the test results were saved in the memory of the tester.
   h. General Information to be provided in the electronic data base with the test results information for each link:
   i. The identification of the customer site as specified by the end-user

j. The identification of the link in accordance with the naming convention defined in the overall system documentation
k. The overall Pass/Fail evaluation of the link-under-test
l. The name of the standard selected to execute the stored test results
m. The cable type and the value of NVP used for length calculations
n. The date and time the test results were saved in the memory of the tester
o. The brand name, model and serial number of the tester
p. The identification of the tester interface
q. The revision of the tester software and the revision of the test standards database in the tester
r. The test results information must contain information on each of the required test parameters that are listed in Section B and as further detailed below under paragraph C5 & C6.
s. In-link (In-Channel) detailed test results. The detailed test results data to be provided in the electronic database for must contain the following information:
t. For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.
u. Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m (1) and the test limit value
v. Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value
w. Delay Skew: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns) and the test limit value
x. Insertion Loss (Attenuation): Minimum test results documentation as explained in Section B for the worst pair
y. Return Loss: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link
z. NEXT, ACR-F: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link
aa. PS NEXT and PS ACR-F: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link
bb. Between-Link (Between-Channel) Test Results Data - A test report shall be provided for each disturbed link included in the Alien Crosstalk sample test. This test report must contain
cc. PS ANEXT results at each frequency for each wire pair in a victim link as well as the PS ANEXT results for the average of these four wire pairs. The worst case margin

and the worst values shall be provided for each wire pair and the average of the four wire pairs. PS ANEXT shall be measured and tested from the end of the link or channel where all cables are terminated at a distribution panel. In case the cabling runs from panel to panel (data center) where the worst case PS ANEXT margin is less than 2 dB, the PS ANEXT test results for each disturbed link shall be collected and saved from both ends (both panels) of the disturbed link.

dd. PS AACR-F results at each frequency tested for each wire pair in a disturbed link as well as the PS AACR-F results for the average of the four wire pairs. The worst case margin and the worst values shall be provided for each wire pair and the average of the four wire pairs. PS AACR-F only needs to be measured and tested from one end of the link or channel. Connect the main DTX-1800 unit (measurement of PS AACR-F disturbance) to the disturbed link or channel at the end where all cabling links are terminated at a distribution panel. Select End 1 in the AxTalk Analyzer Software.

3.3 ADMINISTRATION

A. Test results documentation

1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., “as saved in the field-test instrument”.
2. The test results documentation shall be available for inspection by the Owner or the Owner’s representative during the installation period. The contractor shall retain a copy to aid preparation of as-built information.
3. The records for each test shall be provided to the owner a minimum of three weeks prior to substantial completion in the native format to the test instrument.
4. Circuit IDs reported by the field-test instrument shall match the label ID specified by the Owner/Design Engineer Drawings.
5. The detailed test results documentation data is to be provided in an electronic database for each tested link and shall contain the following information
   a. The identification of the customer site as specified by the end-user
   b. The identification of the link in accordance with the naming convention defined in the overall system documentation.
   c. The name of the standard selected to execute the stored test results
   d. The cable type and the value of NVP used for length calculations.
   e. The name of the test personnel
   f. The date and time the test results were saved in the memory of the tester
   g. The manufacturer, model and serial number of the field-test instrument
   h. The version of the test software and the version of the test standards database held within the test instrument
   i. The date the tester was last calibrated by the manufacturer.

j. The copper identification number
k. The length for each copper cable
l. The overall Pass/Fail evaluation of the link-under-test.
m. The test results information must contain information for each of the required test parameters that are listed in the performance test parameters for each category of cabling tested.

END OF SECTION 27 08 13

27 08 16 – Optical Fiber Testing

PART 1 – GENERAL

1.1 SUMMARY

A. Test measurements shall be taken for optical fiber cabling, including horizontal and backbone optical fiber cables and wall-to-rack cables. Test measurements shall be carried out in accordance with the Tier 2 specification of ANSI/TIA-568-C.0, Annex E. Tier 2 testing is a higher level of testing that provides qualitative measures of the installed condition and performance of the cabling system and its components. Tier 2 testing includes length measurement, attenuation measurement, verifying polarity using an optical lost test set (OLTS) and obtaining a trace and event table of the fiber with an optical time domain reflectometer (OTDR). OTDR traces are used to evaluate the installed cabling for anomalies and assuring uniformity of cable attenuation and connector insertion loss.

B. Testing shall be performed on each optical fiber cabling link (adapter to adapter).

C. All tests shall be documented including OLTS dual wavelength attenuation measurements for multimode (850nm and 1300nm) and singlemode links (1310nm and 1550nm), OLTS length measurements for multimode and singlemode links, OTDR traces and event tables for multimode and singlemode links.

D. Provide test measurement results (in test set native electronic format) a minimum of three weeks prior to substantial completion.

E. *Though obsolete, 62.5/125 µm Multimode (OM1) Splice Insertion Loss and Cable Attenuation Performance is retained for maintenance and repair purposes. In this section, see Table 2 - Splice Insertion Loss; Table 3 - Optical Fiber Cable Attenuation Performance and Part 3 Execution, Optical Fiber Testing, Table 4 - Mandrel Sizing.

1.2 RELATED DOCMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions of Division 01 Specifications Sections, apply to this section.

B. Section 270000 “Communications” including all referenced codes, standards and guidelines.

C. Section 271300 “Communications Backbone Cabling”

D. Section 271500 “Communications Horizontal Cabling”

1.3 DEFINITIONS

A. Optical fiber cabling link: An optical fiber with an adapter on each end.

1.4 QUALITY ASSURANCE

A. All testing procedures and field-test instruments shall comply with applicable requirements of :

1. ANSI/EIA/TIA-455-50B, Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements

2. ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR.
3. ANSI/TIA/EIA-455-60A, Measurement of Fiber or Cable Length Using an OTDR.
4. ANSI/TIA/EIA-455-61A, Measurement of Fiber or Cable Attenuation Using an OTDR.
5. ANSI/TIA/EIA-526-7, Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant.
6. ANSI/TIA/EIA-526-14-A, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
7. ANSI/TIA -568-C.0, Generic Telecommunications Cabling for Customer Premises.
8. ANSI/TIA -568-C.3, Optical Fiber Cabling Components Standard.

B. Trained technicians who have successfully attended an optical fiber testing training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
   1. Manufacturer of the fiber optic cable and/or the fiber optic connectors.
   2. Manufacturer of the test equipment used for the field certification.
   3. Training organizations (e.g., BICSI, A Telecommunications Association).

C. The KU IT Representatives and the Design Engineer shall be invited to witness, review or both witness and review field-testing.
   1. The KU IT Representatives and the Design Engineer shall be notified of the testing start date, five (5) business days before testing commences.
   2. The KU IT Representatives and the Design Engineer may select a random sample of 5% of the installed links and test that sample. The measured results obtained from the random sample shall be compared to the data provided by the contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the contractor under supervision of the KU IT Representatives and the Design Engineer shall repeat 100% of the testing at no cost to the KU.

1.5 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:
   1. Names of individuals that will be performing the testing and their training certificates (from BICSI or manufacturer).
   2. Manufacturer’s cut sheet or specifications sheet for the field-test instrument to be used, along with calibration data sheet.
   3. Sample Test Report, which shall show that the field-test instrument software and firmware is up-to-date (the most recent version). This sample test report shall also show all required test parameters as required by the referenced standards.

B. The following submittals are due a minimum of three weeks prior to substantial completion, in accordance with the submittal requirements in Section 27 00 00 Communications:

1. Complete test measurement results indicating that all cable permanent links have passed. Submit electronic versions in their native format to the KU IT Representatives and the Design Engineer.
   a. Test measurement results in their native format and the manufacturer's PC software to read test results.

1.6 ACCEPTANCE OF TEST RESULTS

A. Link attenuation measurement and allowance calculation:
   1. The measured link attenuation shall be less than the link attenuation allowance. The link attenuation allowance is calculated as:
      a. Link Attenuation Allowance (dB) = Cable Attenuation Allowance (dB) + Connector Insertion Loss Allowance (dB) + Splice Insertion Loss Allowance (dB) where:
         i. Connector Insertion Loss Allowance (dB) = Number of Connector Pairs x 0.4dB
         ii. Splice Insertion Loss Allowance (dB) = Number of Splices x Splice Insertion Loss (dB, see Table 2)

Splice Insertion Loss		
Optical Fiber and Cable Type	Multimode Fusion	Singlemode Fusion
*62.5/125 µm Multimode (OM1)	0.1dB	N/A
50/125 µm Multimode (OM2)	0.1dB	N/A
Laser-Optimized 50/125 µm Multimode (OM3)	0.1dB	N/A
Laser-Optimized 50/125 µm Multimode (OM4) (OM5)	0.1dB	N/A
Singlemode (OS1/OS2)	N/A	0.05 dB

Table 2 - Splice Insertion Loss *1.1E page 120

         iii. Cable Attenuation Allowance (dB) = Maximum Cable Attenuation Coefficient (dB/km, see table below) x Length (km) (See Table 3)

Optical Fiber Cable Attenuation Performance		
Optical Fiber and Cable Type	Wavelength	Maximum Attenuation (dB/km)
*62.5/125 µm Multimode (OM1)	850 1300	3.5 1.5

50/125 µm Multimode (OM2)	850 1300	3.5 1.5
Laser-Optimized 50/125 µm Multimode (OM3)	850 1300	3.5 1.5
Laser-Optimized 50/125 µm Multimode (OM4) (OM5)	850 1300	3.5 1.5
Singlemode (OS1/OS2)	1310 1550	0.5 0.5

Table 3 - Optical Fiber Cable Attenuation Performance *1.1E page 120

b. All installed cabling links shall be field-tested and pass the link attenuation measurement and allowance calculation and OTDR analysis. Any optical fiber link that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation in accordance with Part 3.
c. Individual connector, splice and fiber insertion loss shall be evaluated using the OTDR trace. These components shall meet or exceed the values in 1.6, A.

PART 2 – PRODUCTS

2.1 OPTICAL FIBER CABLE TESTERS

A. The field-test instrument shall be within the calibration period recommended by the manufacturer.
B. The field-test instrument shall contain the most recent software and firmware provided by the manufacturer prior to testing.
C. Optical Lost Test Set (OLTS)
   1. The OLTS shall be cable of providing length measurement of the fiber under test.
   2. Multimode optical light source:
      a. Provide dual LED light sources with central wavelengths of 850 nm (±30nm) and 1300 nm (±20nm).
      b. Output power of -20 dBm minimum.
      c. The light source shall meet the launch requirements of ANSI/TIA-455-50B, Method A. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap with a Category 1 light source.

3. Singlemode optical fiber light source
    a. Provide dual laser light sources with central wavelengths of 1310 nm (±20 nm) and 1500 nm (±20 nm).
    b. Output power of –10 dB minimum.
4. Power Meter
    a. Provide 850nm, 1300nm and 1500nm wavelength test capability.
    b. Power measurement uncertainty of ± 0.25 dB.
    c. Store reference power measurement.
    d. Save at least 100 results in internal memory.
    e. PC interface (serial or USB).
5. Acceptable manufacturers, models:
    a. Fluke Networks, OptiFiber (OLTS and OTDR combined)
    b. Fluke Networks, DTX (OLTS; MFM2, SFM2)
    c. Approved equivalent

D. Optical Time Domain Reflectometer (OTDR)
1. Shall have a bright, color transmissive LCD display with backlight.
2. Shall have rechargeable Li-Ion battery for 8 hours of normal operation.
3. Internal non-volatile memory and removable memory device with at least 16 MB capacity for results storage.
4. Serial and USB ports to transfer data to a PC.
5. Multimode OTDR
    a. Wavelengths of 850 nm (± 20 nm) and 1300 nm (± 20 nm).
    b. Event dead zones typically of 0.5 m at 850 nm and 1.3 m at 1300 nm.
    c. Attenuation dead zones 4.5 m at 850 nm and 10.5 m at 1300 nm.
    d. Distance range 3 km at 850 nm and 7 km at 1300 nm.
    e. Dynamic range 15 dB at 850 nm and 14 dB at 1300 nm.
6. Single-mode OTDR
    a. Wavelengths of 1310 nm (± 25 nm) and 1550 nm (± 30 nm).
    b. Event dead zones typically of 1 m at 1310 nm and 1 m at 1550 nm.
    c. Attenuation dead zones typically of 8 m at 1310 nm and 8 m at 1550 nm.
    d. Distance range at least 60 km.
    e. Dynamic range 26 dB at 1310 nm and 24 dB at 1550 nm.
7. Acceptable manufacturers, models:
    a. Fluke Networks, OptiFiber (OLTS and OTDR combined with end face image capture)
    b. Fluke Networks, DTX (QUAD-OTDR)
    c. Approved equivalent

E. Administration
1. The test result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.

2. The test result records saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records.

PART 3 – EXECUTION

3.1 GENERAL

A. All tests performed on optical fiber cabling that use laser or LED in a test set shall be carried out with safety precautions in accordance with industry standards. NOTE – A visible fault locator (VFL) normally uses a Class2 or 3 light source and should not be directly viewed. Safe usage of the tool requires indirect viewing of the light source by pointing the end of the fiber at an adjacent surface (or introducing another surface in front of a fixed mounted connector) until the presence of light is determined.

B. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.

C. Dust caps shall be placed on fiber end faces or adapters for each optical fiber link after all testing is complete on the fiber link.

D. Testing shall be performed in accordance with ANSI/TIA-568-C.0, Annex E, Tier 2 testing on each cabling segment (i.e., verify polarity, measuring length, OLTS attenuation measurement, and OTDR trace).

E. Optical fiber link test results from the OLTS and OTDR shall be recorded in the memory of the field-test instrument.

F. Each optical fiber test shall be uploaded to a PC in which the administrative documentation (reports) shall be generated.

G. The records for each test shall be provided to the owner a minimum of two weeks prior to substantial completion in Excel format and the native format to the test instrument. The Owner can supply an Excel spreadsheet template upon request for the contractor's use.

3.2 OPTICAL FIBER TESTING

A. Polarity
   1. For duplex connector systems, polarity shall be verified. The polarity shall be verified with an OLTS while performing attenuation tests.

B. Length Measurement
   1. Each optical fiber link shall be measured for its length. The fiber length may be obtained by a capable OLTS or by OTDR.

C. Attenuation measurement (OLTS)
   1. General
      a. Optical sources shall be turned on for a minimum of five (5) minutes prior to referencing.
      b. Test jumpers shall be reference quality and between 1-meter and 5-meters in length.

c. Mandrels shall be used when testing attenuation of multimode optical fiber cabling with an OLTS. The mandrel sizes are shown in Table 4:

Fiber core/cladding size (µm)	900 µm buffered fiber (mm)	2.0 mm jacketed cable (mm)	2.4 mm jacketed cable (mm)	3.0 mm jacketed cable (mm)
50/125	25	23	23	22
*62.5/125	20	18	18	17

Table 4 - Mandrel Sizing *1.1E page 120

d. Where mandrels are used, secure the mandrel to the light source by some means such as a Velcro or tape. Care should be taken to ensure that the fiber jacket is not deformed or damaged when using Velcro or tape.
e. The light source shall be referenced to the meter a minimum of twice daily (i.e., in the morning and noon).
f. Fiber test jumpers shall be of the same core size as the cabling under test (e.g., singlemode to singlemode, 62.5µm multimode to 62.5µm multimode, 50µm multimode to 50µm multimode). Additionally the test jumpers shall meet the performance specifications of the fiber under test and that of the test instrument manufacturer.
g. Fiber test jumpers shall be cleaned prior to connection to the test instrument. After cleaning, cleaning solutions shall be given sufficient time to evaporate (approximately 30 seconds) prior to the mating of fiber test jumper to the test instrument.
h. The end of the fiber test jumper that will connect to the fiber link to be tested, the adapters and fiber under test shall be cleaned immediately prior to each fiber being tested. After cleaning, cleaning solutions shall be given sufficient time to evaporate (approximately 30 seconds) prior to the mating of fiber test jumper to the fiber under test.
i. The test jumper connected to the source shall not be removed after referencing so as not to adversely influence the attenuation measurement. Removal and reattachment of the test jumper connection from the source may affect the referenced power level. Re-referencing is to be performed if the test jumper is disconnected from the light source.
j. Singlemode optical fiber links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1, One Reference Jumper.
k. Multimode optical fiber links shall be tested at 850 nm and 1300 nm in accordance with ANSI/TIA/EIA-526-14-A, Method B, One Reference Jumper.

l. Multimode and singlemode optical fiber links shall be measured and reported for attenuation in each direction and attenuation bi-directionally (averaged in both directions). The measurements shall be less than or equal to the link attenuation allowance calculation (see Part 1, 1.6, A.).

2. Steps to measure and calculate optical fiber link attenuation include a) verifying test jumper quality; b) setting the reference; c) measuring link attenuation; and d) calculating link attenuation.

This example below describes the process when testing multimode fiber with the test jumper connected to the source having five non-overlapping wraps of multimode fiber on a mandrel. The procedure is also applicable to single-mode cabling, however, the five non-overlapping wraps of multimode fiber would be replaced with a single 30 mm (1.2 in) diameter loop of single-mode fiber.

a. Verifying test jumper quality
   i Test jumpers shall be tested for quality prior to use as a test jumper. To verify that the test jumpers are in acceptable condition, first reference the light source to the optical power meter. Disconnect test jumper (J_1) from the power meter (only) and insert a second test jumper (J_2) by connecting it to the power meter and to (J_1) with a mating adapter and record the measurement. Disconnect both ends of J_2, interchange the ends, and reconnect it and record the measurement. The resulting measurements, P_{verify}, should be within the appropriate connector loss specification. For example, if the connector used is specified at 0.32 dB, the reading on the power meter should be within 0.32 dB of P_1.
b. Setting the reference
   i One test jumper (J_1) is to be connected between the light source and the power meter and a reference measurement taken (P_1[dBm]). When testing a multimode optical fiber link, a mandrel wrap shall be applied to the test jumper (J_1) prior to setting the reference and for all subsequent measurements. When testing a singlemode optical fiber link, a single 30mm (1.2-inch) diameter loop shall be applied to the test jumper (J_1) prior to setting the reference and for all subsequent measurements.
c. Measuring link attenuation
   i Connect the end of test jumper (J_1)(source end) to one end of the link, and connect a verified test jumper (J_2) between the other end of the link and the meter. The optical power reading is P_2 (dBm).
d. Calculating link attenuation
   i Link attenuation shall be calculated by the OLTS. Calculated optical fiber link attenuation is applied by using the following equation.

   Attenuation (dB) = P_1(dBm) – P_2(dBm) where:
   P_1 = Reference power measurement

P_2 = Cabling test power measurement

3. Link attenuation measurement and allowance calculation
   a. The measured link attenuation shall be less than the link attenuation allowance (see Part 1, 1.6, A.).

D. OTDR Trace
1. An OTDR trace shall be taken of each optical fiber link in each direction to ensure uniformity of cable attenuation and connector insertion loss. Multimode fiber traces shall be taken at 850nm and 1300nm. Singlemode fiber traces shall be taken at 1310nm and 1550nm.
2. A launch cable to the length specified by the manufacturer of the OTDR shall be installed between the OTDR and the first link connection. The launch cable shall be of the same fiber type as the link under test.
3. A receive cable shall be installed after the last link connection to be part of the OTDR trace. The receive cable shall be at least 100m (328ft) in length and of the same fiber type as the link under test.
4. Selectable parameters affecting the OTDR measurement may include the test source wavelength, pulse duration or signal strength, length range, backscatter coefficient, signal averaging (time or count) and the group index of the fiber (also known as the index of refraction or the refractive index). The display shall be adjusted to view the region of interest on the trace on both the horizontal and vertical axes.

3.3 ADMINISTRATION

A. Test results documentation
1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., “as saved in the field-test instrument”.
2. The test results documentation shall be available for inspection by the Owner or the Owner’s representative during the installation period. The contractor shall retain a copy to aid preparation of as-built information.
3. The records for each test shall be provided to the owner a minimum of two weeks prior to substantial completion in Excel format and the native format to the test instrument. The Owner can supply an Excel spreadsheet template upon request for the contractors use.
4. Circuit IDs reported by the field-test instrument shall match the label ID specified by the Owner.
5. The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and shall contain the following information
   a. The identification of the customer site as specified by the end-user
   b. The name of the standard selected to execute the stored test results
   c. The name of the test personnel

d. The date and time the test results were saved in the memory of the tester
e. The manufacturer, model and serial number of the field-test instrument
f. The version of the test software and the version of the test standards database held within the test instrument
g. The date the tester was last calibrated by the manufacturer.
h. The value of the 'index of refraction' used for length calculations
i. The fiber identification number
j. The length for each optical fiber calculated by the OLTS.
k. Test results to include OLTS attenuation link and channel measurements at 850 nm and 1300 nm for multimode cabling, and at 1310 nm and 1550 nm for singlemode cabling and the margin (difference between the measured attenuation and the test limit value) in both directions.
l. Test results shall be submitted to include OTDR link and channel traces and event tables at 850 nm and 1300 nm for multimode cabling, and at 1310 nm and 1550 nm for singlemode cabling and the margin (difference between the measured attenuation and the test limit value) in both directions.
m. The length for each optical fiber calculated by the OTDR.
n. The overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements

END OF SECTION 27 08 16

27 10 00 – Structured Cabling

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes basic Telecommunications Room requirements. Refer to "T" series drawings for specific communication room requirements.

B. The design of communications rooms depend on the size of the building, floor space served, occupant needs, services deployed and future growth.

C. Section Includes the following sub-sections:

1. Sub-section 271100 "Communications Equipment Room Fittings"
2. Sub-section 271113 "Communications Entrance Protection"
3. Sub-section 271116 "Communications Cabinets, Racks, Frames and Enclosures
4. Sub-section 271119 "Communications Termination Blocks and Patch Panels"

1.2 SCOPE OF WORK

A. Provide all labor, materials, tools and equipment required for the complete and proper communications equipment room fittings installation.

B. In order to conform to the overall project event schedule, the contractor shall survey and coordinate the communications equipment room fittings installation with other applicable trades.

C. In addition to the details specified within this Section, the contractor shall notify the KU IT Representatives of any additional items deemed necessary to guarantee a fully functional system. The contractor shall furnish and install all necessary items for a fully functional system at no additional charge.

1.3 DEFINITIONS

A. Communications Room: A generic term for an equipment room or telecommunications room.

B. Entrance Facility (telecommunications, EF) – An entrance to a building for both public and private network service cables (including wireless) including the entrance point of the building and continuing to the entrance room or space. The location where the main telecommunications service enters a building from the outside; where the demarcation between the inter-building and intra-building cabling system occurs.

C. Equipment Room (telecommunications, ER) – A environmentally controlled space in which the joining of inter or intra building telecommunications facilities takes place. The location which provides space and maintains a suitable operating environment for large telecommunications equipment. Equipment rooms tend to serve an entire building as compared to a Telecommunications Room which serves a single floor or part of a single floor. This space may be co-located with the Entrance Facility and/or Telecommunications Room, provided the room is sized for all functions.

D. Telecommunications Room (TR) –The location where the connection between the horizontal cabling and the building backbone cabling occurs. This room also contains the electronic equipment that transitions between the data, voice and video building backbone and the end user's telecommunications equipment. This space may be co-located with the Entrance Facility and/or Equipment Room, provided the room is sized for all functions.

1.4 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

1.5 MINIMUM TELECOMMUNICATIONS SPACE REQUIREMENTS

A. The following minimum requirements apply to ALL University of Kansas Telecommunications Spaces (TS) including but not limited to the Entrance Facility, Equipment Room, and Telecommunications Rooms:
   1. Location:
      a. When selecting the site, avoid locations that are restricted by building components that limit expansion such as elevators, core, outside walls, or other fixed building walls. Accessibility for the delivery of large equipment should be provided.
      b. The telecommunications space should be located away from sources of electromagnetic interference or designed to mitigate the effects of this interference. Special attention shall be given to electrical power supply transformers, motors and generators, X-ray equipment, radio and radar transmitters, and induction sealing devices.
   2. Access:
      a. The room should be located in an accessible area (e.g. common hallway). Access to the space shall be controlled by KU IT.
   3. Architectural Design:
      a. Each TS shall be secured and dedicated solely to the purpose of providing telecommunications services. All other building services are prohibited unless otherwise indicated. Exceptions may be made for services which interface with the KU IT network such as: CCTV, Access Control and Classroom Technology/Audio/Video systems. If these systems are combined into the TS, the TS shall be upsized to accommodate these systems and a cage or other means of segregating and securing KU IT equipment shall be provided. This secure separation is needed to maintain a controlled security environment for compliance regulations such as PCI.
      b. Each TS shall be open to structure with a minimum structure height between the finished floor and the lowest point of the ceiling of 9'-6" to accommodate taller equipment racks and overhead pathways. False or suspended ceilings are prohibited.
      c. Each TS shall have a door which is at least 36 in. wide and 80 in. high and hinged to open outward (code permitting).

If it is anticipated that large equipment will be delivered to the entrance facility or equipment room, a double door 72 in. wide by 90 in. high, with no doorsill or center post, is recommended. The door shall be fitted with a lock keyed to match the KU I.T. AB1 lock. In the event that the space shall be shared as described in 1.5A.1.a, the cage shall be keyed to match the KU I.T. AB1 lock.

d. Brick and gypsum board walls shall be painted or sealed to minimize dust. Each wall, except the wall that contains the entrance door, shall be lined with plywood backing panels (backboard) as specified in Section 271100 "Communications Equipment Room Fittings." Blocking or additional studs shall be provided in framed walls to receive plywood backboard panel fasteners.
e. Each TS floor shall have vinyl composition tile and shall be designed to support at minimum 2.4 kPA (50 lb./ft^2). Finishes shall be light in color to enhance room lighting.
f. The Telecommunication Spaces shall not have exterior windows, as exterior windows may increase heat load.

4. Electrical Design:
   a. Each TS shall have a minimum lighting level of 540 lux (50 foot-candles) as measured 3-feet above finished floor.
   b. Lighting fixtures shall not be powered from the same electrical distribution panel as that serving the telecommunications equipment in the space.
   c. Each TS shall have at minimum, two (2) dedicated 120 V, 20A , non-switched, ac quad electrical receptacles, each on a separate branch circuit, having no shared Neutral conductors. These shall be provided for wall-mounted equipment power. Additional receptacles for wall-mounted equipment may be required and shall be coordinated with the electrical designer.
   d. Each TS shall have at minimum one (1) 120V, 20A duplex convenience receptacle mounted at 18 in. above the floor. This receptacle shall be identified and marked as a convenience receptacle.
   e. Equipment layout, project plans or code may dictate the need for additional electrical outlets to be installed.
   f. Each equipment rack shall have at minimum, one (1) dedicated 120V, 20A, non-switched, ac quad electrical receptacle, each on a separate branch circuit, installed in the bottom of each equipment rack to support rack-mounted uninterruptable power supply(s) (UPS). UPS's are typically furnished by KU IT. In addition, at minimum a dedicated 208V/20A, NEMA L6-20 receptacle shall be mounted adjacent to the above described 120V receptacle. The final size and type of UPS may affect the exact electrical receptacle type required. Designer shall coordinate this with KU IT early in the design phase. Up-size electrical wiring to support at minimum 30 amps to allow the flexibility to up-size outlets in the future.
   g. The introduction of Voice-over-IP and other network based life-safety systems drives the need for emergency stand-by power to be available.

All receptacles (with the exception of any convenience receptacles) within Telecommunications Spaces shall be on emergency generator power if available.

h. A dedicated power panel(s) shall be installed to serve the telecommunications spaces.

5. Mechanical Design:
   a. TS's shall not have any plumbing, HVAC piping, or ductwork within the room's interior space, interior walls, routing horizontally on the floor directly above the room, or within the floor slab.
   b. Sufficient space shall be left around each TS to allow for cable tray and communications pathways to enter the TS.
   c. Each TS shall have HVAC to control temperature and humidity. Temperature under load shall remain between 64 and 75 degrees F. The specific BTU's of heat load and required cooling shall be coordinated with Mechanical/HVAC Engineer. Humidity shall be controlled at 50% plus/minus 10%.
   d. A positive pressure differential with respect to surrounding areas should be provided unless prohibited by the AHJ.
6. Fire Protection Design:
   a. Fire protection shall be provided as per applicable codes.
   b. Each TS shall have a smoke/fire sensor that is part of the overall building fire alarm system.
   c. Sprinklers in TS's are not recommended, but if they are required by code, consideration should be given to the installation of a pre-action sprinkler or other "dry" fire suppression system for some applications. If wet pipe sprinklers are installed:
      1) the heads shall be provided with wire cages to prevent accidental operation; and
      2) drainage troughs shall be placed under the sprinkler pipes to prevent leakage onto the equipment within the room.

B. Entrance Facility (EF)
1. Comply with minimum TS requirements.
2. Comply with BICSI TDMM.
3. Architectural:
   a. Location: The EF shall be located in a dry area not subject to flooding and should be as close as practicable to the building entrance point and next to the Equipment Room in order reduce the length of bonding conductor to the main electrical grounding system and to provide easy access to the OSP cabling and entrance conduits. The preference would be for this space to be located at or near an exterior wall, at or just below grade. Code requires entrance cables shall terminate within 50-feet from where they enter the building. Locating the entrance facility within 50-feet of the entrance conduits will reduce the need for rigid or intermediate conduit.

b. Size: The EF shall be sized as follows:
   1) When serving buildings with less than 5,000 square feet, dimensions shall be at minimum 4-feet by 6-feet
   2) When serving buildings with more than 5,000 square feet, dimensions shall be at minimum 8-feet by 8-feet.
   3) When the EF is combined with an Equipment Room or Telecommunications Room, the room shall be sized to accommodate each use case. The room size shall be coordinated with the Architect and KU IT as early as possible in the design process.
c. Quantity: More than one entrance facility may be required, depending upon building use and diversity of telecommunications issues.

4. Pathways
   a. Comply with Section 270528 "Pathways for Communications Systems" and Section 270536 "Cable Trays for Communications Systems."
   b. For inter-building conduit entrances (OSP conduits), conduits and sleeves shall extend 3-inches above finished floor or 3-inches out from wall face for a "through-wall" penetration.
   c. Two (2) 4-inch conduits at minimum shall be provided from the nearest maintenance hole or hand-hole to the EF. One of the 4-inch conduits shall have two (2) 4-inch, 3-cell MaxCell fabric innerducts. Additional entrance conduits may be required and should be considered on a building by building basis, based on cabling infrastructure needs.
   d. Cable basket tray shall be provided around the perimeter of the room at 8-feet above finished floor. Cable basket tray shall also be provided between two walls, centered over the top of the equipment rack(s). Final size and location of cable tray shall be determined by the designer. The tray must be sized to meet all applicable standards and codes as well as allow room for future cabling and expansion.
5. Grounding and Bonding
   a. Comply with J-STD-607-B and Section 270526 "Grounding and Bonding for Communications Systems" within these standards.
6. Equipment Racks
   a. Comply with Section 271116 "Communications Cabinets, Racks, Frames and Enclosures."
   b. Equipment racks shall be laid out in the EF to maximize usage of space and provide at minimum, 36-inches working clearance in front of and behind each equipment rack. This working clearance shall be provided to allow for installation of equipment and to accommodate deeper equipment. Some equipment may require service clearances of greater than 36-inches.
   c. Future expansion space should be considered and equipment racks shall be laid out in such a way that additional equipment racks may be added if space allows.
   d. Provide quantity of equipment racks necessary to support the telecommunications equipment to be housed within the EF.

e. All equipment racks shall be floor mounted, free-standing racks unless otherwise indicated. Prior approval must be obtained by KU IT to utilize wall-mounted equipment racks. Wall-mounted equipment racks severely limit the type, size (depth, weight), and amount of equipment which may be housed in them.
f. Provide rack mounted vertical and horizontal cable management as required to support cables and maintain a neat and workmanlike installation.

7. Cable Management
   a. Comply with 271116 “Communications Cabinets, Racks, Frames and Enclosures.”
   b. Cables may be loosely bundled using Velcro cable wraps; Plastic cable ties are prohibited.
   c. All cables, whether on the backboards or in equipment racks shall have cable management devices installed to support the cabling.
   d. Cable management devices supplied with termination devices or equipment racks shall be used as required for a neat and workmanlike installation.
8. Labeling
   a. Comply with requirements in Section 270553 “Identification for Communications Systems.”

C. Equipment Room (ER)
1. Comply with minimum TS requirements.
2. Comply with BICSI TDMM.
3. Architectural:
   a. Location: The ER location shall ensure that backbone cabling pathways are easily accessible. Consideration shall also be given for the need to bring in large telecommunications equipment and the potential accessibility requirements based on this need. The ER shall be located away from sources of EMI, machinery causing vibration, piping, drains, clean outs. The ER shall not be located adjacent to or underneath restrooms or other areas prone to flooding. If the ER is separate from the EF, it shall be located directly adjacent to or directly above the EF.
   b. Size: The ER shall be sized as follows:
      1) When serving buildings with less than 5,000 square feet, dimensions shall be at minimum 8-feet by 10-feet.
      2) When serving buildings with greater than 5,000 square feet, dimensions shall be at minimum 10-feet by 16-feet.
      3) Consideration should be given to all of the current and future equipment needs and a larger space may be required.
      4) When the ER is combined with an EF or Telecommunications Room, the room shall be sized to accommodate each use case. The room size shall be coordinated with the Architect and KUIT as early as possible in the design process.
4. Pathways
   a. Comply with Section 270528 “Pathways for Communications Systems” and Section 270536 “Cable Trays for Communications Systems.”

b. Two (2) 4-inch conduits at minimum shall be provided from the EF. Additional conduits may be required and should be coordinated on a building by building basis, based on cabling infrastructure needs. These pathways shall be sized to allow for at minimum 25% growth.
c. Cable basket tray shall be provided around the perimeter of the room at 8-feet above finished floor. Cable basket tray shall also be provided between two walls, centered over the top of the equipment rack(s). Final size and location of cable tray shall be determined by the designer. The tray must be sized to meet all applicable standards and codes as well as allow room for future cabling and expansion.

5. Grounding and Bonding
   a. Comply with J-STD-607-B and Section 270526 "Grounding and Bonding for Communications Systems" within these standards.
6. Equipment Racks
   a. Comply with Section 271116 "Communications Cabinets, Racks, Frames and Enclosures."
   b. Equipment racks shall be laid out in the ER to maximize usage of space and provide at minimum, 36-inches working clearance in front of and behind each equipment rack. This working clearance shall be provided to allow for installation of equipment and to accommodate deeper equipment. Some equipment may require service clearances of greater than 36-inches.
   c. Future expansion space should be considered and equipment racks shall be laid out in such a way that additional equipment racks may be added if space allows.
   d. Provide quantity of equipment racks necessary to support the telecommunications equipment to be housed within the ER.
   e. All equipment racks shall be floor mounted, free-standing racks unless otherwise indicated. Prior approval must be obtained by KU IT to utilize wall-mounted equipment racks. Wall-mounted equipment racks severely limit they type, size (depth, weight), and amount of equipment which may be housed in them.
   f. Provide rack mounted vertical and horizontal cable management as required to support cables and maintain a neat and workmanlike installation.
7. Cable Management
   a. Comply with Section 271116 "Communications Cabinets, Racks, Frames and Enclosures. Cables may be loosely bundled using Velcro cable wraps; Plastic cable ties are prohibited.
   b. All cables, whether on the backing boards or in an equipment rack shall have cable management devices installed to support the cabling.
   c. Cable management devices supplied with termination devices or equipment racks shall be used as required for a neat and workmanlike installation.
8. Labeling
   a. Comply with Section 270553 "Identification for Communications Systems."
   b. The TS identifier shall be coordinated with KU IT and should comply with TIA-606-A. The TS identifier shall have the format "*fs*," where "*f*" is a numeric character(s)

identifying the floor of the building occupied by the TS and the "*s*" is an alpha character(s) uniquely identifying the TS on floor "*f*", or the building area in which the space is located. For buildings with non-numeric floors, alpha-numeric characters may be used in the "*f*" format and shall be consistent with the floor naming convention used within the building. All TS identifiers in a single infrastructure should have the same format where possible. The TS shall be labeled with the TS identifier inside the room so as to be visible to someone working in that room.

c. The horizontal link identifier labeling scheme shall be coordinated with KU IT prior to labeling of blocks or telecommunications outlets. The horizontal link identifier, unique within the building, shall be assigned to each horizontal link and to its elements. The horizontal link identifier shall have the format "*fs-anpp*" where "*fs*" is the TS identifier described above for the TS in which the horizontal link originates. "*an*" is the block location identifier where "*a*" represents the blocks row and "*n*" represents the blocks column. "*pp*" is the port identifier which identifies the port on the block in which the cable is terminated. Accurate as-built/administration drawings are critical and shall be provided to KU IT at the completion of a project.

D. Telecommunications Room

1. Comply with minimum TS requirements.
2. Comply with BICSI TDMM.
3. Architectural:
   a. Location: The TR location shall ensure that backbone and horizontal cabling pathways are easily accessible. The TR shall be located away from sources of EMI, machinery causing vibration, piping, drains, clean outs. The TR shall not be located adjacent to or underneath restrooms or other areas prone to flooding. One (1) TR shall be located on each floor and shall be vertically stacked. If it is not possible to stack TRs vertically, they shall have a readily available means to easily access the other TRs via conduits. The TR should be as close as possible to the center of the floor it is intended to serve. The farthest distance between a TR and the farthest work area outlet it serves shall not exceed 295-feet. This distance is measured as the cabling would travel through the communications pathways including ups, downs and other transitions. This limitation may require there to be multiple TR's on each floor.
   b. Size: The TR shall be sized as follows:
      1) When serving an area less than 5,000 square feet, dimensions shall be at minimum 8-feet by 10-feet.
      2) When serving an area greater than 5,000 square feet, dimensions shall be at minimum 10-feet by 11-feet.
      3) Consideration should be given to all of the current and future equipment needs and a larger space may be required.

4) When the TR is combined with an EF or ER, the room shall be sized to accommodate each use case. The room size shall be coordinated with the Architect and KUIT as early as possible in the design process.

4. Pathways
   a. Comply with Section 270528 “Pathways for Communications Systems” and Section 270536 “Cable Trays for Communications Systems.”
   b. Two (2) 4-inch conduits at minimum shall be provided from the ER to the first TR. Additional conduits may be required and should be coordinated on a building by building basis, based on cabling infrastructure needs. These pathways shall be sized to allow for at minimum 25% growth.
   c. Two (2) 4-inch conduits/sleeves at minimum shall be provided between stacked TRs or TRs on adjacent floors in the event they are not stacked. These pathways shall be sized to allow for at minimum 25% growth.
   d. Cable basket tray shall be provided around the perimeter of the room at 8-feet above finished floor. Cable basket tray shall also be provided between two walls, centered over the top of the equipment rack(s). Final size and location of cable tray shall be determined by the designer. The tray must be sized to meet all applicable standards and codes as well as allow room for future cabling and expansion.
5. Grounding and Bonding
   a. Comply with J-STD-607-B and Section 270526 “Grounding and Bonding for Communications Systems” within these standards.
6. Equipment Racks
   a. Comply with Section 271116 “Communications Cabinets, Racks, Frames and Enclosures.”
   b. Equipment racks shall be laid out in the TR to maximize usage of space and provide at minimum, 36-inches working clearance in front of and behind each equipment rack. This working clearance shall be provided to allow for installation of equipment and to accommodate deeper equipment. Some equipment may require service clearances of greater than 36-inches.
   c. Future expansion space should be considered and equipment racks shall be laid out in such a way that additional equipment racks may be added if space allows.
   d. Provide quantity of equipment racks necessary to support the telecommunications equipment to be housed within the TR.
   e. All equipment racks shall be floor mounted, free-standing racks unless otherwise indicated. Prior approval must be obtained by KU IT to utilize wall-mounted equipment racks. Wall-mounted equipment racks severely limit they type, size (depth, weight), and amount of equipment which may be housed in them.
   f. Provide rack mounted vertical and horizontal cable management as required to support cables and maintain a neat and workmanlike installation.
   g. Place side of beginning floor rack at 12" from wall to utilize wall electrical receptacle.

7. Cable Management
   a. Comply with Section 271116 “Communications Cabinets, Racks, Frames and Enclosures.”
   b. Cables may be loosely bundled using Velcro cable wraps; Plastic cable ties are prohibited.
   c. All cables, whether on the backing boards or in equipment racks shall have cable management devices installed to support the cabling.
   d. Cable management devices supplied with termination devices or equipment racks shall be used as required for a neat and workmanlike installation.
8. Labeling
   a. Comply with Section 270553 “Identification for Communications Systems.”
   b. The TS identifier shall be coordinated with KU IT and should comply with TIA-606-A. The TS identifier shall have the format “*fs*,” where “*f*” is a numeric character(s) identifying the floor of the building occupied by the TS and the “*s*” is an alpha character(s) uniquely identifying the TS on floor “*f*”, or the building area in which the space is located. For buildings with non-numeric floors, alpha-numeric characters may be used in the “*f*” format and shall be consistent with the floor naming convention used within the building. All TS identifiers in a single infrastructure should have the same format where possible. The TS shall be labeled with the TS identifier inside the room so as to be visible to someone working in that room.
   c. The horizontal link identifier labeling scheme shall be coordinated with KU IT prior to labeling of blocks or telecommunications outlets. The horizontal link identifier, unique within the building, shall be assigned to each horizontal link and to its elements. The horizontal link identifier shall have the format “*fs-anpp*” where “*fs*” is the TS identifier described above for the TS in which the horizontal link originates. “*an*” is the block location identifier where “*a*” represents the blocks row and “*n*” represents the blocks column. “*pp*” is the port identifier which identifies the port on the block in which the cable is terminated. Accurate as-built/administration drawings are critical and shall be provided to KU IT at the completion of a project.
   d. Typical as-built information shall include identifying all cables at their outlet locations and, to note the room number or identified space they are located in.
   e. Typical as-built information shall include identifying the network switch and network switch port number where activated cables are connected.

END OF SECTION 271000

27 11 00 – Communications Equipment Room Fittings

PART 1 – GENERAL

1.1 SUMMARY

A. Sub-Section Includes:
   1. Backboards.

B. Related Sections:
   1. Section 061000 "Rough Carpentry"
   2. Section 270526 "Grounding and Bonding for Communications Systems"
   3. Section 270528 " Pathways for Communications Systems"
   4. Section 270536 "Cable Trays for Communications Systems"

PART 2 – PRODUCTS

2.1 PLYWOOD BACKBOARD

A. The plywood backboard shall be 4-feet x 8-feet sheets of 3/4-inch thick plywood.
B. Plywood shall be A/C grade and finished with two coats of white fire-retardant paint. Plywood shall be painted prior to installation of equipment.
C. Comply with requirements for plywood backing panels specified in Section 061000 "Rough Carpentry."

PART 3 – EXECUTION

3.1 INSTALLATION

A. The backboard shall be 4-feet x 8-feet sheets, mounted vertically, with the bottom of the plywood mounted 6 in above the finished floor with the best side (A side) toward the room.
B. Plywood shall be permanently fastened to the wall by means of wall anchors utilizing galvanized, zinc plated, or stainless steel hardware. Finished installation shall have flush appearance with countersunk screw heads to prevent splitting of the plywood. Drywall screws shall be prohibited. The plywood shall be anchored securely to wall substrate with a minimum of five (5) equally space fasteners along each vertical edge and down the centerline of each sheet of plywood. Fasteners shall be of the appropriate type for each substrate. Blocking or additional studs shall be provided in framed walls to receive plywood backboard panel fasteners.
C. Coordinate location of power raceways and receptacles.

3.2 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-A.
B. Comply with requirements in Section 270553 "Identification for Telecommunications Systems."

END OF SECTION 27 11 10

27 11 13 – Communications Entrance Protection

PART 1 – GENERAL

1.1 SUMMARY

A. Provide all labor, materials, tools, and equipment required for mounting communications cabling entrance protection.

B. Sub-Section Includes:

1. Building Entrance Terminals (BET)
2. 4-Pair Building Entrance Protector

C. Related Sections:

1. Section 270000 “Communications” including all referenced codes, standards and guidelines.
2. Section 270526 “Grounding and Bonding for Communications Systems”
3. Section 270528 “ Pathways for Communications Systems”
4. Section 270536 “Cable Trays for Communications Systems”
5. Section 271100 “ Communications Equipment Room Fittings”

1.2 QUALITY ASSURANCE

A. Listed materials (by Nationally Recognized Testing Laboratory)

1.3 SUBMITTAL

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:

1. Product Information
   a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
   b. Provide manufacturer’s product information cut sheet or specifications sheet with the specific product number identified or filled out.

PART 2 – PRODUCTS

2.1 4-PAIR BUILDING ENTRANCE PROECTOR

A. For all applications where a single voice/data/security 4-pair category cable serves an outlet outside the footprint of the building (e.g. emergency telephone, exterior wireless access point, or exterior IP CCTV Camera).

B. 110 Termination

C. Shall be certified up to category 6A performance, including power-over-Ethernet applications.

D. Shall contain solid state modules.

E. Protectors shall be UL listed.

1. Manufacturer shall be: Ditek – DTK-110C6APOE

2.2 BUILDING ENTRANCE TERMINALS (BET) Multi-pair.

Note: Copper feeder installation is not specified for new building construction projects, eliminating the need for a multi-pair BET. Information here is retained for reference or if project specified.

A. Wall mountable
B. Populated with factory-installed and tested 5-pin, 3-element gas tube protector unit.
C. Protectors shall be UL listed.
D. Shall have external ground lug for building ground or connecting additional protectors.
E. Refer to drawings for location, quantity and type of entrance terminals.
F. Manufacturer shall be one of the following:
    1. Circa
    2. Porta Systems
    3. ITW Linx

PART 3 – EXECUTION

3.1 INSTALLATION

A. 4-Pair Building Entrance Protector
    1. Where conduit for exterior outlets stubs into Telecommunications Room, locate protector on plywood backboard. Label protector with outlet identifier.
    2. Where conduit for exterior outlets stubs into building in a place other than in a Telecommunications Room, install protector into an appropriately-sized junction box for physical protection. Label junction box with "ENTRANCE PROTECTION FOR EXTERIOR COMMUNICATIONS OUTLETS" and outlet identifier(s).
        a. Identify this location on Record Drawings.
B. Grounding and Bonding
    1. Where protector is located in Telecommunications Room, bond protector to PBB/SBB with #6 AWG copper ground wire.
    2. Where protector is not located in Telecommunications Room, bond protector to Telecommunications grounding system. Refer to Section 270526 "Grounding and Bonding for Communications", referenced standards and manufacturer instructions for additional information and requirements.

3.2 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-A.
B. Comply with requirements in Section 270553 "Identification for Telecommunications Systems."

END OF SECTION 27 11 13

27 11 16 – Communications Cabinets, Racks, Frames and Enclosures

PART 1 – GENERAL

1.1 SUMMARY

A. Sub-Section Includes:
   1. Equipment Cabinets.
   2. Equipment Racks.
   3. Equipment Rack Cable Management.
   4. *Wall Racks.

B. Related Sections:
   1. Section 270526 "Grounding and Bonding for Communications Systems"
   2. Section 270553 "Identification for Telecommunications Systems."
   3. Section 271100 " Communications Equipment Room Fittings"

1.2 SUBMITTAL

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:
   1. Product Information
      a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
      b. Provide manufacturer's product information cut sheet or specifications sheet with the specific product number identified or filled out.

PART 2 – PRODUCTS

2.1 EQUIPMENT CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. APC

B. Communications cabinets are unique to the installation and should be coordinated with and specified by the KU IT Telecommunications Engineer.

2.2 EQUIPMENT RACKS

A. Free Standing Relay Racks (Standard Rack)
   1. Racks shall be manufactured from aluminum and/or steel extrusion.
   2. Each rack will have two L-shaped top angles, two L-shaped based angles and two C-shaped equipment mounting channels. The rack will assemble with nut and bolt hardware. The base angles will be pre-punched for attachment to the floor.
   3. Equipment mounted channels will be at minimum 6-inches deep and punched on the front and rear flange with the EIA-310-D Universal hole pattern to provide 45 rack-mount spaces for equipment. Each mounting space will be marked and numbered on the mounting channel.

4. When assembled with top and bottom angles, equipment-mounting channels will be spaced to allow attachment of 19-inch EIA rack-mount equipment. Attachment points will be threaded with 12-24 roll-formed threads. The rack will included assembly and equipment mounting hardware. Racks will include 40 each combination pan head, pilot point mounting screws.
5. The assembled rack will measure 7-feet high, 20.32-inches wide, and at minimum 18-inches deep. The sides of the equipment-mounting channels will be punched to allow attachment of vertical cable managers along the sides of the rack or for rack-to-rack baying.
6. The rack will have a static load rating of 1000 lb. of equipment.
7. The rack will be UL Listed.
8. Finish shall be black powder coat.
9. Manufacturer: Systimax, a CommScope Inc. brand, Part Number: RK6-45A (760082495)

2.3 EQUIPMENT RACK CABLE MANAGEMENT

A. Vertical Cable Management
   1. Vertical cable management shall be manufactured from aluminum and/or steel extrusion.
   2. The assembled vertical cable manager will measure 7-feet high, at minimum 6-inches wide (consideration should be given to cable quantities and required width) and 11-inches deep.
   3. Each vertical cable manager shall be punched to all attachment along the sides of the rack.
   4. The vertical cable manager will be UL Listed.
   5. Finish shall be black powder coat.
   6. Manufacturer: Systimax, a CommScope Inc. brand,
      - End of rack: 6” double-sided vertical manager Part Number: VCM-DS-84-6B (760089342)
      - Between adjacent racks: 10” double-sided vertical manager Part Number: VCM-DS-84-10B (760089367)

B. Horizontal Cable Management
   1. Horizontal cable management shall be manufactured from aluminum and/or steel extrusion.
   2. The assembled horizontal cable manager will measure 19-inches wide and be at minimum 1 rack unit high.
   3. The horizontal cable manger will be UL Listed.
   4. Finish shall be black powder coat.
   5. Manufacturer: Systimax, a CommScope Inc. brand.

2.4 *WALL RACKS

A. In general, the use or installation of a wall rack or an enclosed wall cabinet is not allowed. Prior approval must be obtained by KU IT to utilize wall-mounted equipment racks. Wall-

mounted equipment racks severely limit the type, depth, weight, and amount of equipment which may be housed in them.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.
B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
C. Assemble racks according to manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mounted equipment before attached the rack to the floor.
D. All racks must be attached to the floor in four places using appropriate floor mounting anchors. When placed over a raised floor, threaded rods should pass through the raised floor and be secured in the structural floor below.
E. Racks shall be grounded to the PBB or SBB using appropriate hardware provided by the contractor. The ground will meet local code requirements and comply with Section 270526 "Grounding and Bonding for Communications Systems" and J-STD-607-B.
F. Cable tray may be attached to the top of the rack to deliver cables to the rack. The rack should not be drilled to attach cable tray. Use appropriate hardware from the cable tray manufacturer.
G. The equipment load should be evenly distributed and uniform on the rack. Place large and heavy equipment towards the bottom of the rack. Secure all equipment to the rack with equipment mounting screws.
H. One (6") vertical cable manager should be installed on each side of each an equipment rack. In the event equipment racks are side by side, a single (10") vertical cable manager may be used to bay the equipment racks together and shared for cable management (e.g. two equipment racks set side-by-side would only require three vertical cable managers).
I. Horizontal cable managers shall be used as required and specified in the Contract Documents.
J. Coordinate layout and installation of communications equipment with KU IT. Coordinate service entrance arrangement with KU IT.
    1. Meet jointly with KU IT to exchange information and agree on details of equipment arrangements and installation interfaces.
    2. Record agreements reached in meetings and distribute them to other participants.
    3. Adjust arrangements and locations of distribution frames, cross-connects, block fields, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of voice, video and network equipment.
    4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, block fields, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
K. Coordinate location of power raceways and receptacles with locations of communications equipment racks.

L. The installation or attachment of electrical conduit and junction boxes to floor racks shall not impede, reduce capacity, prohibit or interfere with the installation of telecom equipment placed within the floor racks.

3.2 GROUNDING

A. Comply with requirements in Section 270526 “Grounding and Bonding for Communications Systems” within these standards.
B. Comply with J-STD-607-B.
C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
   1. Bond the Shield of shielded cable to the grounding bus bar in communications room and spaces.

3.3 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-A.
B. Comply with requirements in Section 270553 “Identification for Telecommunications Systems.”

END OF SECTION 27 11 16

27 11 19 – Communications Termination Blocks and Patch Panels

PART 1 – GENERAL

1.1 SUMMARY

A. Sub-Section Includes:
   1. *Wall-mounted blocks (for wall field applications) Project specific with prior approval
   2. Rack-mounted Copper Patch Panels
   3. Rack-mounted Fiber Enclosures

B. Related Sections:
   1. Section 270526 "Grounding and Bonding for Communications Systems"
   2. Section 270553 "Identification for Telecommunications Systems."
   3. Section 271100 " Communications Equipment Room Fittings"

1.2 QUALITY ASSURANCE

A. Termination blocks, patch panels, fiber enclosures and modules are to be covered by the Advanced System Warranty (Refer to definition in Section 27 00 00).

B. At a minimum, their performance shall be Category 6A, unless otherwise noted. Coordinate this requirement with KU IT on a project-by-project basis.

1.3 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:
   1. Product Information
      a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
      b. Provide manufacturer's product information cut sheet or specifications sheet with the specific product number identified or filled out.
   2. Shop Drawings
      a. In conjunction with enlarged (1/4" = 1'-0" scale or greater) drawing elevations for equipment cabinets, racks, frames, or enclosures, indicate locations of wall termination blocks and patch panels.

B. The following submittals are due at the Post-Construction Phase, in accordance with submittal requirements in Section 270000 "Communications".
   1. Record Drawings
      a. In conjunction with enlarged (1/4" = 1'-0" scale or greater) drawing elevations for equipment cabinets, racks, frames, or enclosures, indicate locations of wall termination blocks and patch panels.
   2. Manufacturer and Maintenance Manuals for all installed equipment.
      a. Provide manufacturer's product information cut-sheet or specifications sheet with the specific product number identified or filled out.

b. List of bill of materials, including all parts, pieces and connectors required for installation.

PART 2 – PRODUCTS

2.1 GENERAL

A. All connectivity components either for copper or fiber (patch panels, faceplates, modules, etc.) shall be by the same manufacturer and covered under the same Advanced System Warranty.

B. In the MDF, in addition to providing required riser VisiPatch blocks, the contractor will provide adequate use-available VisiPatch 360 block kits for KU I.T. riser cross-connects to other terminals.

C. KU I.T. is responsible for VisiPatch activations.

D. KU I.T. will provide cross connect and/or VisiPatch patch cords.

2.2 COPPER

A. Wall-mounted blocks (for wall field applications) Project-specific prior approval required.

1. Performance shall meet the performance of Category 6A or better.
2. Manufacturer shall be:
   a. Systimax Solutions; a CommScope Inc. brand, VisiPatch 360 Block Kits.

B. Rack-mounted Copper Patch Panels

1. Performance shall meet the performance of Category 6A or better.
2. Manufacturer shall be:
   a. Systimax Solutions; a CommScope Inc. brand, M4800A-1U-GS Angled Panel, 48-port (P/N 760109744) for use with Systimax Category 6 and 6A Information Outlets.

2.3 FIBER

A. Rack-mounted Fiber Enclosures (Shelves)

1. Rack-mounted Fiber Enclosures shall be sized appropriately to house the required strands of fiber, associated splices, and provide room for future expansion
2. Shall be 1U, 2U or 4U in height and fit into a standard 19-inch wide rack.
   a. Refer to drawings for size and location.
3. Shall have a front cover that swings down. Labeling shall also be integrated on the fiber enclosure and fiber inserts.
4. Shall include a sliding mechanism to allow easier access to the inside of the enclosure.
5. Shall include a mechanism or means to maintain the cable manufacturer's minimum bend radius.
6. Shall include a splice tray option.
7. Manufacturer shall be:
   a. (1RU) – SYSTIMAX HD 1U Sliding Fiber Panel (P/N 760231506).
      1) Include (1) fusion splice tray kit item: (760148502- 360-LP-STACK-SPT).
   b. (2RU) – SYSTIMAX HD-2U-SP Sliding Fiber Splice Panel (P/N 760231514).

1) Include (2) fusion splice tray kits item: (760148502- 360-LP-STACK-SPT).

c. (4RU) –SYSTIMAX HD-4U-SP Sliding Fiber Splice Panel (P/N 760231522).

1) Include (4) fusion splice tray kits item: (760148502- 360-LP-STACK-SPT)

B. 360 Distribution Adapter Packs

1. Shall fit into specified fiber enclosures.
2. Shall be in multiples of 12 strands.
3. Manufacturer shall be:
   a. Singlemode: Systimax Solutions; 360 Distribution Adapter Pack 12 LC Singlemode Blue (P/N 760230946 – 360DPis-12LC-SM).
   b. Multimode: Systimax Solutions; 360 Distribution Adapter Pack 12 LC Multimode OM4 Aqua (P/N 760230938 – 360DPis-12LC-LS).
4. Singlemode adapter packs shall be connected to incoming fiber with Systimax LC to Unconnectorized, Teraspeed 12-Fiber pigtail kit 1M (P/N FAWLCUC0C-XXM001).
5. Multimode adapter packs shall be connected to incoming fiber with Systimax LC to Unconnectorized, LazrSPEED 12-Fiber pigtail kit 1M (P/N FAXLCUC0C-XXM001).

PART 3 – EXECUTION

3.1 GENERAL

A. Follow all manufacturers' instructions. Pay special attention to the cable/system manufacturer's recommended minimum bend radius.

B. Coordinate with all other trades prior to installation.

C. Quantity on drawings is illustrative in nature. Provide as many wall-blocks, patch panels, enclosures, and modular cassettes to support the necessary quantity of cable pairs and strands.

1. Coordinate with KU IT for planned quantity and type of fiber strands KU IT will use to bring service into building or construction space.
   a. At a minimum, assume 24-strands of singlemode optical fiber will be brought into each buildings Entrance Facility.

3.2 COPPER

1. For all terminations, avoid untwisting and separation of cable pairs. Maintain twists to the point of termination and avoid pair wrapping.
   a. Maintain sheath to within 1/2-inch for category 6 cables and above.

3.3 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-A.

B. Comply with requirements in Section 270553 "Identification for Telecommunications Systems."

END OFSECTION 27 11 19

27 13 00 – Communications Backbone Cabling

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

A. Section Includes:
   1. Pathways.
   2. Inside Plant and Outside Plant UTP cable.
   3. 50/125-micrometer, OM3, OM4 & OM5 multimode optical fiber cabling.
   4. Inside Plant and Outside Plant 8/125-micrometer, singlemode optical fiber cabling.
   5. Coaxial cable.
   6. Splice Closures

B. Related Sections:
   1. Section 270000 “Communications” including all referenced codes, standards and guidelines.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.
B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
C. EMI: Electromagnetic interference.
D. IDC: Insulation displacement connector.
E. LAN: Local area network.
F. RCDD: Registered Communications Distribution Designer.
G. UTP: Unshielded twisted pair.

1.4 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.
C. Telecommunications Contractor shall furnish, install, test and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete ANSI/TIA compliant communications backbone cabling system.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.0**,** when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:
   1. Product Information
      a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
      b. Provide manufacturer's product information cut sheet or specifications sheet with the specific product number identified or filled out.
      c. Include the following installation data for each type of cable used:
         (i) Nominal OD
         (ii) Minimum bending radius, loaded
         (iii) Minimum bending radius, unloaded
         (iv) Maximum pulling tension
   2. Shop Drawings:
      a. Cabling administration drawings and printouts.

1.6 QUALITY ASSURANCE

B. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
   3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

B. Test cables upon receipt at Project site.
   1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
   2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
   3. Test each pair of UTP cable for open and short circuits.

1.8 PROJECT CONDITIONS

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

C. Do not deliver or install cables and connecting materials until temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.9 COORDINATION

B. Coordinate layout and installation of telecommunications pathways and cabling with KU IT and other trades.

PART 2 – PRODUCTS

2.1 GENERAL

A. Unless otherwise noted, provide items as specified. "Or equal" or equivalent items are not acceptable.

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

2.2 PATHWAYS

A. General Requirements: Comply with TIA-569-C.

B. Comply with Section 270528 "Pathways for Communications Systems," of this standard.

C. Cable Support: NRTL labeled for support of Category 6A cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with Velcro tie slots for fastening Velcro ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

2.3 INSIDE PLANT UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Systimax Solutions; a CommScope Inc. brand.
2. Superior Essex (for cables greater than 25 pairs, shall be Category 3)

B. Description: 100-ohm, 25 pair at minimum UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket and overall metallic shield.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA-568-C.2 for performance specifications.
3. Comply with TIA-568-C.2, Category 5e for 25 pair or less cables.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
   a. Communications Plenum Rated: Type CMP, complying with NFPA 262.
   b. Communications Riser Rated: Type CMR, complying with UL 1666.

2.4 OUTSIDE PLANT UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Superior Essex
B. Description: 100-ohm 25 pair at minimum UTP, formed into 25-pair binder groups covered with a black jacket and overall metallic shield.
C. Indoor/Outdoor UTP cable and coax cable shall be used for the portion of cable which enters a campus building to guarantee compliance with NFPA 70 Article 800.48.

2.5 COPPER SPLICE CLOSURES

A. Closures shall be re-enterable without the destruction of the housing. Closures shall be complete with all incidental and/or required hardware including, but not limited to, cans, end caps, grommet kits, covers, splice connectors, and grounding/bonding hardware. Closures shall not require special tooling for entry and sealing of the enclosure.
B. Outdoor: Splice closure shall have a stainless steel shell and shall be watertight sealable.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Preformed Line Products: ARMADILLO Splice Closure
   2. A properly installed splice closure should be watertight without encapsulant. However, in an abnormally harsh environment, it may be beneficial to use an encapsulant. Coordinate need for encapsulant with KU IT Representatives prior to closure design/installation.
C. Indoor:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. 3M: K&B Riser Closure
D. Connectors: Shall be RUS Listed.
   1. Manufacturers: Subject to compliance with requirements, provide products appropriate for the environment in which they are to be installed, by one of the following:
      a. Straight Only: 3M 710 Series Straight Modules
      b. Straight or Bridge: 3M 710 Series Straight/Half-Tap Modules

2.6 UTP CABLE HARDWARE

A. Comply with Section 271119 “Communications Termination Blocks and Patch Panels.”

2.7 OPTCIAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Systimax Solutions; a CommScope Inc. brand.

B. Description: Indoor Multimode, 50/125-micrometer, OM4, 24-fiber, tight buffer, optical fiber cable at minimum. Coordinate exact strand count with KU IT prior to design, specification and/or installation.
   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with TIA-568-C.3 for performance specifications.
   3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
      a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
      b. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
   4. Multimode: Maximum Attenuation: 3.50 dB/km at 850nm; 1.5 dB/km at 1300nm.
   5. Minimum Modal Bandwidth: 1500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
   6. OM4 Jacket:
      a. Jacket Color: Aqua
      b. Cable cordage jacket, fiber unit, and group color shall be according to TIA-598-C.
      c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

C. Description: Outdoor Multimode: Use of multimode optical fiber in the outside plant is prohibited unless otherwise indicated or approved by KU IT.

D. Multimode, 50/125-micrometer, OM5 WideBand Multimode Fiber (WBMMF), 12-fiber, tight buffer, optical fiber cable at minimum.
   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with TIAra-568-C.3 for performance specifications.
   3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
      a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
      b. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
   4. Conductive cable shall be aluminum armored type.
   5. Multimode: Maximum Attenuation: 3.00 dB/km at *850nm; 1.5 dB/km at *1300nm. (*Note): There is an attenuation value for the 953 nm wavelength @ 2.3 dB per KM. Field testing of OM5, however, only needs done at 850 and 1300 nm wavelengths.
   6. Minimum Effective Modal Bandwidth: 4700 MHz-km at 850 nm; 2470 MHz-km at 953 nm.
   7. Jacket:
      a. Jacket Color: Lime Green;

   Cable cordage jacket, fiber unit, and group color shall be according to TIA-598-C. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

E. Description: Multimode, 50/125-micrometer, OM5 WideBand Multimode Fiber (WBMMF): Use of OM5 multimode optical fiber in the outside plant is prohibited unless otherwise indicated or approved by KU IT.

F. Description: Indoor Singlemode, 8/125-micrometer, OS2, 12-fiber, tight buffer, optical fiber cable at minimum. Coordinate exact strand count with KU IT prior to design, specification and/or installation.
   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with TIA-568-C.3 for performance specifications.
   3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
      a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
      b. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
   4. Singlemode: Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 db/km at 1550 nm.
   5. Jacket:
      a. Jacket Color: Yellow
      b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-B.
      c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

G. Description: Outdoor Singlemode, 8/125-micrometer, OS2, 24-fiber, loose tube, gel-free, all-dielectric optical fiber cable at minimum. Coordinate exact strand count with KU IT prior to design, specification and/or installation.
   1. Comply with ICEA S-87-640 for mechanical properties.
   2. Comply with TIA-568-C.3 for performance specifications.
   3. Singlemode: Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 db/km at 1550 nm.
   4. Jacket:
      a. Jacket Color: Black
      b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-B.
      c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
   5. Indoor/Outdoor optical fiber cables shall be used for the portion of cable which enters a campus building to guarantee compliance with NFPA 70 Article 770.48A.

2.8 OPTICAL FIBER SPLICE CLOSURES

A. Closures shall be outdoor rated and re-enterable without the destruction of the housing. Closures shall no require special tooling for entry and sealing of the enclosure. 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 or in-line depending upon the application.

B. Outdoor:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Preformed Line Products: COYOTE Dome Closures
   2. A properly installed splice closure should be watertight without encapsulant. However, in an abnormally harsh environment, it may be beneficial to use an encapsulant.

Coordinate need for encapsulant with KU IT Representatives prior to closure design/installation.

C. Indoor: Cables shall terminate on optical fiber shelves. Refer to Section 271119 "Communications Termination Blocks and Patch Panels."

D. Splice Trays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Preformed Line Products: LITE-GRIP® Splice Trays

E. Grommets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Preformed Line Products: COYOTE Grommet

2.9 OPTICAL FIBER CABLE HARDWARE

A. Comply with Section 271119 "Communications Termination Blocks and Patch Panels."

2.10 COAXIAL CABLE

A. Manufacturers: Subject to compliance with requirement, provide products by one of the following:

1. CommScope Inc.

B. General Coaxial Cable Requirements: Backbone coax shall be a minimum RG-11 in size. Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with return loss of 20dB maximum from 7 to 806 MHz.

C. INDOOR USE – RG-11/U: Type CMP: Item: 2285K WHRL RG11 RG 11 Type 60% braid plenum video coaxial cable, white jacket. 4136903/10.

1. No. 14 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.

2. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.

D. OUTDOOR, IN-SLAB CONDUIT USE – RG-11/U: Item: 8292903/10, 5917 BKRL RG11 60 OSP. RG 11 Type 60% Braid Coaxial Cable, black jacket.

1. No. 14 AWG, solid, copper-covered steel conductor, gas-injected, foam-PE insulation.

2. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.

3. Jacketed with sunlight-resistant, black PVC or PE, suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 degrees C.

E. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:

1. CATV Cable: Type CATV.

2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
3. CATV Riser Rated: Type CATVR, complying with UL 1666.

2.11 COAXIAL CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden. Coaxial-Cable Connectors: Type F, 75 ohms.
B. RG-11 CONNECTORS:
   1. Non-plenum RG-11 coax: Belden 716SNS1P11H - 7/16" Universal "F" Connector for Standard or Quad-Shield Cable, black band.
   2. Plenum RG-11 coax: Belden 716SNS1P11HPLA - 7/16" Universal "F" Connector for Standard or Quad-Shield Cable, gray band.
   3. Recommended tool: CPLCCT-LS59/11.

2.12 GROUNDING

A. Comply with requirements in Section 270526 “Grounding and Bonding for Communications Systems” for grounding conductors and connectors.
B. Comply with J-STD-607-B.

2.13 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
B. Comply with Section 270553 “Identification for Communications Systems.”

2.14 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.
B. Factory test cables on reels according to TIA-568-C.2/TIA-568-C.3.
C. Factory test UTP cables according to TIA-568-C.2.
D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA-568-C.3.
E. Factory test singlemode optical fiber cables according to TIA-526-14-A and TIA-568-C.3.
F. Cable will be considered defective if it does not pass tests and inspections.
G. Prepare test and inspection reports.

PART 3 – EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by Telecommunications Contractor.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in all spaces unless otherwise indicated.
   2. Comply with requirements for raceways and boxes specified in Section 270533 "Conduits and Back-boxes for Communications Systems."

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

C. Wiring Method within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
   1. Comply with TIA-568-C.1.
   2. Comply with current edition BICSI ITSIMM, Chapters 5 and 6, "Cable Termination Practices."
   3. Install 110-style IDC termination hardware unless otherwise indicated.
   4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   5. Cables shall not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitation on bending radii, but no less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapters 5 & 6. Use lacing bars and distribution spools.
   8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   9. Cold-Weather Installation: Bring cable to room temperature before removing from reel. Heat lamps or other heat sources shall not be used for the purpose of heating cable spools.
   10. Install a 10-foot long service loop on each end of cable. Maintaining appropriate bend radii, coil service loop at work area outlet above-ceiling secured with Velcro to conduit stub or j-hook. Do not rest cable on ceiling grid or ceiling tile. In terminal room observing appropriate bend radii and bundling requirements, wrap and dress the 10ft. service loop within cable tray.

11. Pulling Cable: Comply with BICSI ITSIMM, Chapter 5 and 6, "Pulling and Installing Cable." Monitor cable pull tensions.

C. UTP Cable Installation:
1. Comply with TIA-568-C.0.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.
3. Do not exceed a pulling tension of 25 lbf. during the installation of 4-pair balanced twisted-pair cables. Refer to manufacturer's pulling tension guidelines for multi-pair cables.
4. Cable bend radius may vary depending on the cable condition during installation and after installation when the cable is at rest (no-load). The minimum inside bend radius, under no-load or load, for 4-pair balanced twisted-pair cable shall be four-times the cable diameter. The minimum bend radius for multi-pair cable shall follow the manufacturer's guidelines.

D. Copper Splice Closure Installation:
1. Follow splice closure manufacturer recommended installation procedures for specified splice closure.

E. Optical Fiber Cable Installation:
1. Comply with TIA-568-C.0.
2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted unless otherwise indicated.
3. Do not exceed manufacturer's pulling tension guidelines.
4. Do not exceed the manufacturer's recommended bend radii.

F. Optical Fiber Splice Closure Installation:
1. Follow splice closure manufacturer recommended installation procedures for specified enclosures.

G. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable with supports a minimum of 8 inches above ceilings, ideally 48 inches but not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
4. Cables shall not be tied to or supported by pipes, ducts, ceiling support wires or other building components which are not part of the communications pathway system.

H. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

I. Outdoor Coaxial Cable Installation:
1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.

2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

J. Group connecting hardware for cables into separate logical fields.

K. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-C recommendations for separating unshielded copper voice and data communications cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 kVA and 5 kVa: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 kVA and 5 kVa: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 kVA and 5 kVa: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRE-STOPPING

A. Comply with TIA-569-C, Annex A, “Fire-stopping.”

B. Comply with BICSI TDMM, Chapter 8 “Fire-stopping.”

C. Comply with Section 270545 “Penetration Fire-stopping for Communications Systems.”

3.5 GROUNDING

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

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

C. Comply with Section 270526 “Grounding and Bonding for Communications Systems.”

3.6 FIELD QUALITY CONTROL

A. Perform Tests and Inspections

B. Comply with Sections 270813 “Copper Testing” and 270816 “Optical Fiber Testing.”

C. Flash Test all Outdoor splice closures (copper and optical fiber) following the manufacturer's recommended procedure for flash testing to ensure the splice closure has been properly sealed against the ingress of water.

END OF SECTION 271300

27 15 00 – Communications Horizontal Cabling

PART 1 – GENERAL

1.1 SUMMARY

A. Description of work:

1. Provide a complete and fully-functioning communications horizontal cabling system. All cables, terminations and support hardware shall be furnished, installed, tested, labeled, and documented by the Telecommunications Subcontractor.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 270000 "Communications" including all referenced codes, standards and guidelines.

C. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International

B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

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

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. LAN: Local area network.

G. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.

H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

I. RCDD: Registered Communications Distribution Designer.

J. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with KU IT.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.5 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 270000 "Communications":

1. Product Information

a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
b. Provide manufacturer's product information cut sheet or specifications sheet with the specific product number identified or filled out.
c. Include the following installation data for each type of cable used:
i. Nominal OD.
ii. Minimum bending radius, loaded.
iii. Minimum bending radius, unloaded.
iv. Maximum pulling tension.

2. Shop Drawings:
a. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by KU IT.
b. System Labeling Schedules: Electronic copy of labeling schedules that are a part of the cabling and asset identification system of the software.
c. Cabling administration drawings and printouts.
d. Wiring diagrams to show typical wiring schematics, including the following:
e. Cross-connects.
f. Patch panels.
g. Patch cords.
h. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

B. The following submittals are due Post-Construction, in accordance with submittal requirements in Section 270000 "Communications":
1. Record Drawings
a. Provide scaled drawings (not less than 1/8" = 1'-0") indicating actual installed routing of horizontal cabling. Design or shop drawings modified in the field will not be accepted.

1.6 DELIVERY, STORAGE, AND HANDING

A. Test cables upon receipt at Project site.
1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss vale of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

PART 2 – PRODUCTS

2.1 HORIZONATAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
   1. KU IT requires that a minimum of two telecommunications outlet/connectors be installed for each work area. In addition, the Telecom Consultant is responsible in determining additional or project-specific connection needs.
   2. Horizontal cabling shall not contain a transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector unless otherwise indicated.
   3. Bridged taps and splices shall not be installed in the horizontal cabling.
   4. Horizontal UTP cables shall not have pairs split off to provide connectivity to another telecommunications outlet/connector. Each horizontal UTP cable shall serve only one outlet/connector.
   5. Splitters shall not be installed as part of the UTP or optical fiber cabling.
B. A work area is approximately 100 sq.-feet, and includes the components that extend from the telecommunications outlet/connectors to the station equipment (computer, phone, etc.).
C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or 16 feet in the horizontal cross-connect.
D. All new construction shall be Category 6A cable plant. Coordinate Cable Category requirements with KU IT prior to design and/or installation.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with the transmission standards in TIA-568-C.3 when tested according to test procedures of this standard.
B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. Grounding: Comply with J-STD-607-B.

2.3 CATEGORY 6 UTP CABLE – Existing Structures ISP Maintenance, Repairs, Remodels

A. Manufacturer shall be Systimax Solutions; a CommScope Inc. brand.
   a. Model: GigaSPEED XL 2071E – Jacket Color: Spring Green imprinted with pair count, cable type, and aggregate length at regular intervals not to exceed 40 inches.
B. Cable shall be plenum rated unless otherwise noted. One exception to this is where installed in a wet-rated environment, including cables installed in conduits poured into slabs-on-grade.

C. Description: Category 6, 100-ohm, four-pair UTP, covered with thermoplastic jacket.
   1. Comply with ICEA S-102-700 for mechanical properties.
   2. Comply with TIA-568-C.3 for performance specifications.
   3. Comply with TIA-568-C.3, Category 6.
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
      a. Communications Plenum Rated: Type CMP, complying with NFPA 262.
      b. Cables installed in wet-rated environment shall be wet-rated.

2.4 CATEGORY 6A UTP CABLE – TO BE USED FOR ALL NEW CONSTRUCTION

A. Manufacturer shall be Systimax Solutions; a CommScope Inc. brand.
   a. Model: GigaSPEED X10D 2091B – Jacket Color: Orange. Imprinted with pair count, cable type, and aggregate length at regular intervals not to exceed 40 inches.

B. Cable shall be plenum rated unless otherwise noted. One exception to this is where installed in a wet-rated environment, including cables installed in conduits poured into slabs-on-grade.

C. Description: Category 6A, 100-ohm, four-pair UTP, covered with thermoplastic jacket.
   1. Comply with ICEA S-90-661, ICEA S-102-700 for mechanical properties.
   2. Comply with TIA-568-C.3 for performance specifications.
   3. Comply with TIA-568-C.3, Category 6A.
   4. Coordinate cable category type with KU IT prior to design, bid and installation.
   5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
      a. Communications Plenum Rated: Type CMP, complying with NFPA 262.
      b. Cables installed in wet-rated environment shall be wet-rated.

2.5 UTP CABLE HARDWARE

A. Comply with requirements of Section 271119 “Communications Termination Blocks and Patch Panels.”

2.6 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Systimax Solutions; a CommScope Inc. brand.

B. Description: Multimode, 50/125-micrometer, OM4, 12-fiber, tight buffer, optical fiber cable at minimum.
   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with TIA-568-C.3 for performance specifications.
   3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
      a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
      b. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.

4. Conductive cable shall be aluminum armored type.
5. Multimode: Maximum Attenuation: 3.50 dB/km at 850nm; 1.5 dB/km at 1300nm.
6. Minimum Modal Bandwidth: 1500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
7. Jacket:
   a. Jacket Color: Aqua
   b. Cable cordage jacket, fiber unit, and group color shall be according to TIA-598-C.
   c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

C. Description: Singlemode, 8/125-micrometer, OS2, 12-fiber, tight buffer, optical fiber cable at minimum.
1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   b. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
4. Conductive cable shall be aluminum armored type.
5. Singlemode: Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.
6. Jacket:
   a. Jacket Color: Yellow
   b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-B.
   c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.7 OPTICAL FIBER CABLE HARDWARE

A. Comply with requirements of Section 271119 “Communications Termination Blocks and Patch Panels.”

2.8 COAXIAL CABLE

A. Manufacturers: Subject to compliance with the requirements, provide products by the following:
1. CommScope, Inc.

B. General Coaxial Cable Requirements: Horizontal coax shall be a minimum RG-6 in size. Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with return loss of 20dB maximum from 7 to 806 MHz.

C. INDOOR USE – RG-6/U: Type CMP Item: 4138003/10, 2275V WHRL RG6 60. 60% Braid Plenum Video Coaxial Cable, white jacket.
1. No. 18 AWG, solid, copper-covered steel conductor, gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.

3. Environmental space, plenum.

D. OUTDOOR, IN-SLAB CONDUIT USE – RG6 item: 4685203/10 5738 BKRL RG6 60 OSP, 60% Braid Buried Coaxial Cable, black jacket.
   1. No. 18 AWG, solid, copper-covered steel conductor, gas-injected, foam-PE insulation.
   2. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
   3. Environmental space, burial.

E. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
   1. CATV Cable: Type CATV.
   2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
   3. CATV Riser Rated: Type CATVR, complying with UL 1666.

2.9 COAXIAL CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden. Coaxial-Cable Connectors: Type F, 75 ohms.

B. RG-6 CONNECTORS:
   1. Non-plenum RG-6 coax: Belden FSNS6U - RG-6 Universal F Male Coax Connector for Standard or Quad-Shield Cable, green band. (FSNS6URA) – Right angle.
   2. Plenum RG-6 coax: Belden FSNS6P; - RG-6 F Male Coax Connector for plenum cable, green band.

C. 3. Recommended tool: CPLCCT-SLM or CPSNSCT-596.

2.10 CONSOLIDATION POINTS

A. Consolidation points are prohibited unless otherwise indicated or approved by KU IT.

2.11 MULTIUSER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

A. Multiuser telecommunications outlet assemblies are prohibited unless otherwise indicated or approved by KU IT.

2.12 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Comply with requirements in Section 271543 "Communications Faceplates and Connectors."

2.13 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

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

2.14 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
B. Comply with Section 270553 "Identification for Communications Systems."

2.15 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.
B. Factory test cables on reels according to TIA-568-C.0.
C. Factory test UTP cables according to TIA-568-C.0.
D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA-568-C.0.
E. Factory test singlemode optical fiber cables according to TIA-526-14-A and TIA-568-C.0.
F. Cable will be considered defective if it does not pass tests and inspections.
G. Prepare test and inspection reports.

PART 3 – EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point identified by KU IT.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in all spaces unless otherwise indicated.
   2. Comply with requirements for raceways and boxes specified in Section 270533 "Conduit and Back-boxes for Communications Systems."
B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
C. Wiring Method within Enclosures:
   1. Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
   2. Provide and use lacing bars and distribution spools.
   3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.
B. General Requirements for Cabling:
   1. Comply with TIA-568-C.0.
   2. Comply with BICSI ITSIMM, Chapters 5 and 6, "Cable Termination Practices."
   3. Install 110-style IDC termination hardware unless otherwise indicated.

4. MUTOA's are prohibited unless indicated otherwise or approved by KU IT.
5. Consolidation Points are prohibited unless indicated otherwise or approved by KU IT.
6. Terminate all conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables shall not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitation on bending radii, but no less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before reel removal. Heat lamps or other heat sources shall not be used for heating.
12. Install a 10-foot long service loop on each end of cable. Maintaining appropriate bend radii, coil service loop at work area outlet above-ceiling secured with Velcro to conduit stub or j-hook. Do not rest cable on ceiling grid or ceiling tile. In terminal room observing appropriate bend radii and bundling requirements, wrap and dress the 10ft. service loop within cable tray.
13. For remodel projects where new cables are proposed to be installed. It may not be possible to provide a minimum of 10ft. of cable slack in the existing terminal room. Discuss possible slack alternatives with KU I.T. before cable installation.
14. For remodel projects where existing cables may be relocated or will not be removed from the space(s). It is not the intent to rewire a room, suite or building with the use of existing cable slack. If existing outlet locations are moved further from a terminal room, a new cable with minimum slack requirements shall be installed. With prior approval, existing cables that move closer to a terminal may be relocated.
15. Pulling Cable: Comply with BICSI ITSIM, Chapter 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:
   1. Comply with TIA-568-C.0.
   2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:
   1. Comply with TIA-568-C.0.
   2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted unless otherwise indicated.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable a minimum of 8 inches above ceilings by cable supports ideally 48 inches but not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
4. Cables shall not be tied to or supported by pipes, ducts, ceiling support wires or other building components which are not part of the communications pathway system.

F. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

G. Outdoor Coaxial Cable Installation:
1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

H. Group connecting hardware for cables into separate logical fields.

I. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-C recommendations for separating unshielded copper voice and data communications cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 kVA and 5 kVa: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 kVA and 5 kVa: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 kVA and 5 kVa: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRE-STOPPING

A. Comply with TIA-569-C, Annex A, "Fire-stopping."
B. Comply with BICSI TDMM, Chapter 8, "Fire-stopping."

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
B. Comply with J-STD-607-B.
C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-A.
B. Comply with requirements of Section 270553 "Identification for Communications Systems."

3.7 FIELD QUALITY CONTROL

A. Perform the following Tests and Inspections with a representative from KU IT:
    1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.0.
    2. Visually confirm Category 6 or Category 6A marking of outlets, cover plates, outlet/connectors, and patch panels.
    3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
    4. Optical Fiber Cable Tests:
        a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
        b. Link End-to-End Attenuation Tests:
            i. Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.
            ii. Horizontal and singlemode backbone link measurements: Test at 1310 or 1550 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.
            iii. Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA-568-C.0.

5. UTP Cable Performance Tests: Conduct tests according to Section 270813 “Copper Testing”.
6. Optical Fiber Cable Performance Tests: Conduct tests according to Section 270816 “Optical Fiber Testing”.
7. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.

B. Documentation data for each measurement. Data for submittals shall be transferred from the instrument to the computer, saved as text files, and printed and submitted.
C. End-to-end cabling will be considered defective if it does not pass tests and inspections
D. Prepare test and inspection reports and provide to KU IT.

END OF SECTION 271500

27 15 43 – Communications Faceplates and Connectors

PART 1 – GENERAL

1.1 SUMMARY

A. This section shall govern the products and installation of communications faceplates and information outlets/modular jacks.

1.2 RELATED DOCMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions of Division 01 Specifications Sections, apply to this section.
B. Section 270000 "Communications" including all referenced codes, standards and guidelines.
C. Section 271300 "Communications Backbone Cabling"
D. Section 271500 "Communications Horizontal Cabling"
E. Section 270533 "Conduits and Back-boxes for Communications Systems"
F. Section 270553 "Identification for Communications Systems"

1.3 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 270000 "Communications.":
   1. Product Information
      a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
      b. Provide manufacturer's product information cut sheet or specifications sheet with the specific product number identified or filled out.
   2. Shop Drawings
      a. Provide scaled drawings (not less than 1/8" = 1'-0") indicating location and type/part number of faceplate to be used. This information shall be included on shop drawing(s) for 270553 "Identification of Communications Systems."
B. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 270000 "Communications":
   1. Record Drawings
      a. Provide scaled drawings (not less than 1/8" = 1'-0") indicating location and type/part number of faceplate actually installed. This information may be included on record drawing for Section 270554 "Identification of Communications Systems."

PART 2 – PRODUCTS

2.1 GENERAL

A. All faceplates and information outlets/modular jacks shall be by the same manufacturer. This manufacturer shall also be the same manufacturer that will be offering the advance system warranty as required by Section 270000 "Communications."

2.2 FACEPLATES

A. Wall-Phone Outlet
   1. Shall be single-gang.
   2. Shall be stainless steel.
   3. Shall meet the dimensional requirement for faceplate and information outlet/modular jack as specified in ANSI/TIA-570-B.
   4. Wall-Phone Faceplate shall be SYSTIMAX P/N M10LW4 (760100891).

B. Typical Work-Area Outlets:
   1. Single-Gang Faceplate
      a. Color and material shall meet requirements for environment and match electrical faceplates. Coordinate faceplate material and color with Architect.
      b. Shall have a recessed label field with high impact thermo-plastic cover.
      c. Single-Gang Faceplate shall be Systimax L Type Flush Mounted Faceplate in required port quantity. Typical port quantity of (4) installing blanks as needed.
      d. Design Engineer shall limit faceplate port quantity taking into account conduit fill ratio and cable bend radii in back-box.
   2. Double-Gang Faceplate
      a. Double-gang faceplates shall not be permitted for new construction without prior written approval from KU IT Representatives. Typically, conduit fill and cable bend radii is exceeded before the additional available double-gang ports are installed. In these instances, an additional back-box or low-voltage mounting plate bracket shall be installed.
      b. Double-gang faceplates may be permissible for existing construction and renovations in areas where no suitable alternative exist and conduit fill ratios and cable bend radii are not exceeded.
      c. If approved, double-gang faceplate shall be Systimax L Type Flush Mounted Faceplate in required port quantity. Color and material shall meet requirements for environment and match electrical faceplates.

C. Systems/Modular Furniture Bezels
   1. Furniture Bezels/Faceplates shall be used when cables are installed in systems furniture. The furniture bezels/faceplates shall be specified to match the furniture color as closely as possible and shall be compatible with Systimax information outlets as described in 2.3 below. The Design Engineer and/or Contractor shall coordinate with the Architect or KU prior to specifying, ordering or installing bezels.

D. Above-ceiling Outlets for Wireless Access Points
   1. CommScope Ceiling Connector
      a. CommScope Ceiling Connector Cat 6A item: 760235592 White or 760235591 black.
      b. CommScope Ceiling Connector Cat 6 item: 760235588 White or 760235587 Black.

2.3 INFORMATION OUTLETS/MODULAR JACKS

A. Category 6 Information Outlets/Modular Jacks

1. Performance shall meet that of Category 6.
2. Color and material in work area shall meet requirements for environment and match electrical faceplates.
3. MDF and IDF patch cord color shall be spring green.
4. Category 6 Information Outlet/Modular jack shall be Systimax GigaSPEED® XL MGS400 Series Category 6 U/UTP Information Outlet.
5. For new construction, horizontal cable shall be Category 6A. For existing buildings or structures that have Category 6 cabling or below, Category 6 cable shall be installed unless noted otherwise.

B. Category 6A Information Outlets/Modular Jacks
1. Performance shall meet that of Category 6A.
2. Color and material in work area shall meet requirements for environment and match electrical faceplates.
3. MDF and IDF patch cord color shall be orange.
4. Category 6A Information Outlet/Modular jack shall be Systimax GigaSPEED® X10D MGS600 Series Category 6A U/UTP Information Outlet.

C. F-Type Connector (for CATV)
1. Module shall include coax pass-through “F”-connector.
2. Color and Material shall meet requirements for environment and match electrical faceplates.
3. F-Type Connector shall be Systimax M81C-Plus Coaxial Coupler, (760049221).

PART 3 – EXECUTION

3.1 GENERAL

A. Follow all manufacturers’ instructions.
B. All category information outlets/modular jacks shall be terminated using the T568B termination scheme as specified in ANSI/TIA-568-C.0.
C. Coordinate with all other trades prior to pre-construction submittals and installation.

3.2 FACEPLATES

A. Faceplates shall be installed straight and plumb in all directions.
B. Should the faceplate not cover the entirety of the outlet box hole in the wall due to overcutting or rough workmanship, the wall shall be appropriately patched and painted for a neat and clean finished appearance.
C. Fill all module openings with blank modules that are the same color as the face plate.

END OF SECTION 27 15 43

27 16 19 – Communications Patch Cords, Station Cords, and Cross-Connect Wire

PART 1 – GENERAL

1.1 SUMMARY

A. This section shall govern the products and installation of telecommunications patch cords (cables), station cords (at work area outlets), and cross-connect wires.
   1. The contractor shall supply all necessary cross-connect wires as part of a complete and functioning telecommunications system.
   2. The contractor shall supply station cords for all of the work area outlets to be activated.
   3. The contractor shall supply IDF or MDF patch cords for all of the work area outlets to be activated.

1.2 RELATED DOCMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions of Division 01 Specifications Sections, apply to this section.
B. Section 270000 “Communications” including all referenced codes, standards and guidelines.
C. Section 270533 “Conduits and Back-boxes for Communications Systems”
D. Section 270553 “Identification for Communications Systems”
E. Section 271119 “Communications Termination Blocks and Patch Panels”
F. Section 271300 “Communications Backbone Cabling”
G. Section 271500 “Communications Horizontal Cabling”

1.3 SUBMITTALS

A. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 270000 “Communications.”:
   1. Product Information
      a. Provide table of contents with all product names, manufacturer, and specific product number identified to accompany manufacturer cut-sheets.
      b. Provide manufacturer’s product information cut sheet or specifications sheet with the specific product number identified or filled out.

PART 2 – PRODUCTS

2.1 COPPER CROSS- CONNECTS – Included for maintenance, repairs or remodels

A. Provide cross-connect wires as indicated on the drawings and as required to form a complete and functional telecommunications system.
B. Cross-connect wires shall be 4-pair, 24 AWG insulated solid copper wire and be rated to meet or exceed Category 6 standards.
C. Cross-connect wire shall be designed and manufactured to serve as cross-connect wire. 4-pair UTP cable with the jacket stripped off shall not be permitted. Two (2) 2-pair cross-connect wires shall not be permitted. If the Design Engineer or KU IT Representatives

discover that 4-pair UTP cable with the jacket stripped off or two (2) 2-pair cross-connects have been used in place of 4-pair cross-connect wire, it shall be removed and replaced at no cost to KU.

2.2 COPPER PATCH CORDS

Manufacturer shall be SYSTIMAX.

A. Cable shall be 4-pair, unshielded twisted pair cables within a single jacket with factory-terminated RJ-45 modules on each end. Contractor to determine other lengths as needed for project.
B. Performance shall meet the performance of ANSI/TIA-568 Category 6 standard at minimum and ANSI/TIA-568 Category 6A standard for Category 6A installations.
C. Lengths and color shall vary. Contractor to determine other lengths as needed for project. Assume:
   1. Provide one (1) 2-meter spring green Category 6 patch cord for each Category 6 port on a patch panel.
   2. Provide one (1) 2-meter orange patch cord for each Category 6A port on a patch panel.

2.3 COPPER STATION CORDS (WORK AREA CORDS)

Manufacturer shall be SYSTIMAX.

A. Cable shall be 4-pair, unshielded twisted pair cables within a single jacket with factory-terminated RJ-45 modules on each end.
B. Performance shall meet the performance of ANSI/TIA-568 Category 6 standard at minimum and ANSI/TIA-568 Category 6A standard for Category 6A installations.
C. Lengths and color shall vary. Assume:
   1. Provide one (1) 3-meter/10-foot dark grey Category 6 station cord for each activated Category 6 work area outlet plus twenty-five (25) percent.
   2. Provide one (1) 3-meter/10-foot dark grey Category 6A station cord for each activated Category 6A work area outlet plus twenty-five (25) percent.

PART 3 – EXECUTION

3.1 GENERAL

A. Follow all manufacturers' instructions.
B. All category information outlets/modular jacks shall be terminated using the T568B termination scheme as specified in ANSI/TIA-568-C.0.
C. Coordinate with all other trades prior to pre-construction submittals and installation.

3.2 FACEPLATES

A. Faceplates shall be installed straight and plumb in all directions.
B. Should the faceplate not cover the entirety of the outlet box hole in the wall due to overcutting or rough workmanship, the wall shall be appropriately patched and painted for a neat and clean finished appearance.

C. Fill all module openings with blank modules matching the faceplate cover.

END OF SECTION 27 16 19

27 21 33 – Data Communications Wireless Access Points

PART 1 – GENERAL

1.1 SUMMARY

C. This section shall govern the products and installation of all necessary parts, pieces, and accessories for installation of wireless access points.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Section 270000 "Communications" including all referenced codes, standards and guidelines.
C. Section 271119 "Communications Termination Blocks and Patch Panels."
D. Section 271500 "Communications Horizontal Cabling."
E. Section 271543 "Communications Faceplates and Connectors."
F. Section 271619 "Communications Patch Cords, Station Cords, and Cross Connect Wire."
G. Section 270528 "Pathways for Communications Systems."

1.3 DEFINITIONS

1.4 SUBMITTALS

A. The following submittals are due at the Post-Construction Phase, in accordance with submittal requirements in Section 270000 "Communications":
   1. Record Drawings
      a. Provide scaled drawings (floor plans not less than 1/16" = 1'-0") indicating actual location of each removed, relocated or new access point.
      b. Provide a completed wireless access point schedule detailing at minimum, work area outlet identifier, switch port and AP MAC address.

1.5 QUALITY ASSURANCE

C. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
   2. Field Inspector: Currently registered by BICSI as a Registered Communications Distribution Designer (RCDD) to perform the on-site inspection

PART 2 – PRODUCTS

2.1 BACK BOXES

A. Comply with requirements of Section 270533 “Conduits and Back Boxes for Communications Systems.”

2.2 HORIZONTAL CABLING

F. Comply with requirements of Section 271500 “Communications Horizontal Cabling.”
G. All new horizontal cabling for wireless access points shall be at minimum Category 6A.

2.3 FACEPLATES

A. When applicable, comply with requirements of Section 271543 “Communications Faceplates and Connectors.”

2.4 CONNECTORS

A. Comply with requirements of Section 271543 “Communications Faceplates and Connectors.”
B. All new connectors for wireless access points shall be at minimum Category 6A.

2.4 LABELING

A. Comply with requirements of Section 270553 “Identification for Communications Systems.”
B. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8-inch. Overlay shall provide weatherproof and UV-resistant seal for label.

PART 3 – EXECUTION

3.1 INSTALLATION

NOTE: Some newer Aruba wireless access point models are now able to be secured to a double-gang junction box. Project and AP model-specific and prior to project start, verify either the use of a junction box or a CommScope Ceiling Connector as/where required.

A. At each access point location identified in the drawings as “NEW”, the Telecommunications Subcontractor shall provide the following:
   1. One (1) new CommScope GigaSPEED X10D 2091B, orange jacket cat6A UTP cable originating from new/existing patch panel or termination block in the nearest Telecommunications room.
   2. One (1) new CommScope Systimax Solutions 760235591 CAT6A U/UTP Cord Plenum RJ45 to Ceiling Connector 1.5FT BLK.
   3. Or, item: CommScope Category 6A U/UTP Cord, Plenum, and RJ45 to 1.5 ft. white. 760235592, CCA-CAT6A-PLENUM-WHITE-N018. Verify color choice with KU I.T.

4. Each ceiling connector body shall be labeled to match the termination block & patch panel port cable label.
5. Install one (1) access point (model TBD), to be furnished by KU IT (unless otherwise noted), per manufacturer recommended installation procedure.
   Connect the AP to the ceiling connector and secure any excess cable or cord slack to building structure per Section 270529 “Hangers and Supports,” section 2.1, item #8..
6. Secure any excess cable slack to building structure per Section 270529 “Hangers and Supports,” section 2.1, item #8.

B. At each access point location identified in the drawings as “RELOCATE” the Telecommunications Subcontractor shall:
   1. Remove the existing access point as well as any associated antennas and return them to the KU IT Warehouse (where applicable).
   2. Verify the outlet and cable meet the following standards:
      a. Outlet box is galvanized steel with stainless steel faceplate.
      b. Horizontal cable is at minimum Category 5E.
   3. If the outlet and cable meet the above standards, the outlet and cable shall be relocated to the vertical structure (wall/column) nearest to the new access point location shown in the drawings. If the existing outlet location meets the above standards, is located in the same room as the new access point location, and the new access point can be connected to the outlet with a patch cord twenty-feet in length or less, the existing outlet can remain in its current location.
   4. If the existing cable or outlet does not meet standards, a "NEW" CommScope Systimax Solutions 760235591 CAT6A U/UTP Cord Plenum RJ45 to Ceiling Connector 1.5FT BLK and a CommScope Orange Category 6A UTP 760107227, shall be installed nearest to the new access point location shown in the drawings. All old outlet and cable materials shall be completely removed. In the event a cable is removed, it shall be noted as such by the contractor in their as-built documentation.
   5. Install one (1) access point to be furnished by KU IT (unless otherwise noted) per manufacturer recommended installation procedure.

C. At each access point location identified in the drawings as “REPLACE” the Telecommunications Subcontractor shall:
   1. Remove the existing access point as well as any associated antennas and return them to the KU IT Warehouse.
   2. Verify the outlet and cable meet the following standards:
      a. Outlet box is galvanized steel with stainless steel faceplate.
      b. Horizontal cable is at minimum Category 5E.
   3. If the existing location meets the above Standards, the Contractor shall install one (1) access point to be furnished by KU IT (unless otherwise noted) per manufacturer recommended installation procedure.
   4. If the existing cable or outlet does not meet standards, a "NEW" CommScope Systimax Solutions 760235591 CAT6A U/UTP Cord Plenum RJ45 to Ceiling Connector 1.5FT BLK and a CommScope Orange Category 6A UTP 760107227, shall be installed on a vertical

structure (wall/column) nearest to the new access point location shown in the drawings and the contractor shall install one (1) access point to be furnished by KU IT (unless otherwise noted) per manufacturer recommended installation procedure. All old outlet and cable materials shall be completely removed.

D. At each access point location labeled as "REMOVE" in the drawings, the Contractor shall:
   1. Remove the existing access point as well as any associated antennas and return them to the KU IT Warehouse.
   2. Verify the outlet and cable meet the following standards:
      a. Outlet box is galvanized steel with stainless steel faceplate.
      b. Horizontal cable is at minimum Category 5E.
   3. If the existing outlet location meets the above Standards, the outlet shall remain and the contractor shall note the outlet identifier and location on their as-built drawings
   4. If the existing outlet location does not meet the above standards, the old cable and outlet shall be removed back to its origination point. In the event a cable is removed, it shall be noted as such by the contractor in their as-built documentation.

E. At each access point location labeled as "DEMO" in the drawings, the Contractor shall:
   1. Remove the existing access point as well as any associated antennas and return them to the KU IT Warehouse.
   2. Remove the existing outlet and cable back to its origination point. In the event a cable is removed, it shall be noted as such by the contractor in their as-built documentation.

3.2 LABELING

A. Each access point shall be labeled with the access point identifier detailed in the drawings. The label shall be mechanically produced and affixed to the exposed surface, visible from the ground.

3.3 TESTING

A. Each newly installed or relocated access point shall be channel tested (against appropriate Category Standard per cable type).
B. Comply with Section 270813 "Copper Testing."

END OF SECTION 27 21 33

Appendix

Standards Variance/Product Substitution Request Form (KU IT Projects Only)

(Use A1.1 Standards Variance Request Form for KU FPD (Facilities Planning Development, Led Projects)

Project Name: _____

Project Numbers: KU I.T. #_____Date: _____

Submitted By: _____

Name: _____ Firm: _____

Current KU IT Standard for which variance is requested:

Page Number:_____Paragraph Title: _____

Briefly Describe Current KU Standard:

Requested Variance /Product Substitution

Reasons or Justification for Variance/Product Substitution Approval:

KU Action ☐ Approved ☐ Denied

KU IT Project Manager _____ Date: _____

KU IT Telecom. Engineer _____ Date: _____

Summary of Submittals

Pre-Bid Phase Submittals

Section	Phase	Description
270000	Pre-Bid	Requests for Product Substitutions
270000	Pre-Bid	Project Questions or Clarifications

Table 5 - Pre-bid phase submittals

Bid Phase Submittals

Section	Phase	Description
270000	Bid	Proof of Telecommunications Subcontractor and personnel qualifications
270000	Bid	Voluntary alternatives (that realize substantial cost savings)
270000	Bid	Unit Pricing

Table 6 - Bid phase submittals

Pre-Construction Phase Submittals

Section	Phase	Description
270000	Pre-Construction	Pre-construction product submittals and shop drawings
270526	Pre-Construction	Product Information
270526	Pre-Construction	Shop Drawings
270528	Pre-Construction	Product Information
270528	Pre-Construction	Shop Drawings
270529	Pre-Construction	Product Information
270529	Pre-Construction	Shop Drawings
270529	Pre-Construction	Coordination Drawings
270533	Pre-Construction	Product Information
270533	Pre-Construction	Shop Drawings
270536	Pre-Construction	Product Information
270536	Pre-Construction	Shop Drawings
270539	Pre-Construction	Product Information
270543	Pre-Construction	Product Information

270544	Pre-Construction	Product Information
270545	Pre-Construction	Product Information
270545	Pre-Construction	Product Schedule
270813	Pre-Construction	Personnel Training Certificates
270813	Pre-Construction	Tester Information including Calibration
270813	Pre-Construction	Sample Test Report
270816	Pre-Construction	Personnel Training Certificates
270816	Pre-Construction	Tester Information including Calibration
270816	Pre-Construction	Sample Test Report
271113	Pre-Construction	Product Information
271116	Pre-Construction	Product Information
271119	Pre-Construction	Product Information
271119	Pre-Construction	Shop Drawings
271300	Pre-Construction	Product Information
271300	Pre-Construction	Shop Drawings

271500	Pre-Construction	Product Information
271500	Pre-Construction	Shop Drawings
271543	Pre-Construction	Product Information
271543	Pre-Construction	Shop Drawings
271619	Pre-Construction	Product Information

Table 7 - Pre-construction phase submittals

Construction Phase Submittals

Section	Phase	Description
270000	Construction	Change order requests, RFIs, DCDs
270813	Construction	Test Results - electronic native tester format
270816	Construction	Test Results - electronic native tester format

Table 8 - Construction phase submittals

Post-Construction Phase Submittals

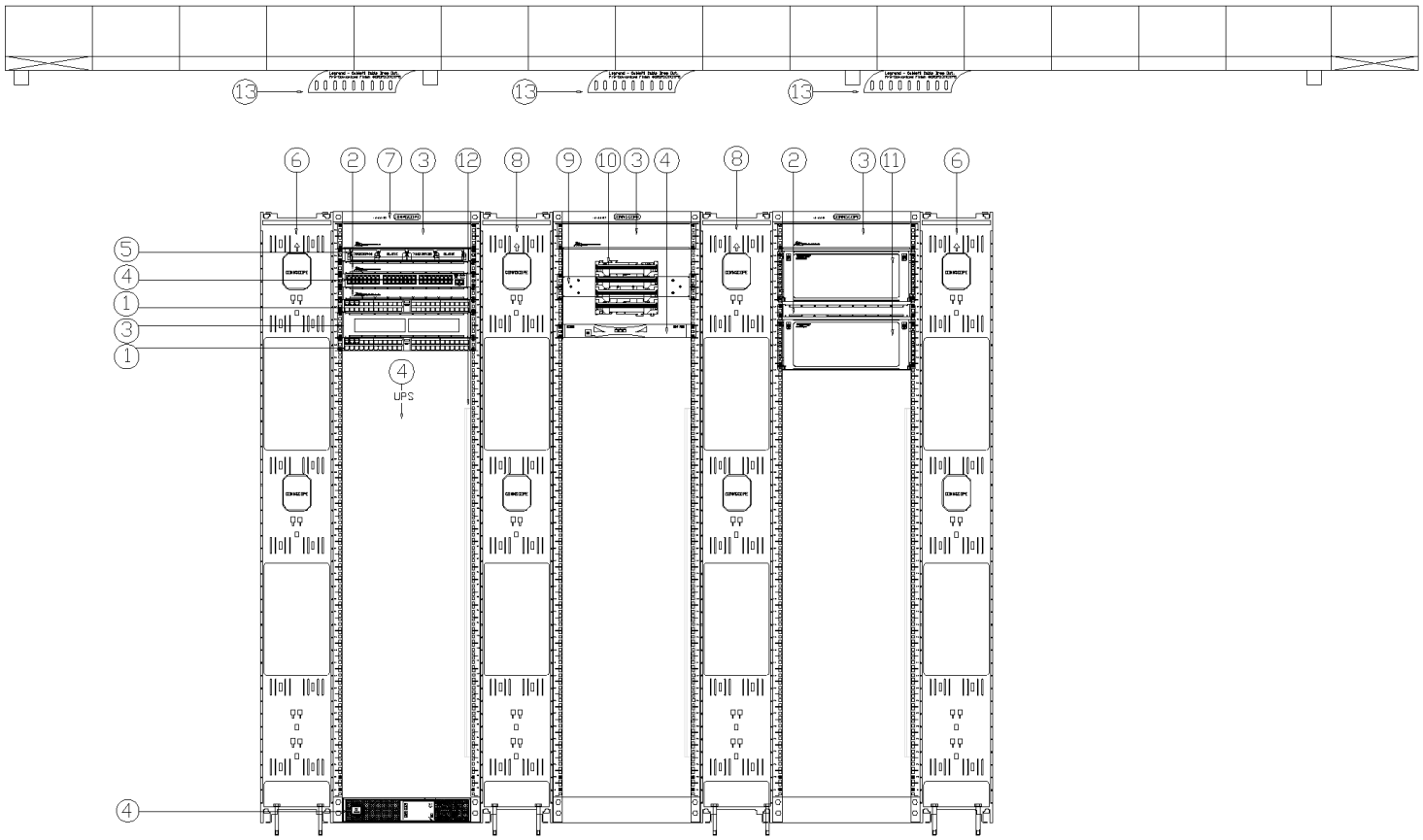
Section	Phase	Description
270000	Post-Construction	Record drawings and warranty certificates/letters
270526	Post-Construction	Record Drawings
270526	Post-Construction	Project RCDD Letter verifying system
270528	Post-Construction	Record Drawings
270528	Post-Construction	Keys for Pull Boxes/Enclosures/Cabinets
270529	Post-Construction	Record Drawings
270529	Post-Construction	Manufacturer and Maintenance Manuals
270533	Post-Construction	Record Drawings
270533	Post-Construction	Keys for Pull Boxes/Enclosures/Cabinets
270536	Post-Construction	Record Drawings
270536	Post-Construction	Manufacturer and Maintenance Manuals
270539	Post-Construction	Manufacturer and Maintenance Manuals
270539	Post-Construction	Special Tools
270543	Post-Construction	Manufacturer and Maintenance Manuals
270543	Post-Construction	Special Tools
270544	Post-Construction	Manufacturer and Maintenance Manuals
270544	Post-Construction	Special Tools
270545	Post-Construction	Record Drawings
270545	Post-Construction	Installer Certificates
271119	Post-Construction	Record Drawings
271119	Post-Construction	Manufacturer and Maintenance Manuals
271500	Post-Construction	Record Drawings
271543	Post-Construction	Record Drawings

272133	Post-Construction	Record Drawings

Table 9 - Post-construction phase submittals

Typical MDF Equipment Rack Elevation

TYPICAL MDF THREE FLOOR RACKS



1) 760109744 M4800A-1U-GS 48 port angled patch panel

2) Middle Atlantic EB1 Blank Panel 1RU

3) Middle Atlantic EB2 Blank Panel 2RU

4) Network & UPS equipment by KU

5) 760231506 SYSTIMAX HD 1U Sliding Fiber Panel with 760230946 & 760230938

6) CommScope 760244779 - VCM-DS-84-6B End of rack six inch double-sided vertical manager

7) 760082495 RK6-45A All floor racks

8) CommScope 760244781 - VCM-DS-84-10B Between adjacent racks ten inch double-sided vertical manager

9) 760060327 VisiPatch Bracket VP360-RMBKT

10) 760049445 VisiPatch 360 4U Patch Panel Kit VP360-4U-32P

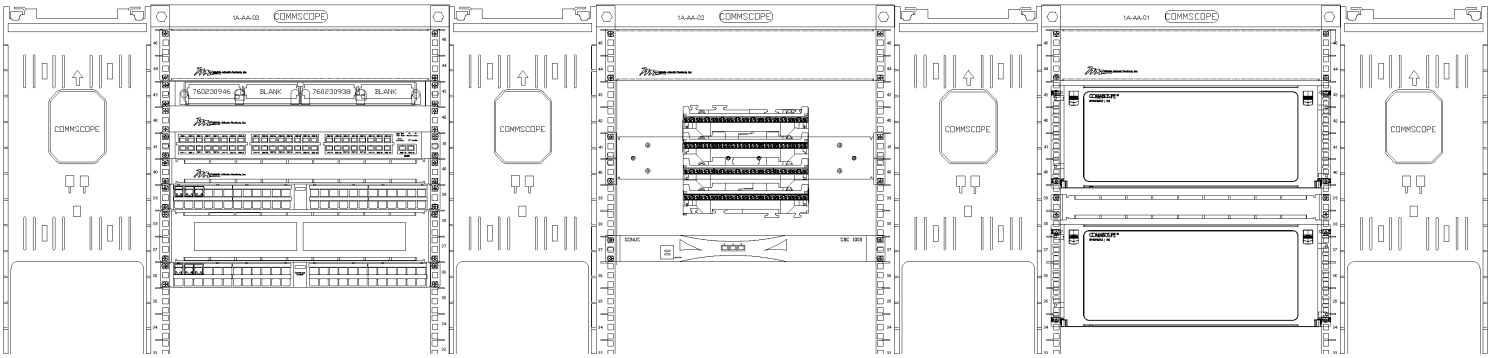
11) 760231522 HD-4U-SP For backbone fiber to intermediate telecom rooms.

12) Back of all racks: EPBZ73 Eaton Basic rack PDU, 0U, 5-15P input, 1.44 kW max, 100-120V, 15A, 15 ft cord, Single-phase, Outlets: (18) 5-15R.

13) Legrand - Cablofil Cable Drop Out, Pre-Galvanized Finish #DROPOUTKITPG

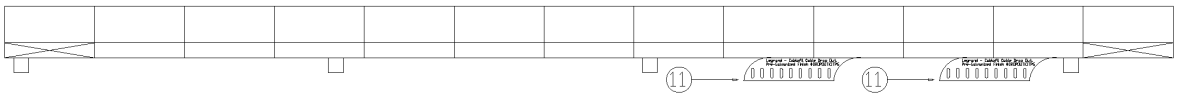
PART NUMBERS ARE SUBJECT TO CHANGE. VERIFY ITEMS WITH KU I.T. PRIOR TO PROJECT START.

Typical MDF Equipment Rack Elevation Zoom



Typical IDF Equipment Rack Elevation

TYPICAL IDF TWO FLOOR RACKS



1) 760109744 M4800A-1U-GS 48 port angled patch panel

2) Middle Atlantic EB1 Blank Panel 1RU

3) Middle Atlantic EB2 Blank Panel 2RU

4) Network & UPS equipment by KU

5) 760231506 SYSTIMAX HD 1U Sliding Fiber Panel with 760230946 & 760230938

6) CommScope 760074286 VP360-32PR-WB VisiPatch 360 wiring block kit.

7) CommScope 760244779 - VCM-DS-84-6B End of rack six inch double-sided vertical manager

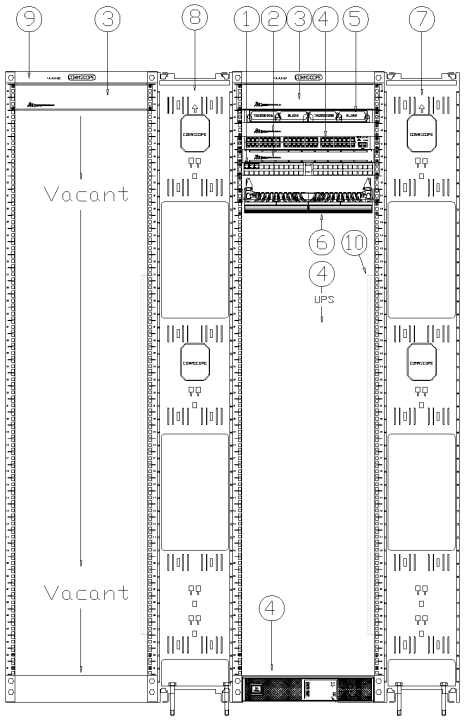
8) CommScope 760244781 - VCM-DS-84-10B Between adjacent racks ten inch double-sided vertical manager

9) 760082495 RK6-45A All floor racks

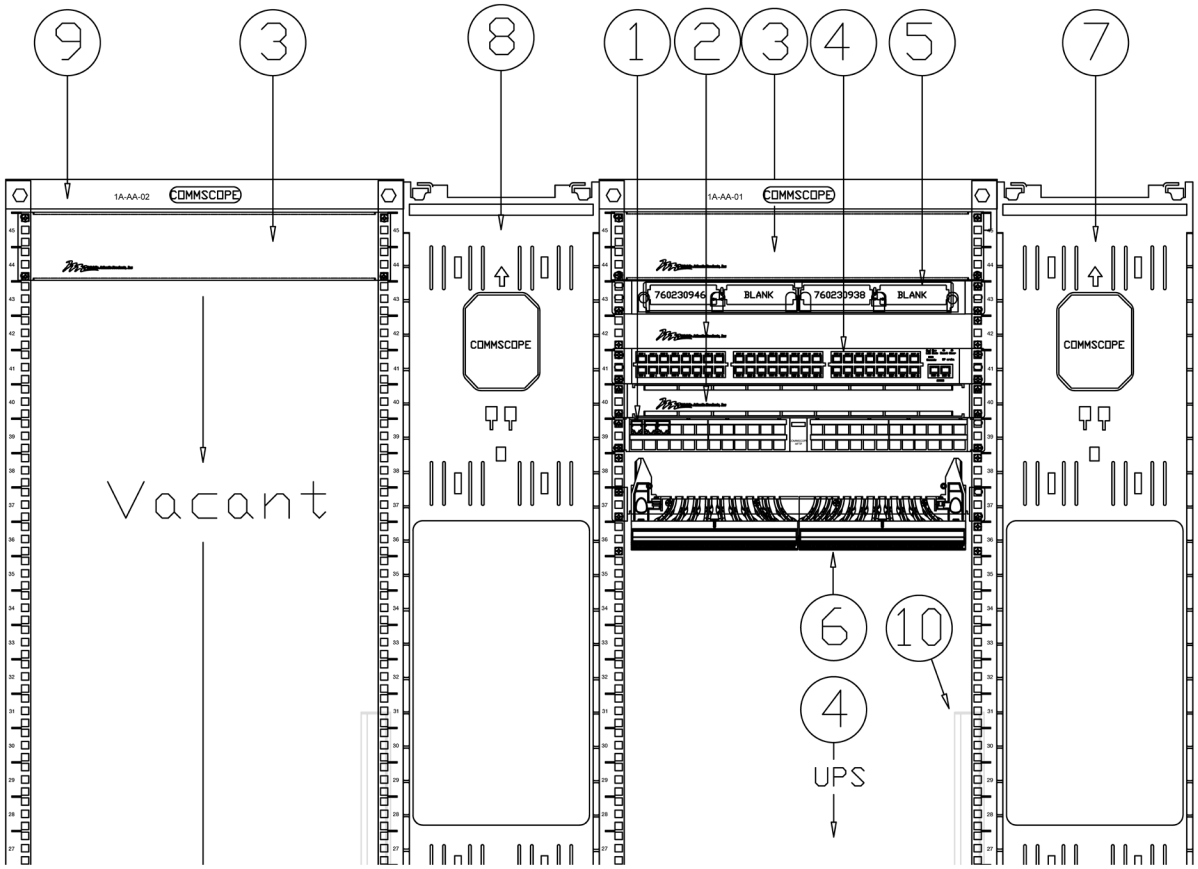
10) Back of all racks: EPBZ73 Eaton Basic rack PDU, 0U, 5-15P input, 1.44 kW max, 100-120V, 15A, 15 ft cord, Single-phase, Outlets: (18) 5-15R.

11) Legrand - Cablofil Cable Drop Out, Pre-Galvanized Finish #DROPOUTKITPG

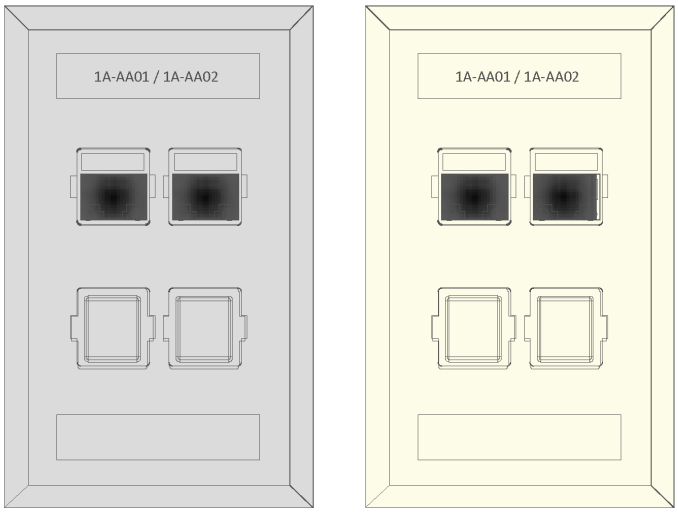
PART NUMBERS ARE SUBJECT TO CHANGE. VERIFY ITEMS WITH KU I.T. PRIOR TO PROJECT START.



Typical IDF Equipment Rack Elevation Zoom



Typical Work Area Outlet



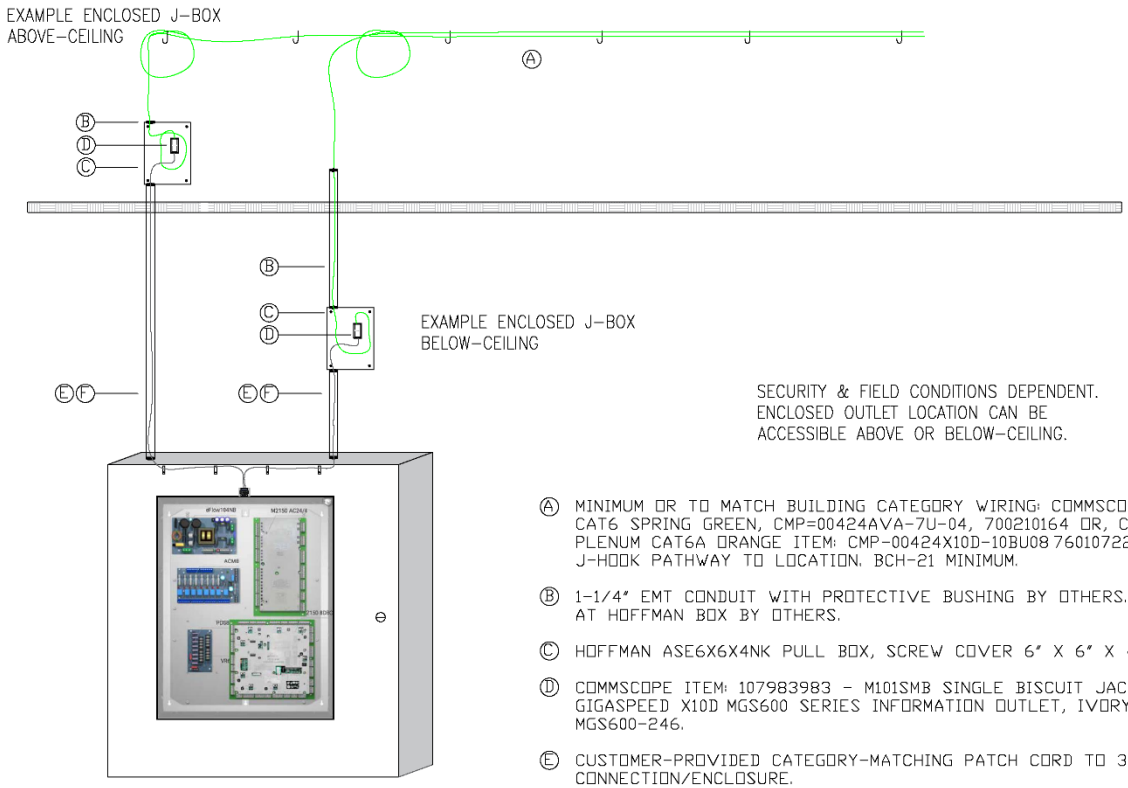
Single-gang faceplate with Label, items:
Faceplate four port ivory: 108168550 M14L-246 or,
Faceplate four-port stainless steel: 760072207 M14SP-L

GigaSPEED X10D® MGS600 Series Information Outlet:
Ivory P/N: 760092411 MGS-600246 or,
Gray P/N: 760092437, MGS-600-270.

M20 Dust Cover for M-Series Outlets,
107067860, M20AP-246
M21 Dust Cover for M-Series Outlets,
108066473 M21A-270 Gray

Typical Enclosed Termination at 3rd Party Enclosures

KU I.T. DEMARCATION SHALL NOT BE PLACED IN 3RD PARTY ENCLOSURES



SECURITY & FIELD CONDITIONS DEPENDENT.
ENCLOSED OUTLET LOCATION CAN BE
ACCESSIBLE ABOVE OR BELOW-CEILING.

Ⓐ MINIMUM OR TO MATCH BUILDING CATEGORY WIRING: COMMSCOPE PLENUM CAT6 SPRING GREEN, CMP=00424AVA-7U-04, 700210164 OR, COMMSCOPE PLENUM CAT6A ORANGE ITEM: CMP-00424X10D-10BU08 760107227. PROVIDE J-HOOK PATHWAY TO LOCATION. BCH-21 MINIMUM.

Ⓑ 1-1/4" EMT CONDUIT WITH PROTECTIVE BUSHING BY OTHERS. 1-1/4" BUSHING AT HOFFMAN BOX BY OTHERS.

Ⓒ HOFFMAN ASE6X6X4NK PULL BOX, SCREW COVER 6" X 6" X 4", GRAY.

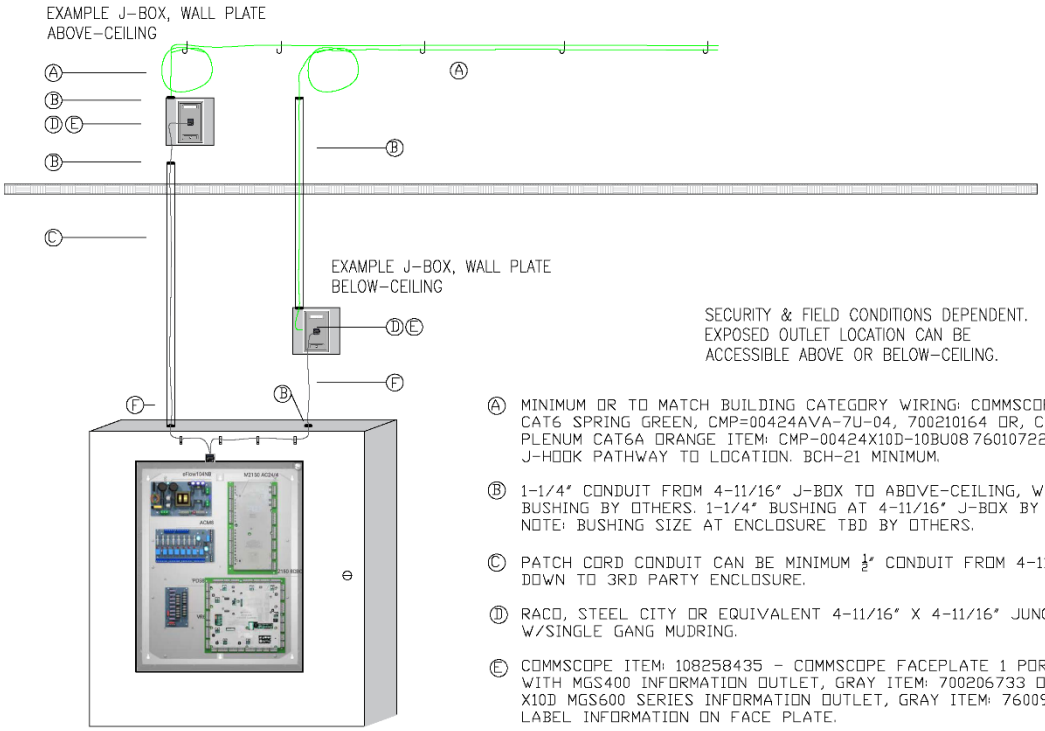
Ⓓ COMMSCOPE ITEM: 107983983 - M101SMB SINGLE BISCUIT JACK WITH GIGASPEED X10D MGS600 SERIES INFORMATION OUTLET, IVORY, 760092411, MGS600-246.

Ⓔ CUSTOMER-PROVIDED CATEGORY-MATCHING PATCH CORD TO 3RD PARTY CONNECTION/ENCLOSURE.

Ⓕ CONDUIT FOR PATCH CORD CAN BE MINIMUM ½" CONDUIT FROM HOFFMAN ENCLOSURE DEMARK DOWN TO 3RD PARTY ENCLOSURE.

NOTE: IF OUTLET IS PLACED ABOVE-CEILING, A MINIMUM 12" CLEARANCE FROM CEILING TILE GRID TO BOTTOM OF J-BOX IS REQUIRED.

Typical Exposed Termination at 3rd Party Enclosures



SECURITY & FIELD CONDITIONS DEPENDENT.
EXPOSED OUTLET LOCATION CAN BE
ACCESSIBLE ABOVE OR BELOW-CEILING.

Ⓐ MINIMUM OR TO MATCH BUILDING CATEGORY WIRING: COMMSCOPE PLENUM CAT6 SPRING GREEN, CMP=00424AVA-7U-04, 700210164 OR, COMMSCOPE PLENUM CAT6A ORANGE ITEM: CMP-00424X10D-10BU08 760107227. PROVIDE J-HOOK PATHWAY TO LOCATION. BCH-21 MINIMUM.

Ⓑ 1-1/4" CONDUIT FROM 4-11/16" J-BOX TO ABOVE-CEILING, WITH PROTECTIVE BUSHING BY OTHERS. 1-1/4" BUSHING AT 4-11/16" J-BOX BY OTHERS. NOTE: BUSHING SIZE AT ENCLOSURE TBD BY OTHERS.

Ⓒ PATCH CORD CONDUIT CAN BE MINIMUM ½" CONDUIT FROM 4-11/16" J-BOX DOWN TO 3RD PARTY ENCLOSURE.

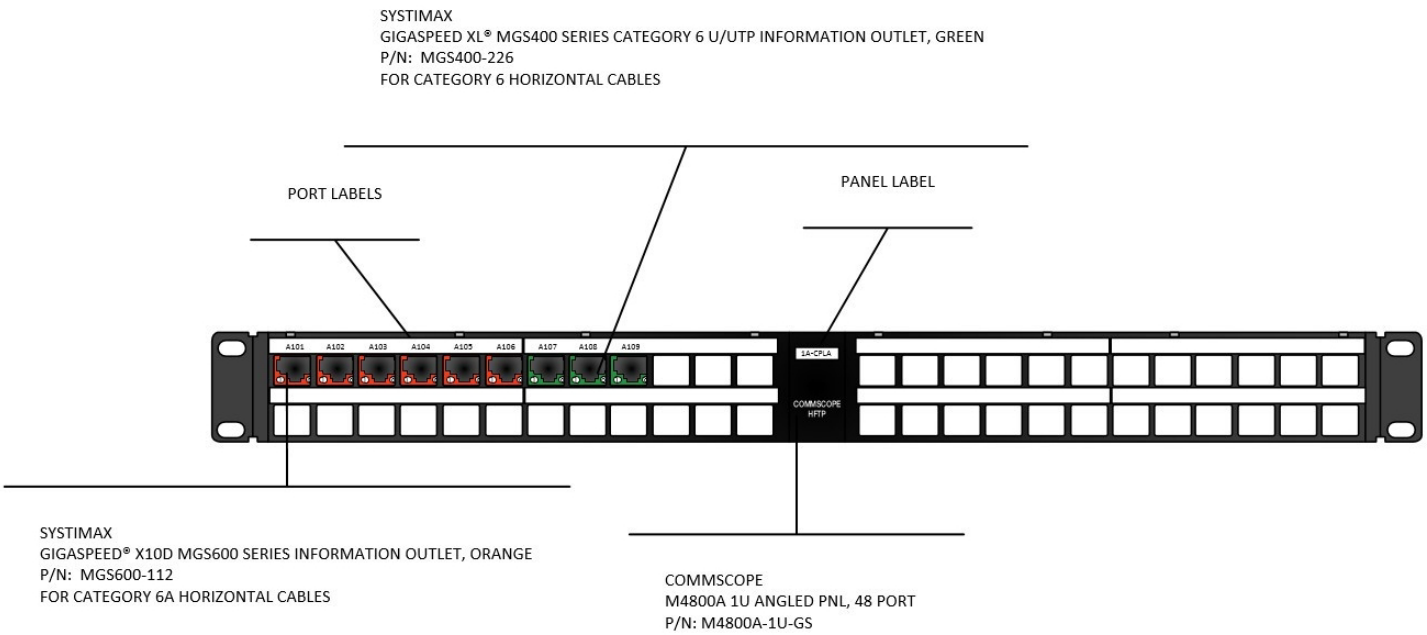
Ⓓ RACO, STEEL CITY OR EQUIVALENT 4-11/16" X 4-11/16" JUNCTION BOX W/SINGLE GANG MUDRING.

Ⓔ COMMSCOPE ITEM: 108258435 - COMMSCOPE FACEPLATE 1 PORT 1 GANG GRAY WITH MGS400 INFORMATION OUTLET, GRAY ITEM: 700206733 OR; GIGASPEED X10D MGS600 SERIES INFORMATION OUTLET, GRAY ITEM: 760092437. INCLUDE LABEL INFORMATION ON FACE PLATE.

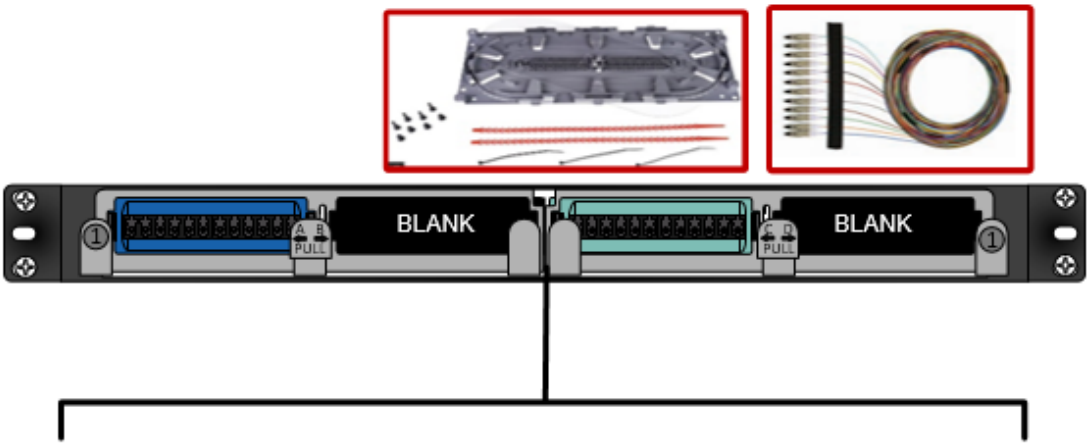
Ⓕ CUSTOMER-PROVIDED CATEGORY-MATCHING PATCH CORD TO 3RD PARTY CONNECTION/ENCLOSURE.

NOTE: IF OUTLET IS PLACED ABOVE-CEILING, A MINIMUM 12" CLEARANCE FROM CEILING TILE GRID TO BOTTOM OF J-BOX IS REQUIRED.

Typical Patch Panel



Typical Fiber Sliding Shelf Connectivity



Systimax High Density 1U Sliding fiber Panel P/N: HD-1U-SP 760209940. Place Inside panel: 1-CommScope splice tray item: 360-LP-STACK-SPT 760148502

SYSTIMAX 360 Distribution Adapter Pack 12 LC Singlemode Blue (P/N 760230946). Fusion-splice to fiber, Systimax FAWLCUC0C-XXM001 LC to open, Teraspeed 12-Fiber pigtail kit, 1M

SYSTIMAX 360 Distribution Adapter Pack 12 LC Multimode Aqua (P/N 760230938). Fusion-splice to fiber, Systimax FAXLCUC0C-XXM001 LC to open, Lazrspeed 550LC to open, 12-Fiber pigtail kit, 1M

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2.2 Copper

Systimax Solutions; a CommScope Inc. brand, M4800A-1U-GS Angled Panel, 48-port (P/N 760109744) combined with rear cable manager (P/N 760104737) for use with Systimax Category 6 and 6A Information Outlets.

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2.3 FIBER

Manufacturer shall be:

a. (1RU) – SYSTIMAX HD-1U Sliding Fiber Panel (P/N 760209940).

~~1) Include (1) fusion splice tray kit item: (760148502- 360-LP-STACK-SPT).~~

b. (2RU) – SYSTIMAX HD-2U~~-SP~~ Sliding Fiber Splice Panel (P/N ~~760231514~~ 760209957).

~~1) Include (2) fusion splice tray kits item: (760148502- 360-LP-STACK-SPT).~~

c. (4RU) –SYSTIMAX HD-4U~~-SP~~ Sliding Fiber Splice Panel (P/N ~~760231522~~ 760209965).

~~1) Include (4) fusion splice tray kits item: (760148502- 360-LP-STACK-SPT)~~

B. ~~360 Distribution Adapter Packs~~ G2 Splice Cassettes

1. Shall fit into specified fiber enclosures.

2. Shall be in multiples of 12 strands.

3. Manufacturer shall be:

a. Singlemode: Systimax Solutions; ~~360 Distribution Adapter Pack~~ G2 Splice cassette 12 LC Singlemode Blue (P/N ~~760230946 – 360DPis-12LC-SM~~ 760258027 | G2-SP-12LC-SM-PT).

b. Multimode: Systimax Solutions; ~~360 Distribution Adapter Pack~~ G2 Splice cassette 12 LC Multimode OM4 Aqua (~~P/N 760230938 – 360DPis-12LC-LS~~ 760258206 | G2-SP-12LC-OM4-PT).

~~4. Singlemode adapter packs shall be connected to incoming fiber with Systimax LC to Unconnectorized, Teraspeed 12-Fiber pigtail kit 1M (P/N FAWLCUC0C-XXM001).~~

~~5. Multimode adapter packs shall be connected to incoming fiber with Systimax LC to Unconnectorized, LazrSPEED 12-Fiber pigtail kit 1M (P/N FAXLCUC0C-XXM001).~~

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2.10 COAXIAL CABLE

C. INDOOR USE – RG-11/U: Type CMP: Item: ~~2285K~~ 2285V WHRL RG11 Type 60% braid plenum video coaxial cable, white jacket. ~~4136903/10~~ 4101403/10

D. OUTDOOR, IN-SLAB CONDUIT USE – RG-11/U: Item: ~~8292903/10, 5917 BKRL~~ RG11 60 OSP. RG 11 Type 60% Braid Coaxial Cable, black jacket. (Note CommScope no longer manufacturers an OSP RG11 cable)

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2.8 COAXIAL CABLE

D. OUTDOOR, IN-SLAB CONDUIT USE – RG6 item: ~~4685203/10 5738~~ BKRL RG6 60 OSP, 60% Braid Buried Coaxial Cable, black jacket. (Note CommScope no longer manufacturers an OSP RG6 cable)

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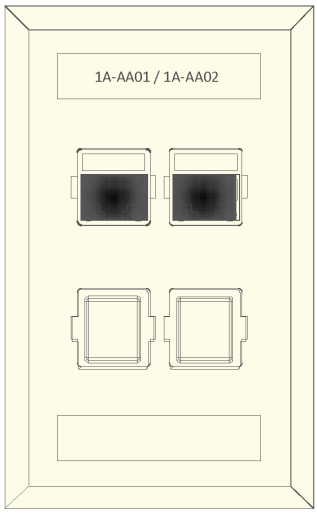

Single-gang faceplate with Label, items:
Faceplate four port ivory: 108168550 M14L-246 or,
Faceplate four-port stainless steel: 760072207 M14SP-L

GigaSPEED X10D® MGS600 Series Information Outlet:
Ivory P/N: 760092411 MGS-600246 or,
Gray P/N: 760092437, MGS-600-270.

M20 Dust Cover for M-Series Outlets,
107067860, M20AP-246
M21 Dust Cover for M-Series Outlets,
108066473 M21A-270 Gray

Regarding the above images, please see below:

Single-gang faceplate with Label, items:
Faceplate four port ivory: ~~108168550 M14L-246~~ 760249170 | FP-LBL-4P-246 or,
Faceplate four-port stainless steel: 760072207 M14SP-L

M20 Dust Cover for M-Series Outlets,
~~107067860, M20AP-246~~ 1-1116412-1 SL Blanking Insert for Universal Faceplates
M21 Dust Cover for M-Series Outlets,
~~108066473 M21A-270 Gray~~ 1116412-4 SL Series Gray Blanking Insert for Universal Faceplate

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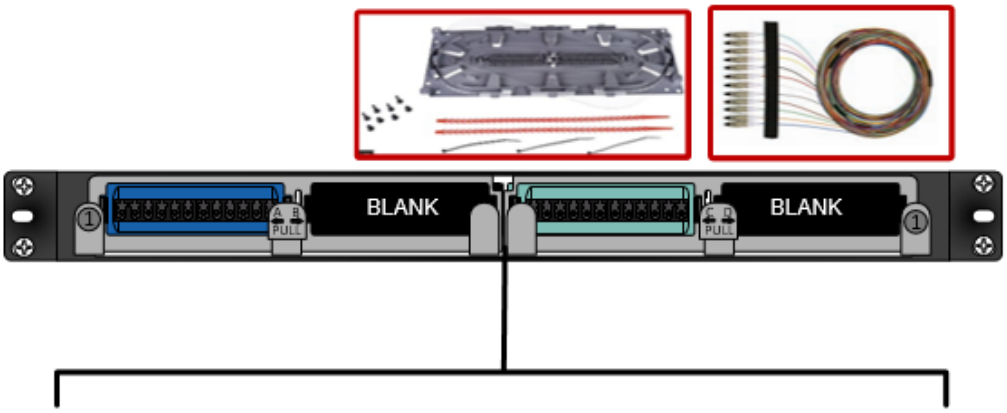

Systimax High Density 1U Sliding fiber Panel P/N: HD-1U-SP 760209940. Place Inside panel: 1-CommScope splice tray item: 360-LP-STACK-SPT 760148502

SYSTIMAX 360 Distribution Adapter Pack 12 LC Singlemode Blue (P/N 760230946). Fusion-splice to fiber, Systimax FAWLCUC0C-XXM001 LC to open, Teraspeed 12-Fiber pigtail kit, 1M

SYSTIMAX 360 Distribution Adapter Pack 12 LC Multimode Aqua (P/N 760230938). Fusion-splice to fiber, Systimax FAXLCUC0C-XXM001 LC to open, Lazrspeed 550LC to open, 12-Fiber pigtail kit, 1M

SYSTIMAX High Density 1U Sliding fiber Panel P/N: ~~HD-1U-SP 760209940~~ HD-1U 760209940. ~~Place Inside panel: 1-CommScope splice tray item: 360-LP-STACK-SPT 760148502~~

SYSTIMAX ~~360 Distribution Adapter Pack~~ G2 Splice Cassette 12 LC Singlemode Blue ~~(P/N 760230946)~~ (P/N 760258027). ~~Fusion-splice to fiber, SYSTIMAX FAWLCU0C-XXM001 LC to open, TeraSPEED 12-Fiber pigtail Kit, 1M~~

SYSTIMAX ~~360 Distribution Adapter Pack~~ G2 Splice Cassette 12 LC Multimode Aqua ~~(P/N 760230938)~~(P/N 760258206) . ~~Fusion-splice to fiber Systimax FAXLCUC0C-XXM001 LC to open, LazrSPEED550 LC to open, 12-Fiber pigtail kit, 1M~~