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Colorado State University-Pueblo

Telecommunications Specifications

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CSU-PUEBLO
TELECOMMUNICATIONS INFRASTRUCTURE
SPECIFICATIONS
FOR
CAMPUS BUILDINGS

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Colorado State University-Pueblo Telecommunications Infrastructure Specifications for Campus Buildings

PART 1 - GENERAL SPECIFICATIONS

1.1 SCOPE

- A. Horizontal (distribution) communications wiring and connecting hardware from Telecommunications Room (TR) to Telecommunication Outlets (TO).
- B. This document describes the products and execution requirements related to furnishing and installing telecommunications cabling in new or remodeled buildings for Colorado State University-Pueblo (CSU-Pueblo). Backbone and horizontal cabling comprised of Copper, Coaxial, and Fiber cable and their support systems are covered in this document. **Electrical engineers and contractors, this document applies to you as well! Be certain to adhere to the specifications as described within!**
- C. The typical Horizontal (workstation) Cabling System shall consist of (3) 4-pair category 6A unshielded twisted pair (UTP) Copper Cables to each outlet unless otherwise noted for specific locations. The cables shall be installed in a 1 ¼" inch conduit run from the outlet to the nearest cable tray or Telecommunications Room (TR) located on the same floor, and routed to the appropriate patch panel/termination block serving that area and terminated as specified in this document. The conduit shall be terminated at the outlet end in a deep 4 sq. box fitted with appropriate mud ring, and at the tray or (TR) end with a connector and bushing. **Plastic bushings installed on conduit without the use of a connector will not be accepted!**
- D. All cables and related terminations, support and grounding hardware shall be furnished, installed, wired, tested, labeled and documented by the telecommunications contractor as detailed in this document.
- E. Product specifications, general design considerations and installation guidelines are provided in this document. Architectural drawings will be provided as an attachment. If the bid documents are in conflict, the telecommunications specifications shall take precedence. The successful vendor shall meet or exceed all requirements for the cable system described in this document.

1.2 REFERENCE STANDARDS

- A. ANSI/TIA-492.AAAC-B – Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class 1a Graded-index Multimode Optical Fibers (OM3/OM4). Current Edition.
- B. ANSI TIA-492.CAAB – Detail Specification for Class Iva Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak. Current Edition.
- C. ANSI/TIA 526 – OFSTP-19 Optical Signal-to-Noise Ratio Measurement Procedures for Dense Wavelength-Division Multiplexed Systems.
- D. ANSI/TIA-568-C.0 – Generic Communications Cabling for Customer Premises.

- E. ANSI/TIA-568-C.1 – Commercial Building Communications Cabling Standard Part 1: General Requirements.
- F. ANSI/TIA 568-C.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
- G. ANSI/TIA 568-C.3 – Optical Fiber Cabling Components Standard.
- H. ANSI/TIA-569-C – Commercial Building Standard for Telecommunications Pathways and Spaces.
- I. ANSI/TIA-606-B – Administration Standard for the Commercial Telecommunications Infrastructure.
- J. ANSI/JSTD-607-B – Commercial Building Bonding and Grounding (Earthing) Requirements for Telecommunications.
- K. NFPA 70 – National Electrical Code (NEC).
- L. BICSI – TDMM, Building Industries Consulting Services International, Telecommunications Distribution Methods Manual (TDMM).
- M. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the local Electrical Code and present manufacturing standards.
- N. All materials shall be UL listed and marked as such. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.
- O. The cabling system described in this document is derived from the recommendations made in recognized telecommunications industry standards.
- P. This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact this project.

1.3 APPROVED CONTRACTOR

The telecommunications contractor must be an approved Mohawk Accredited Contractor (MAC) and provide Colorado State University-Pueblo a Mohawk 25-year warranty for this project. A copy of certification documents must be submitted with the quote in order for such quote to be valid. The telecommunications contractor is responsible for workmanship and installation practices in accordance with the MAC warranty. Mohawk will extend a 25-year product, labor and channel performance Applications Warranty to the end user once the telecommunications contractor fulfills all requirements under the MAC Program. Any contractor that is not currently a Mohawk Accredited Contractor may contact the local representative of Mohawk Wire and Cable for qualifications/requirements on becoming a Mohawk Accredited Contractor.

1.4 APPROVED PRODUCTS

- A. 4-pr. UTP CMP Cable: Category 6A - Mohawk M58683 (Green - Wireless Access Points), M58685 (Orange – Audio/Visual), M58686 (Black – Telephone), M58687 (Violet - CBORD), M58646 (Blue - Data), M58648 (Yellow – Security Cameras) (see note 1).
- B. 50-pr. UTP CMP Riser Cable: Mohawk M56126. 100-pr. UTP CMP Riser Cable: Mohawk M56128 (see note 1).
- C. Fiber Optic Cable: Inside Building - Mohawk M98886. 12 / 12, Singlemode Corning SMF28e+ / OM3 Corning ONFP Distribution (see note 1).
- D. Fiber Optic Cable: Outside Building Data – M9W516T, 24 Singlemode SMF-28e+.
- E. Fiber Optic Cable: Outside Building Fire Alarm – Mohawk M96503, 24/24 Singlemode Corning SMF-28e+ / Corning OM1 Dry Block.
- F. Coaxial Cable: RG-6/U-Mohawk M71002; RG-11/U-Mohawk M71001 (see note 1).
- G. Category 6A Jacks: Data – Belden AX104156; Telephone – Belden AX102283, Wireless Access Points – Belden AX104155, CBORD – Belden AX104157, Audio/Visual – Belden AX104152, Security – Belden AX104154
- H. Category 6A modular plugs: Platinum Tools 106190 RJ45 CAT6A 10 GIG with boot
- I. Patch Panel - Belden AX103248
- J. Patch Cords: Belden 10GX Modular Patch Cords. Lengths/Colors TBD by CSU-Pueblo IT.
- K. Wall Plates - Leviton 41080-XIP (see note 2).
- L. Fiber Optic Cabinet: **MDF** (1) Belden AX104682 with (2) AX104684 loaded with (1) Belden FC3U12LSMFAA and (1) FCSU12LSMFAB and (2) to match fiber type and strand counts. **IDF** (1) Belden AX104681 with (1) AX104684, loaded with (1) FC#U06LSMFAA and (1) FCSU06LSMFA1 to match fiber type and strand counts.
- M. Fiber Optic Cabinet Adapter Panels – See cassettes above.
- N. Fiber Optic Cabinet Splice Trays - AX103912
- O. Fiber Optic Patch Cords – Belden Fiber Express FX Patch Cords. Lengths TBD by CSU- Pueblo IT.
- P. Fiber Optic Pigtails – FT3MM250PS01A2M, FTSMM250PS01Y2M
- Q. Coaxial Connector: Belden ICM Series compression connectors ICM RG-6/U; RG-11/U (see note 3).
- R. F-81 Insert – Belden AX102903 or AX102904. Insert color to match wall plate.
- S. Relay Rack: B-Line SB556084XUFB 19 inch X 84 inch Black Equipment Rack.
- T. Ladder Rack – B-Line SB17U Flat Black Series.

- U. Cable Tray – B-Line Series 24 Solid Bottom Aluminum Cable Tray.
- V. Cable Hooks – Caddy CAT Series. Use of cable hooks must be approved by CSU-Pueblo Manager of Telecommunications Services.
- W. Vertical Cable Managers: (2) B-Line SB865610DBF per Relay Rack.
- X. Cable Bundling/Dressing: Contractor will use “black” 1/2 or 5/8 inch Velcro.
- Y. Voice – Riser multi-pair cable to be terminated on Belden AX103259 patch panel and installed in B-Line Relay Rack. Termination Blocks/Brackets for telephone cable: 66 Block – Suttle #SE-66M1-50-C5; Bracket – Suttle #SE-A89B.
- Z. Floor poke thru: Wiremold 8ATCXX series poke-thru device with 1125CHA Bottom Housing Assembly (required).
- AA. Concealed Service Floor Box: Thomas & Betts 665-SC with cover (material and color specified by architect) and T & B 665-6RJ keystone plate insert.
- BB. Firestopping – STI EZ-Path Series 44+ on all fire rated wall and floor penetrations.
- CC. Multi-Pair Copper OSP Cable – Superior/Essex 09-104-02100 Pair 24 AWG PE-89.
- DD. Building Entrance Protectors: CIRCA #1890ECM1-100 100% loaded with CIRCA 3B1E Protector Modules.
- EE. Fiber Optic Wall Box for OSP Data Cable (Building End): (1) TE FL1-G Two Door Wall Mount Box, (1) TE IPA-K1 Lock and Key type A, (2) TE FL2-6PSMLC Single-Mode LC 6 Pak Adapter Packs, (2) TE FST-M-HS splice trays, (1) TE FL1-ACC003 Strength Member Anchor Lug Kit, (2) Allen Tel GBLCUPT12FSM-03 12 Fiber 3 Meter LC Single-Mode Pig Tails, (1) PLP 8003381 Elastomeric Splice Block Kit, (1) Corning 2806031-01 Heat Shrink Protector, 50/pk.
- FF. Fiber Optic Wall Box for OSP Data Cable (Data Center End): (1) TE FL1-J Two Door Wall Mount Box, (1) TE IPA-K1 Lock and Key type A, (8) TE FL2-6PSMLC Single-Mode LC 6 Pak Adapter Packs, (4) TE FST-HS splice trays, (1) TE FL1-ACC005 Dual Strength Member Anchor Lug Kit, (8) Allen Tel GBLCUPT12FSM-03 12 Fiber 3 Meter LC Single-Mode Pig Tails, (3) PLP 8003381 Elastomeric Splice Block Kits, (2) Corning 2806031-01 Heat Shrink Protector, 50/pk .
- GG. Fiber Optic Wall Box for OSP Fire Alarm Cable: (1) TE FL1-J Two Door Wall Mount Box, (1) TE IPA-K1 Lock and Key type A, (4) TE FL2-6PSMLC Single-Mode LC 6 Pak Adapter Packs, (4) TE FL2-6PMMLC Multi-Mode LC 6 Pak Adapter Packs, (4) TE FST-HS Splice Trays, (1) TE FL1-ACC005 Dual Strength Member Anchor Lug Kit, (4) Allen Tel GBLCUPT12FSM-03 12 Fiber 3 Meter LC Single-Mode Pig Tails, (4) Allen Tel GBLCUPT12FMM-03 12 Fiber 3 Meter LC Multi-Mode Pig Tails, (3) PLP 8003381 Elastomeric Splice Block Kits, (2) Corning 2806031-01 Heat Shrink Protector, 50/pk.

Note 1: Use equivalent non-plenum rated Mohawk 6A cable for installations where plenum rated cable is not required.

Note 2: Each outlet location must be outfitted with the appropriate Leviton wall plate utilizing the smallest port configuration possible for number of connections indicated.

Note 3: Use appropriate Belden ICM coaxial connector when using non-plenum rated coaxial cable.

1.5 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies to perform all operations necessary for completing the installation of this structured cabling system in compliance with the specifications and drawings. The telecommunications contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.
- B. The work shall include, but will not be limited to the following:
 - 1. Furnish and install a complete telecommunications wiring infrastructure.
 - 2. Furnish, install and terminate all inside building and outside plant UTP, Coaxial and fiber optic cable.
 - 3. Furnish and install all wall plates, jacks, patch panels, fiber optic patch panels, and fiber optic pigtails as indicated.
 - 4. Furnish and install all required cabinets and racks as required and indicated.
 - 5. Furnish any other material required to form a complete system.
 - 6. Perform permanent link or channel testing (100% of horizontal and/or backbone links/channels) and certification of all components.
 - 7. Furnish test results of all cabling to the owner on disk and paper format, listed by each closet, circuit and workstation ID.
 - 8. Adhere and comply with all requirements of the MAC Certification program.
 - 9. Provide owner test results and documentation (Testing documentation and As-built drawings).
- C. The work shall take place concurrently with the activities of the general contractor and their subcontractors on the project site. Care shall be taken by the telecommunications contractor to ensure that work is coordinated with the activities of the general contractor. Point of contact for this coordination shall be the general contractor's project superintendent, unless directed otherwise.

1.6 SUBMITTALS

- A. Under the provisions of this request for proposal, prior to the start of work the telecommunications contractor shall:
 - 1. Submit copies of the certification of the company and names of staff that will be performing the installation and termination of the installation to provide proof of compliance of this specification.
 - 2. Submit proof from manufacturer of contractor's good standing in manufacturer's program.
 - 3. Submit appropriate cut sheets and samples for all products, hardware and cabling.
 - 4. Work shall not proceed without the owner's approval of the above submitted items.
 - 5. No substituted materials shall be installed by the contractor without prior written approval from Colorado State University – Pueblo Manager of Telecommunications Services.

1.7 QUALITY ASSURANCE

The approved MAC telecommunications contractor shall be a licensed and bonded company who has specialized in communication cabling installation for at least 5 years.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Delivery and receipt of products shall be at the site described in Section 1.1, "Scope".
- B. Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F., the cable shall be moved to a heated (50 degrees F. minimum) location. If necessary, cable shall be stored off site at the contractor's expense.
- C. If the telecommunications contractor wishes to have a trailer on site for storage of materials, arrangements shall be made with the owner.

1.9 DRAWINGS

- A. It shall be understood that the electrical details and drawings provided with the specification package are diagrammatic. They are included to show the intent of the specifications and to aid the telecommunications contractor in bidding the job. The telecommunications contractor shall make allowance in the bid proposal to perform whatever work is required in order to comply with the intent of the plans and specifications.
- B. The telecommunications contractor shall verify all dimensions at the site and be responsible for their accuracy.
- C. Prior to submitting the bid, the telecommunications contractor shall call to the owner's attention any materials or apparatus the telecommunications contractor believes to be inadequate and to any portions of work to be omitted.

PART 2 - PRODUCTS

2.1 EQUIVALENT PRODUCTS

Due to the nature and type of communications, all products, including but not limited to faceplates, jacks, patch panels, racks, 66 blocks, etc., for the purpose of this document, shall be manufactured by those specified in Section 1.4, "Approved Products". There will be no substitutions allowed without prior written approval from Colorado State University – Pueblo Manager of Telecommunications Services.

2.2 WORK AREA OUTLETS

- A. TO cables shall each be terminated at their designated TO location in modular CAT 6A telecommunication jacks. These connector assemblies shall be snapped into a faceplate per the manufacturer's installation procedure. Wireless access point locations shall be terminated at their designated location using CAT 6A modular plugs.
- B. The TO Assembly shall accommodate:
 - 1. A minimum of three (3) modular jacks/cables (typical). Two (2) plugs/cables for WAPS.
 - 2. Additional accommodations for specific locations as noted in the plans for optical fiber, coaxial and/or additional copper cables as necessary.
 - 3. A blank filler to be installed when extra ports are not used.

4. Multiple jacks that are identified in close proximity on the drawings (but not separated by a physical barrier) are to be combined in a single assembly. The telecommunications contractor shall be responsible for determining the optimum compliant configuration based on the products proposed.
5. The same orientation and positioning of jacks and connectors is to be utilized throughout the installation. Prior to installation, the telecommunications contractor shall submit the proposed configuration for each outlet assembly for review by the owner.
6. Each jack location shall be labeled as per the convention of Colorado State University-Pueblo using the Brady TLS 2200 thermal printer or equivalent Brother Mobile Systems printer. No hand printed labels shall be accepted.

2.3 66 COPPER TERMINATION BLOCKS

The voice cross connect shall be a passive connection between the Building Entrance Terminal (BET) and the backbone termination blocks. Management rings shall be mounted between vertical columns of blocks to provide management of cross-connect wire. Blocks shall be oriented so that backbone terminations are located on the left and horizontal terminations are located on the right of the termination field when facing the backboard. 66 M1-50 style blocks shall be mounted on 89B style brackets.

2.4 MODULAR PATCH PANELS

All modular patch panels shall be Belden AX103248.

2.5 RACKS

All racks installed shall be B-Line SB556084XUFB. All cable management shall be B-Line. Vertical cable management and support for the patch cords at the front of the rack and wire management, support, and protection for the horizontal cables shall be installed on each rack. Wire management shall also be mounted above each patch panel and/or piece of equipment on the rack. Velcro cable ties shall be used to support and anchor the horizontal cable to cable management installed on the rack.

2.6 HORIZONTAL CABLE

- A. All horizontal cable shall terminate on modular patch panels in the proper Telecommunications Closet or Equipment Room as specified on the drawings.
- B. All horizontal cable shall be terminated according to the numbering scheme in perfect ascending numerical order at the appropriate modular patch panel. Any deviation from this specification will result in the replacement/re-termination of cable/jacks at the telecommunications contractor's expense.

2.7 BACKBONE CABLE

- A. Backbone cable shall be installed between the building MDF and IDF's. The typical backbone cable installation will consist of one (1) 50 or 100 pair CMP riser cable, one (1) 12SM/12 OM3 OFNP fiber optical cable, and one (1) RG-11/U CMP coaxial cable. Larger pair count riser cable may be required depending on the number of possible jacks to be served. Exposed optical fiber cable shall be protected by plenum rated inner-duct installed between the termination of the conduit containing the optical fiber cable and the fiber optic patch panel installed in each equipment rack.

All conduits/sleeves utilized in cabling installation shall be terminated with connectors and plastic bushings. Plastic bushings alone will not be accepted.

2.8 OUTSIDE PLANT COPPER CABLE PROTECTION UNITS

- A. All copper cables shall be provided with building entrance protection between each building with a building entrance terminal. All building-to-building telephone circuits shall be routed through the BET. The BET shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and an adequate earth ground.

2.9 PATCH CORDS

- A. Belden 10GX Modular Patch Cords shall be provided by the contractor and installed by the owner.

2.10 FIRESTOP

- A. Firestop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.
- B. STI EZ-Path 44+ will be used in all penetrations through fire-rated building structures (walls and floors). This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Radius Control Modules are to be used at all cable entrances and exits to manage bend radius.

PART 3 – SCOPE OF WORK

3.1 WORK AREA OUTLETS

- A. Cables shall be coiled in the cable tray without exceeding the manufacturer's bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 36 inches of UTP or coaxial slack shall be stored in the cable tray or in an open wall installation where no back box is present, modular furniture raceway, or insulated walls.
- B. Cables shall be dressed and terminated in accordance with the manufacturer's recommendations and CSU – Pueblo's current procedures.
- C. Pair untwist at the termination shall not exceed 6 mm (0.25 inch).
- D. Bend radius of the cable in the termination area shall not be less than 4 times the outside diameter of the cable.
- E. The cable jacket shall be maintained to within 6mm (0.25 inch) of the termination point.
- F. Data jacks, unless otherwise noted in drawings, shall be located in the bottom position(s) of each faceplate. Data jacks in horizontally oriented faceplates shall occupy the right-most position(s).
- G. Telephone jacks shall occupy the top position(s) on the faceplate. Telephone jacks in horizontally oriented faceplates shall occupy the left-most position(s).

3.2 HORIZONTAL DISTRIBUTION CABLE INSTALLATION

- A. All wiring above ceilings shall be installed in cable tray, conduit, or open-top cable hooks. No other cabling (i.e. fire alarm, building controls, etc.) may utilize or attach to cable tray, conduits, cable hooks, or pathways utilized for telecommunications cabling.
- B. Cable above ceilings shall be supported every 3 feet on center from cable support attached to building structure.
- C. Do not untwist cable pairs more than 6 mm (0.25 inch) when terminating.
- D. The telecommunications contractor shall be responsible for replacing and re-testing all cables that do not pass testing requirements.
- E. Maximum horizontal cable length shall be 90 meters.
- F. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.
- G. Install cable in neat and workmanlike manner. Neatly bundle and tie all cable in closets. Leave sufficient cable for 90 degree sweeps at all vertical drops.
- H. Minimum 1 ¼" metallic conduit with no more than (2) 90 degree sweep bends. Closed conduit pathways shall be sized so as not to exceed 40% cable fill capacity.
- I. All horizontal cables will be installed in designed cable tray, through designed wall penetrations, ladder rack, vertical wire management and horizontal wire management.
- J. "Black" Velcro will be used for dressing in/bundling all horizontal cables, 1/2 inch or 5/8 inch. "Red" plenum rated Velcro will be used for dressing in/bundling all cables in plenum areas.
- K. Do not install any UTP cable with more than 110N (25 pounds) pull force, as specified in EIA/TIA and BICSI TDDM practices. Utilize appropriate cable lubricant in sufficient quantity to reduce pulling friction to acceptable levels on long pulls inside conduit, pulls of multiple cables into a single small bore conduit, on conduit runs greater than 100 linear feet with bends of opposing directions. Tensile rated cords (i.e. fishing line) should be used for difficult or questionable pulls - to judge go/no-go condition of the conduit and pulling setup.
- L. Cable jackets that are chaffed, burned or damaged shall be replaced.
- M. Test, label and document as specified in contract documents.

3.3 HORIZONTAL CROSS CONNECT INSTALLATION

- A. Cables shall be dressed and terminated in accordance with the recommendations made in manufacturer's recommendations and CSU–Pueblo's procedures.
- B. Pair untwist at the termination shall not exceed 6 mm (0.25 inches).

- C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- D. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- E. The cable jacket shall be maintained as close as possible to the termination point.
- F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle (where the label is obscured from view), shall not be acceptable.

3.4 FIBER OPTIC TERMINATION HARDWARE

- A. Fiber optic cable sub-units slack and 900 um slack shall be neatly coiled within the enclosure. Cable sub-unit slack and 900 um slack lengths are determined by manufacturer's specifications. Fiber Optic Cable slack loops shall be coiled and stored per CSU–Pueblo's procedures.
- B. Each cable shall be individually attached to the respective enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket provided by the manufacturer in their respective enclosure.
- C. Each fiber bundle shall be stripped and cleaned upon entering the splice tray and the individual fibers will be routed in the splice tray.
- D. Each cable shall be clearly labeled at the entrance to the enclosure. Cables labeled within the bundle (where the label is obscured from view), shall not be acceptable.
- E. All strands shall be single fusion spliced to their respective pigtail and installed in the correct panel slot.

3.5 BACKBONE CABLE INSTALLATION

- A. Backbone cables shall be installed separately from horizontal distribution cables.
- B. A pull cord (nylon; 1/8 inch minimum) shall be co-installed with all backbone cable installed in any conduit.
- C. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits. All vertical/horizontal cable shall route through STI EZ-Path 44+ pathways. All conduits shall be fitted with connectors and plastic bushings. Plastic bushings alone will not be accepted.
- D. Where backbone cables and distribution cables are installed in a cable tray, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.
- E. All backbone cables shall be securely fastened to the side wall of the telecommunications closet or ladder rack per CSU–Pueblo's procedures on each floor.
- F. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.

- G. Vertical runs of cable shall be supported by conduit, cable tray, or cable hooks to provide proper support for the weight and capacity of the cable.

3.6 COPPER TERMINATION HARDWARE

- A. Cables shall be dressed and terminated in accordance with the recommendations made in the manufacturer's recommendations and CSU–Pueblo's procedures.
- B. Pair untwist at the termination shall not exceed 6 mm (0.25 inch).
- C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- D. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- E. The cable jacket shall be maintained to within 6 mm (0.25 inch) of the termination point.
- F. Each cable shall be clearly labeled with "white" 3/4 inch laminated cable wraps on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle (where the label is obscured from view), shall not be acceptable.

3.7 RACKS, BACKBOARDS AND CABLE TRAY

- A. Racks shall be securely attached to the concrete floor using 1/2 inch hardware per manufacture's recommended installation procedures.
- B. Rack mount screws not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.
- C. Wall mounted termination block fields shall be mounted on 4 foot x 8 foot x .75 inches void-free A/C grade plywood backboards. The plywood backboards shall be mounted horizontally 32 inches above the finished floor and painted with two coats of white fire-retardant paint.
- D. All cable tray and racks must be bonded per manufacturer specifications and NEC requirements.

3.8 FIRESTOP SYSTEM

- A. All firestop systems shall be installed in accordance with the manufacturer's recommendations and shall be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.

3.9 IDENTIFICATION AND LABELING

- A. The contractor shall adhere to CSU-Pueblo's labeling scheme. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system.

Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

- B. All label printing will be machine generated by Brady TLS 2200 or equivalent Brother Mobile Solutions printer on laminated tape. Laminated cable wraps will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Outlet labeling location will be in accordance with CSU-Pueblo's labeling procedures. Patch panel and wiring block labeling location shall be installed according to CSU-Pueblo's labeling procedures.

3.10 TESTING AND ACCEPTANCE

- A. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA-568-C.2. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed. If any of these standards are in conflict, the telecommunications contractor shall bring any discrepancies to the attention of the project team for clarification and resolution. All OSP multi-pair copper UTP cable links shall be tested as indicated below:
1. Continuity - Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by the test unit in accordance with the manufacturers' recommended procedures and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
 2. Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA/EIA-568-B Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.
- B. All Category 6A shall conform to ANSI/TIA-568-C.2 for augmented Category 6 to 500 MHz

The basic tests required are:

- Wire Map
- Length
- Insertion Loss
- NEXT (Near end crosstalk)
- Return Loss
- ELFEXT Loss
- Propagation Delay
- Delay skew
- PSNEXT (Power sum near-end crosstalk loss)
- PSELFEXT (Power sum equal level far-end crosstalk loss)

C. Fiber Testing procedures shall be in accordance with the following:

1. ANSI/TIA-568-C.3.
2. ANSI/TIA-526-7, Method B.
3. Proposed TSB-140 Tier One Fiber Certification, C.
4. Encircled Flux testing per the TSB-4979 and TIA-526-14-B standard.
5. Fiber testing shall be performed on all fibers in the completed end to end system. There shall be no cable splices. Testing shall consist of an end-to-end power meter test. The system loss measurements shall be provided at 850 and 1300 nanometers for multimode fibers and 1310 and 1550 nanometers for singlemode fibers. These tests also include continuity checking of each fiber.
6. Backbone multimode fiber cabling shall be tested at both 850 nanometers and 1300 nanometers in both directions. Singlemode fiber optic cable shall be tested at both 1310 and 1550 nanometers for single-mode in both directions. An OTDR will be used to test all outside plant fiber optic cable, bidirectionally.
7. Where links are combined to complete a circuit between devices, the telecommunications contractor shall test each link from end-to-end to ensure the performance of the system. ONLY LINK TEST IS REQUIRED. The telecommunications contractor will install patch cords to complete the circuit and then test the entire channel. The test method shall be the same used for the test described above. The values for calculating loss shall be those defined in the ANSI/TIA Standard.
8. Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements.

3.11 SYSTEM DOCUMENTATION

- A. Upon completion of the installation, the telecommunications contractor shall provide three (3) full documentation sets to the owner. Documentation shall include the items detailed in the sub-sections below.
- B. Documentation shall be submitted within ten (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase. At the request of the owner, the telecommunications contractor shall provide copies of the original test results.
- C. The owner may request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by the owner, including a 100% re-test. This re-test shall be at no additional cost to the owner.

3.12 TEST RESULTS

- A. Test documentation shall be provided on disk within three weeks after the completion of the project. The disk shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
- B. The field test equipment shall meet the requirements of ANSI/TIA-568-C.2 including applicable TSB's and amendments. Approved Category 6A test equipment is JDSU Certifier40 and Fluke's DSX 5000.
- C. Test results generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. The telecommunications contractor must furnish this information in electronic form (CD-ROM).
- D. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

3.13 AS-BUILT DRAWINGS

- A. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The owner will provide floor plans in paper and electronic PDF formats on which as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the owner.
- B. The telecommunications contractor shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic PDF form.

PART 4 - WARRANTY AND SERVICES

4.1 WARRANTY

- A. Mohawk will extend a 25-year product, labor and channel performance Applications Warranty directly to the end-user once the telecommunications contractor fulfills all the requirements under the MAC program.
- B. The telecommunications contractor shall provide a minimum one-year warranty on the physical installation.

4.2 CONTINUING MAINTENANCE

- A. The telecommunications contractor shall furnish an hourly rate with the proposal submittal, which shall be valid for a period of one year from the date of acceptance. This rate will be used when cabling support is required to affect moves, adds and changes to the system (MACs). MACs performed by the MAC Contractor shall be added to the MAC warranty when registered with Mohawk.

4.3 FINAL ACCEPTANCE & SYSTEM CERTIFICATION

- A. Completion of the installation, in-progress and final inspections, receipt of the test and as-built documentation, and successful performance of the cabling system for a 30 day period will constitute acceptance of the system. Upon successful completion of the installation and subsequent inspection, the end user shall be provided with a numbered certificate from Mohawk, registering the installation.