

## 1. GENERAL REQUIREMENTS

- a. Use the most current specification document found on the “Communications Cabling” web page...  
<https://www.cmu.edu/computing/services/infrastructure/network/cabling/index.html>
- b. This document is to be accompanied with two drawings named as “Communications Room Spec Drawing” and “Typical Communications Outlet Spec Drawing” which are located on the “Communications Cabling” web page...  
<https://www.cmu.edu/computing/services/infrastructure/network/cabling/index.html>
- c. The University may, at its sole discretion, accept or reject any and all bids, proposals, or work not meeting the standards and criteria set forth in this section.
- d. All references in this document to “approval” shall mean approval by the Communications Cabling & Infrastructure (a.k.a. CCI) Manager or his designate. No other member of the University may provide an approval for work covered in this section. All references to the “Cable Plant Manager” include the Manager or a designate.
- e. The communications system shall include underground and aerial cabling, riser systems, horizontal distribution pathway, wiring Communication Rooms, outlets, and other specified equipment, which supports telephone, communications, data, and Cable TV services.
- f. Horizontal copper communications cabling shall be Unshielded Twisted Pair (UTP), of type “Category-6A” as detailed further within this document. This specification may at times include the use of Category-5e & Category-6 UTP cabling when conditions call for it, and when the CCI Manager specifically approves that usage.
- g. The Contractor shall install all UTP wiring and related equipment as outlined in the TIA/EIA T568B wiring scheme.
- h. For installations outside the U.S., parts of this document may need to be adjusted (for: voltages, vendor part numbers, local regulations, etc.). Please contact CCI for specifics.
- i. The University requires that our Communications Contractors be certified by the manufacturer(s) of the ‘structured cabling system(s)’ as to Contractor’s ability to install such a warranted system. A copy of Contractor’s certificate shall be included with all bid proposals.
  - i. Warranty periods will not start until the contractor(s) has given CCI Office a useable, tested, and labeled system.
- j. The ‘master wiring plan’ also includes fiber-optic cable in both laser-optimized multimode and Singlemode types, copper plant, and coaxial cabling for cable television (Cable TV).
- k. The scope of work varies from the intra-building installation of Category-6A station outlets, to the installation of backbone cable, to the construction of wiring Communication Rooms. This work may include installing intra- or inter-building backbone twisted pair cable, coaxial cable and fiber optic cable, backboards and wire management, racks, power and lighting, and HVAC.
- l. All underground, aerial, between-building and intra-building cable or other facilities abandoned as part of a project shall be removed by that project in a timely fashion as specified and required by the National Electrical Code (NEC) per section 800.52(B).
- m. The Contractor shall obtain approval in advance from the CCI Manager before starting any and all work. Unauthorized changes (e.g. cutting, modifying, etc.) to cabling can cause communications network failures campus-wide and will not be tolerated.
- n. The Contractor shall comply with all of the University’s Special Conditions as they apply to this work.
  - i. Contact the CMU Environmental Health and Safety Office (EH&S) at (412) 268-8182 for their hot work/dust permit requirements and other guidelines including information about hazardous materials.
- o. Prior to beginning the tasks described below the Contractor shall meet with the CCI Manager and establish a schedule of work.
- p. It shall be the responsibility of the CCI Manager or his designate to arrange the disconnection and reconnection of all voice, data, and Cable TV services affected by any work.

## CMU Communications Cabling & Infrastructure Specs—Revised 4/19/2024

- q. The Contractor shall visit the project site on a scheduled walkthrough date in order to verify conditions on the job site. The contractor will notify the CCI Manager in writing/email of discrepancies, conflicts or omissions promptly upon discovery.
- r. By submitting a bid, the Contractor is attesting that responsible Contractor personnel have, in fact, visited the site during the bidding period and have verified all pertinent conditions.
- s. Codes, Standards and Safety
  - i. All work shall conform to the latest NEC.
  - ii. Contractor shall notify CMU of any conflicts between the code and design drawings or scope of work via email no less than (3) business days before quotes are due.
  - iii. All work shall be performed by qualified personnel and in a safe, neat manner showing craftsmanship.
    - 1. All electrical work (above 90 VAC), grounding & bonding, ladder tray installation and rack construction must be performed by journeymen electricians.
  - iv. All communications cabling work must be performed according to the manufacturer's standards in harmony with their warranty requirements and then according to industry accepted standards and best-practices.
- t. Bid Submittals
  - i. CMU reserves the right to reject any or all bids without explanation
  - ii. Split (separate) price for Communications Cabling bid into the following:
    - 1. Pathway (conduits, cable tray, supports, waterfalls, tray fittings, etc.)
    - 2. Power (for Data contract work)
    - 3. Communications (Fiber & Copper cabling, workstations, racks, etc.)
    - 4. Alternate #1, #2, #3, etc.
  - iii. With bid, submit:
    - a. Contractor company info on letterhead
    - b. Cutsheets for materials contractor plans to use
    - c. Task schedule showing estimated completion dates
    - d. The first three pages of this document in order to establish which revision the contractor has used for pricing
      - i. The contractor should also store a complete print-out or an electronically saved version.
    - 2. For Projects over \$100K, also include:
      - a. Insurance and Liability info
      - b. List of (3) recent projects most resembling currently proposed project with customers' contact info.
  - iv. Subcontractor info (must be CMU-approved for contracted work).
  - v. Copy of project's latest RFQ and scope.
  - vi. Upon request, the contractor should be able to provide cut sheets, MSDS sheets for materials used.
- u. If the bid is directly for CMU CCI Office, deliver bid materials in sealed envelope to Cyert Hall at date and time specified in RFQ.
- v. CHANGE/SUBSTITUTION PROCESS
  - i. All changes and/or substitutions must be submitted -AND- approved by CCI. Unapproved work and/or substitutions may require rectification at the contractor's expense.
- w. AS-BUILT DOCUMENTATION
  - i. Upon completion of the project, the Contractor shall provide the CCI Project Manager with the following documents, in format(s) acceptable to the CCI Project Manager:
    - 1. UTP Cable test results, Coaxial Cable test results and Fiber Optic Cable test results
    - 2. As-Built plans in AutoCAD format unless given permission for other formats. (The CCI Project Manager will supply the Contractor with a copy of the base floor plan AutoCAD file upon request.)

x. QUESTIONS

- i. If a designated contact has not been defined in a project, use the contacts listed below for all questions:
  1. Pete Bronder, Sr. Mgr., CCI , 412-268-8582, pete@cmu.edu
  2. Brian Painter, Cable Plant Consultant, 412-268 7121, bpainter@andrew.cmu.edu
  3. Jason Dickerson, Cable Plant Consultant, 412-268-3339, jasonld@cmu.edu
  4. Joe Cambest, Cable Plant Consultant, 412-268-1551, jcb8@andrew.cmu.edu

**2. INSIDE PLANT**

a. **Design Criteria**

i. **Drawings**

ii. **Telecommunications Rooms**

1. General dimensions of room: Maintain a minimum of 4' clearances between front and back of racks as measured between center of rack base to each opposing wall such that depth of room is no less than 8' between walls. Maintain a minimum of 4' clearance between one side of a rack and opposing wall. When multiple racks are installed side by side in one row, maintain a minimum clearance of 4' for at least one rack at the end of a row. As an example, a minimum size of a communications room shall be 10' wide by 8' deep when 2 racks are installed side by side. This width includes vertical cable managers at ends and between racks.
2. Allowable equipment and services inside MDFs and IDFs:
  - a. In addition to equipment for the campus network, electronic controllers for fire alarm and controllers for card access are allowed if space permits and clearances can be maintained.
    - i. In general, these items should be mounted on the walls and have their own dedicated power circuits.
      1. Any backboards installed on walls in communications equipment rooms should be UL fire-retardant pressure-treated wood; if painted, use fire-retardant paint and leave the printed designation of the plywood visible and conspicuous.
    - b. No other equipment is to be installed in communications rooms.
3. MDF to IDF interconnects shall, at a minimum, consist of the following...
  - a. Panduit Category-6A plenum UTP, if 90 meters or less.
  - b. 12-strands of OM3 fiber (see section on fiber optic cable)
  - c. 12-strands of SM fiber (see section on fiber optic cable)
4. Cable Managers
  - a. Vertical: 8" with doors between racks and 6" with doors at the end of rack rows (See 'Hardware Part Numbers' section)
  - b. Horizontal: 2RU horizontal managers at the top and also at approx. the 22<sup>nd</sup> RU space from the top (A.K.A. "mid-rack") (See 'Hardware Part Numbers' section)
5. New Racks
  - a. See 'Hardware Part Numbers' section
  - b. See 'Inside Plant Grounding' section below
6. Power
  - a. Each rack shall be provided with its own dedicated, 20-AMP, 120 VAC circuit with double-duplex receptacles (non-surge suppression) in a 2-gang RS cover on a 4" or 4-11/16" square, deep junction box. This is to be mounted on the back of the vertical wire manager at 18" A.F.F.
  - b. Power outlets in communications outlets are to be labeled with breaker/panel info.

- c. Each rack is to be provided with a rack-mounted Power Distribution Unit (PDU). CMU's Network Operations group typically provides the PDUs. The current model of the PDU is a "SERVERTECH CB-12H1-C20 BASIC RACK PDU" along with this option for the power chord... "PTCORD-L5". The PDU is to be mounted directly under the mid-rack horizontal wire manager and is to plug into a locking receptacle on a nearby rack mounted UPS unit.
  - d. Whenever possible, power should be on generator, including HVAC serving MDF & IDFs
- 7. All plumbing, (including supply lines, drain lines and anything with "leak potential") shall not be placed within communications rooms. Ideally communications rooms would not be located beneath bathrooms, kitchens and mechanical/utility rooms.
- 8. HVAC for MDFs & IDFs
  - a. When a communications room are served by an emergency generator, the HVAC serving the communications room shall also be served by the emergency generator.
  - b. HVAC units within communications rooms shall not be placed in vicinity/beneath the communications racks.
  - c. Temperature is to be within +/- 2 degrees of 75 degrees Fahrenheit. Relative Humidity not to be higher than 50%. Heat loads depend on equipment loads as follows...
    - 1. Quantity of data outlets per communications room + 20% future expansion = total qty. data outlets
    - 2. Divide total quantity of data outlets in half since only half are typically activated
    - 3. Divide qty. of activated outlets by 24 to determine how many 24-port Ethernet switches are needed
    - 4. Network Operations then refers to spec plate power ratings on gear, de-rates by 60% to determine running power in watts and multiples by qty. switches
    - 5. Plug equipment load in watts-to-BTU/hr. equation to determine cooling...  $1 \text{ W} = 3.412142 \text{ BTU/hour}$
  - d. Direction of supply air should be pointed to the front of racks which is the same as the direction of the ports on the patch panels.
- 9. Lighting in MDFs & IDFs
  - a. Lighting levels in the wiring Communication Room shall be at least 50 foot-candles at 5 foot above the finished floor at the 19-in. Racks using LED fixtures. All areas of the room should be well lit including the front and rear of the racks.
  - b. Provide/install spring-wound timer switches to control lights.
    - i. 6 hours with no manual override
    - ii. Use Intermatic® #FF6H for single-pole
    - iii. Use Intermatic® #FF46H for double-pole equivalent
- 10. Flooring
  - a. Static Dissipative Tiling Floor is to be installed on all floor surfaces within MDFs & IDFs. "Armstrong Fossil Gray Excelon ESD Tile 51956 Static Control Flooring" or similar product.
- 11. Doors

- a. Doors for new communications rooms shall be secured with card readers maintained by CMU's Access control staff. Locks should provide for bypass key entry in the event that the card reader is not functioning. A pair of bypass keys is to be provided to CCI such that keys are unique to each building.
  - b. On projects where new communications rooms are built, doors must be installed and secured BEFORE networking equipment can be installed. Therefore, responsible CMU parties should direct their contractors and the CMU Lock Shop to complete this in advance of building occupancy (typically no less than 2 or 3 weeks).
12. Signage
- a. Signs on doors to communications rooms should only list the room number, not the function of the room (ex: "communications room"). This to not make the function of the communications rooms obvious to unauthorized users.
13. Environmental Monitoring
- a. One environmental monitoring system shall be provided for each communications room. Current model is a "Vertiv Watchdog-100" with flood sensor model "VERTIV FS-15". Monitor is 2RU in height and is to be mounted on 19" rails of communications rack such that it is centered vertically 2' A.F.F.. Leak Sensor should be secured with two screws into floor, in a low lying spot if available.
14. Other Systems
- a. So as to maintain a secure environment, no other cabling or gear except for that which is in support of the campus network and telecommunications systems are to reside within communications rooms. On an as needed basis, requests have been honored to allow for location of the campus access controllers if space allows.
  - b. In extreme/dire situations (not a precedent) use of a communications cabinet may be approved. If approved, cabinet shall be placed upon concrete curbing such that curbing is 6" in height and extended 6" beyond the cabinet's footprint on all 4 sides.
  - c. All trash/debris is to be removed from communications rooms.
- iii. Voice Riser**
1. Provide and install a 50-pair cable type A.R.M.M. in conduit or type A.P.M.M. in conduit-less installations (plenum version of A.R.M.M. cable; with aluminum armor tape) between the MDF and each IDF.
- iv. Maximum length of UTP cabling:**
1. Horizontal cabling between MDF/IDF patch panel and workstation outlet: 90 meters
  2. A safe length for patch cords is 5 meters. In no case should combined patch cord length (at both ends) be greater than 10 meters.
  3. Maximum channel (e.g., horizontal cabling link + both patch cords) length shall be 100 meters.
- v. Communications Outlets**
1. All new UTP workstation communications cables and outlets are to be installed as Category-6A "universal outlets" A.K.A. 'data' outlets. These outlets originate from Category-6A jacks in the network racks inside network telecommunications rooms. These outlets are capable of being used for either voice or network services. They consist of Panduit® black jacks connected with blue plenum Category-6A cable.
  2. Quantity:

- a. Residence halls
  - i. For student rooms one data outlet for every student in a room or suite of rooms (at each student’s desk area) is recommended.
  - ii. For shared suites, depending on a project’s requirements, one data outlet in a shared space may be required while no outlets are needed in bedrooms. Students rely on WIFI in those situations.
  - iii. Voice outlets (universal outlets used for phone service) shall be provided in common areas such as ‘buggy rooms’, dining rooms, lobbies, and kitchens.
  - iv. Depending on the specific project, (1) CATV outlet per bedroom, living room, recreation/bar area, etc. may be required
  - v. Computer Labs must be wired according to project requirements, likely one jack for each computer.
- b. For offices
  - i. The general rule is to install a minimum of two data/voice outlet (i.e., two universal outlets/cables) for each occupant of an office, ideally outlets will be located on opposing walls to allow for furniture reconfigurations and eliminate tripping hazards of patch cords strewn across flooring.
  - ii. In cases where modular furniture or cubicles are used, one data/voice outlet per workspace. Outlet faceplates with jacks shall be terminated on a nearby wall. Cabling is to be extended via patch cords of the same category or better. See labeling section for additional details on patch cords.
  - iii. Install (1) CATV outlet per lounge, kitchen/dining area, etc.
- c. Note that even if the occupant does not want a data/voice outlet, a minimum number of communications outlets MUST be installed based on the size of the space. If the occupant does not require a data/voice outlet, the following table shall be used to determine the number of outlets.
- d. Calculation table:

Required Number of Data/Voice Outlets	
Area (Sq. Ft)	Number of Outlets Installed
99 or less	1
100 to 499	2
500 to 1,099	4
1,100 or more	6

- 3. The standard ‘horizontal drop’ for new outlets shall consist of the following:
  - a. 1” EMT conduit in wall cavity
  - b. 4-11/16” X 2-1/8” deep junction box with 2-gang plaster ring
  - c. Exceptions:
    - i. Wall phones (1-gang with ¾” EMT)
    - ii. Rental spaces (ask CCI Office)
    - iii. Outlets installed in existing walls
    - iv. Fiber workstation outlets (surface mount over 1- or 2-gang opening)
- 4. Floor Boxes:
  - a. Verify with CCI to match the product to the application.
  - b. Telecommunications outlets may only be installed in the following recessed devices:

- i. Round poke-through boxes: use Wiremold Evolution series (example: #6ATCPBK)
      - ii. Square, in-concrete type (must be cast or grouted in-place).
        - 1. Wiremold® Evolution Series six-gang floor box
        - 2. Wiremold® Evolution Series two-gang floor box with trim flange and covers
        - 3. T&B # 668-S or equivalent
      - c. Apply removable fire-stopping to cables entering floor box
  - 5. Tele-Power Poles (indoor):
    - a. For aesthetics, we do not encourage the use of power poles. As an alternative, cabling pathways which extend down walls or columns are preferred—followed by the use of the floor boxes mentioned above.
    - b. Tele-power poles, if used, should have the following characteristics:
      - i. Shall be well secured at the top.
      - ii. Have a divider from the power wiring.
      - iii. Have enough cross-section area for the communications cabling section.
      - iv. Have grommet protection from sharp edges where cables enter the channel.
      - v. Wiremold-Legrand is the preferred manufacturer.
- a. **Wireless Access Points---** For additional details, refer to "AP Installation Process" document found on the "Communications Cabling" web page...  
<https://www.cmu.edu/computing/services/infrastructure/network/cabling/index.html>
  - vi. All University Buildings are served with Wireless Data, and adequate provisions for such service as noted:
    - 1. CMU Network Operations is the only group who determines the locations of Access Points (aka: "AP's") for 802.11 Wireless LAN service (aka: "WiFi"). Network Operations performs a rough design for planning, then performs final location verification after certain construction has been completed, ex: completion of walls/doors). This is relevant for all new campus buildings, major renovations and for smaller campus building renovations whose wireless infrastructure will require redesign. Even so-called minor renovations can impact wireless coverage—especially if walls are moved, added, or removed. Therefore, Computing Services personnel must be invited into discussions early on, during the planning phases of these projects.
    - 2. Only CMU's certified communications cabling contractors can remove and install AP's. CMU's certified communications cabling contractors are to obtain prior approval from Network Operations or CCI before AP removal. Unless directed otherwise by CCI or Network Operations, changes to AP's should be performed such to turn off one AP at a time or keep every other AP in a given area operating. This is to prevent a complete outage for wireless service in a given area. AP's often provide service beyond the areas they are located at, ex: serving offices/classrooms beyond a construction zone.
    - 3. Cabling for AP's is to be installed at locations indicated on the rough design and by leaving 20 feet of properly coiled cable slack and unterminated. Cabling can be terminated and AP's mounted only after final location verification (see above).
    - 4. Designs shall provide for a minimum of one Access Point for every 200 to 800 square feet (drywall construction) or 50 to 400 square feet (hard plaster or masonry construction) of interior space, depending on capacity: performance ratio. Example: classrooms and lecture halls will require more dense placements.

5. Each AP location will have two Category-6A data outlets installed. The AP's will receive their power over the data cables (aka: PoE) therefore no 120 VAC power is needed.
  - a. Cable: Panduit # PUP6AV04BU-G this is blue cable
  - b. Jacks: Panduit # CJ6X88TGBl
  - c. Plugs: Panduit #'s FP6X88MTG (straight) & FPUD6X88MTG (angled)
6. The communications contractor shall install the AP brackets (supplied by CMU Network Services, contact Daryl Hollinger (Manager of Network Operations-CMU Computing Services)).
7. The exact height and location will be determined by CMU Network Operations.
  - a. Send pdf floorplan of project to Daryl Hollinger (Manager of Network Operations-CMU Computing Services).

**vii. Point-to-point cables**

1. Some campus users have the need for direct, point-to-point cabling between rooms. This cabling can share current pathways only if the following conditions are met:
  - a. These cables **are not** to be used to extend regular services from existing outlets (in such cases, new outlet(s) should be installed)
  - b. Cables must be our specified brand(s) (Panduit™ for copper UTP) and have a black jacket color this is a black cable
  - c. Cables must be installed in a manner according to our regular standard and be installed by one of our CCI Office approved cabling contractors
  - d. Cables must terminate in a separate faceplate from regular voice/data cables
  - e. CCI Office will provide labels with a format like: [bldg.#] -- [1<sup>st</sup> room#] – [2<sup>nd</sup> room#] – [xxxx(1-9999)]. The following shows an example of label that could be printed on black, ½" laminated tape by the contractor (using a Brother® P-Touch labeler):

**P09-Rm144-  
Rm171  
0001**

- f. Cables must be tested according to the "Testing" section in this document
2. A wide variety of services can be run over Category-6A UTP cable including video, sound, CATV, S-video, high def. video, etc., and adhering to our recommendations will help to ensure the following:
  - a. Interference and cross-talk onto current voice/data cabling will be limited
  - b. Cables can be tested, verified and results stored in our current database
  - c. Cables can be given addresses and documented on our AutoCAD drawings
3. Note: The majority of the cabling we provide is activated with services supported by the Network Operations and Telecom groups. These groups have expertise in troubleshooting and problem escalation. Services on the point-to-point cables are to be directly supported by the customers who are expected to have expertise in troubleshooting and problem escalation. Incorrect troubleshooting could lead to additional contractor charges if cable testing proves no problems found.
4. Fiber point-to-point cables **shall not be** zip cord (see "Fiber Cables")

**viii. Pathways**

1. Above suspended ceiling
  - a. Office: J-hooks



- b. Corridor: basket tray
  - 2. Visible, in corridor
    - a. Priority given to aesthetics (Chalfant Series 6)
  - 3. Data Center or equipment room
    - a. CPI universal Runway
    - b. Panduit FiberRunner®
    - c. Panduit WYR-Grid
  - 4. Communications cabling pathways must avoid elevator shafts and elevator machine rooms
    - a. For applications directly related to elevator operation (such as elevator phones), contact CMU FMS department for written approval.
  - ix. **Abandoned/replaced/decommissioned cables** must be completely removed by the electrical/telecommunications contractor and their unused pathways must be sealed/patched and painted if necessary
    - 1. See NEC Art. 800.25 and similar sections
    - 2. A list of all cables to be removed or replaced must be provided to CCI so they can be properly deactivated and removed from databases and campus floor plans.
  - x. **Removal/demolition of communications cabling** must only be performed by CMU's certified communications cabling contractors.
  - xi. **Hazardous Materials**
    - 1. For information about hazardous materials, Contact the [CMU Environmental Health and Safety Office](#) (EH&S) at (412) 268-8182
- b. **Materials**
- i. **Panduit products**
    - 1. CMU has obtained discount pricing from Panduit, for Panduit products purchased for use on our campuses. For more competitive bids, contractors should ask Accutech, Anixter and Graybar for SPA (special pricing agreement) # 11657N.
  - ii. **Cables**
    - 1. **Copper UTP horizontal link** certified warranted system certified warranted system. Category-6A is the standard minimum category for new outlets.
    - 2. **Fiber Optic:** Plenum, Corning certified warranted system (see "Fiber Optic Cable" section)
    - 3. **CATV horizontal drops:** use either of the following cables for CATV.
      - a. **Cable**
        - i. CommScope® #2227V plenum RG-6 quad-shield cable
        - ii. Belden® #6339Q8 plenum RG-6 quad-shield cable
      - b. **Connector**
        - i. Belden #FSNS6PLQ
      - c. **Termination tools**
        - i. Cable stripping: Belden #PSA59/6
        - ii. Snap-n-seal connector closure: Belden #CPLCCT-SLM or Belden #CPSNSCT-596
    - 4. No cable shall be painted
  - iii. **Communications Cabling Pathway**
    - 1. Surface Raceway

- a. Communications cable pathways (ex: conduits, trays and surface mounts) are intended for low voltage, low heat and fiber optic cabling. EMF/EMI interference from high voltages can severely interfere with low voltage signaling therefore isolation methods are required. Low voltage is generally considered 90V potential and below. Advance permission must be obtained from the CCI Office for use of communications cable pathways to determine sufficient capacity and possible interference with existing cabling. In some cases, high voltage cabling can coexist in the same cable trays and surface mount pathways if certain measures are taken to assure there will be no interference such as: use of a grounded metallic barrier isolating high and low voltage cables (ex: metallic (Wiremold product or equivalent)).
  - i. Dual Chamber metallic raceway, Wiremold P/N: 4000B base
    1. 4000D, divider sections; 4000C cover plate; 4047B device mounting straps and duplex receptacle device plate; V4048R device plate
    2. For CATV, use #4047XX or #4007C-1 with 1-gang stainless wall plate.
      - a. Use female bulkhead F-connector with nuts and lock washers both sides.
  - ii. Dual Chamber plastic raceway, Wiremold P/N: V5000B,
  - iii. 5000C cover; 5007C-1 device plate; 5007C-1A; 5507D, face plate
  - iv. Panduit 4 channel above floor raceway system, rigid PVC, Panduit P/N AFR4BCIWG (also in BL or OS)
- b. For short, straight lengths of surface mounted raceway containing 1 or 2 UTP cables, provide and install Wiremold 700-series and fittings.
  - i. Install Wiremold #5703WH supporting clips every 3-feet plus within 12-inches of all raceway ends, couplings, and fittings.
- c. Use 2400-series Wiremold for any run which contains one or more elbow fittings.
  - i. Use available radiused (fiber optic type) elbow fittings (# 2411FO -color?).

2. Cable Tray

**a. Ladder and Basket Tray**

- i. Size for maximum of 40% fill along entire length
- ii. FLEXTRAY Basket Tray, nVent WBT or equivalent.
- iii. Basket tray to be sized based on the number of cables being supported with a maximum 40% fill factor for future installs.
- iv. Basket tray can be used as a vertical raceway.
- v. Basket tray shall be "end support" hung only (no center supports), with rubber or plastic covers on all exposed all-thread rod to prevent cable damage.
- vi. Cable drop-outs must be used where cable exits tray downward.
- vii. Minimum of 2" depth for basket tray.

**iv. Communications Outlets**

1. Yokes (106-style frames)
  - a. Panduit # CF1062EIY (Duplex Yoke, Electric Ivory)
  - b. Blank inserts, to match yoke color
2. Hammond® boxes for outlets serving HVAC & Fire Alarm panels
  - a. To discourage tampering and permit tool-less visual inspection of patch cord connections to these outlets, provide and install the following:

- i. Panduit # CBXZEI-AY plenum-rated surface-mount outlet inside the following special j-box.
        - ii. Hammond Manufacturing # 1554H2GYCL ([hyperlink](#)) j-box with clear cover, to house the Panduit outlet. Connect this box with 1" E.M.T. conduit to the HVAC or Fire alarm panel (to be less than 3-foot between j-box and HVAC/FA panel; to contain patch cord(s)).
  - 3. CATV
    - a. F-type F/F bulkhead installed in a stainless (must be metal) blank wall plate secured with nuts and lock washers on front and back of wall plate
      - i. Toner P/N: WP-81-SS Metallic or equivalent
  - 4. Fiber work area outlets (see "Fiber Optic Cable" section)
- v. Communications Room Hardware**
- 1. Rack systems and hardware: Panduit™
  - 2. Fiber Optic Panels
    - a. Shall be Corning #PCH
    - b. SC housing adapters (bulkheads) shall be installed in the connector plates with their key slots facing up.
  - 3. Communications backboard
    - a. All communications backboards shall be 3/4" plywood, AC grade.
    - b. Backboard shall be painted off-white with fire retardant paint on all sides and edges—DON'T PAINT CERTIFICATION STAMP!
    - c. Backboard shall be mounted with the "C" side against the wall.
  - 4. D-rings
    - a. 2" metal 'D' ring. Allentel P/N GB13A, CPI or equivalent.
    - b. 3" metal 'D' ring. Allentel P/N GB13B, CPI or equivalent.
    - c. 5" metal 'D' ring. Allentel P/N GB13C, CPI or equivalent.
- vi. Fire-stopping**
- 1. Listed removable fire-stopping shall be used at all locations where fire-stopping is required by local codes and shall be used in full compliance with the manufacturer's instructions. Verify with CCI to match the fire stopping method with the location installed.
    - a. Pillows:
      - i. SpecSeal Product P/N: SSB26: 9" lengths or equivalent
    - b. Cable Pathway through Wall Penetrations:
      - i. Pensil Series P/N: PEN 200 Foam or equivalent, or...
      - ii. Fire rated pathways (shall not contain electrical cabling):
        - 1. For more than two UTP cables, use STI EZ-Path®; according to manufacturer's guidelines.
        - 2. For more one or two UTP cables, use SpecSeal Ready® fire stop grommet (# RFG2); may be used with a maximum of (2) Category-6A cables (grommet needs to be able to slide along cable into place)
    - c. Putty:
      - i. SpecSeal Series P/N: SSP Putty or equivalent
- vii. Miscellaneous**
- 1. J-hooks
    - a. Minimum size 1-5/8" (Erico "Caddy" P/N: CAT21 or equivalent)
- viii. Substitutions**

1. Any equipment proposed as equal to that specified shall conform to the standards described here, and the manufacturer must supply proof acceptable to the University in the form of a written guarantee that the equipment substituted meets or exceeds the specifications, and the substitution be accepted in writing by the University

**c. Procedure**

**i. Removing outlets/cables**

1. Contractor must get email approval from CCI Office to remove cable prior to any disconnection/cutting. Contractor must provide electronic (i.e., email) list of outlet addresses to be removed.

**ii. Special Procedures for Raised Floors**

1. Cyert Hall Data Center Spaces... The data center spaces are defined as multiple rooms/floors within Cyert Hall including A82, A84, A100, the ECE machine room on the B-level and the North Lab on the 2nd floor
  - a. Before performing work beneath the floor, contact CCI and Dave Kalbaugh (dk08@andrew.cmu.edu) **via email** so that he is aware (as building manager) and so he, in turn, can coordinate with FMS to have the subfloor sensors disabled. After receiving confirmation that the sensors have been disabled, commence work. After work is completed, contact CCI and Dave again to have sensors re-enabled. Sensors should be re-enabled before the end of each business day.
  - b. Q: What happens if the procedure is not followed?
    - i. A: As the sub floor area is disturbed, debris can become airborne as well as vibrations can be induced from bumping sensors, both of which may trip sensors. When one sensor trips, a building-wide alarm goes off. When a second sensor is tripped, it starts an automated process to turn off power to the data center within seconds.

**iii. Cable installation**

1. Observe manufacturers' installation guidelines including limits on pulling force & bend radius
  - a. Breakaway swivels with having not more than 200 lb. breaking strength must be used for pulling fiber optic cable.

**2. Routing & Support**

- a. Do not obscure access to access doors, hatches, air dampers, valves, cable trays, junction boxes, pull-boxes conduit entries or similar areas of access.
- b. Secure all cable run vertically for continuous distances greater than thirty (30) feet. Provide symmetrical conforming nonmetallic bushings or woven cable grips appropriate to weight of cable(s).
- c. J-hooks, minimum 1-5/8" width shall be used as a raceway from basket tray to workstation where applicable, and staggered between 4' and 5' to avoid an antenna affect
- d. Where drawings specifically allow the installation of cable in void, plenum or suspended ceiling areas, the contractor shall conform to TIA/EIA 569, section 10.4 with respect to separation from power and radio frequency (RF) sources per Table 10.4-1 reproduced below. Provide at least twice the listed separation, including but not limited to motors, transformers and copiers (see table below).

TIA/EIA 569 – Table 10.4-1 Separation of Telecommunications Pathways from Power Lines
--

Condition	Minimum Separation Distance		
	<2KV	2-5KV	>5KV
Unshielded power lines or electrical equipment in proximity to open or non-metal raceways.	5-in.	12in.	24-in.
Unshielded power lines in proximity to a grounded metal raceway.	2.5-in.	6-in.	12-in.
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal raceway.	N/A	3-in.	6-in.

- e. A minimum of 6-in. must be maintained between all UTP cable and fluorescent fixtures.

**iv. Termination**

1. UTP
  - a. As per manufacturer’s instructions (as part of a warranted system)
2. CATV
  - a. For indoor locations, only use CommScope® #2227V plenum RG-6 cable.
  - b. for connectors, use Belden #SNS1P59U (with **Gray** plastic collar)
  - c. for cable stripping and connector installation, use T&B #CST596711(stripping), T&B snap-n-seal tool #SNSUTL
    - i. Alternatively use the T&B all-in-one tool #IT1000
3. Fiber Optic Cable
  - a. Use factory terminated/polished pigtails or complete pre-term solution (as part of Corning warranted system)

**2.1.1. Labeling for copper UTP cabling and outlets**

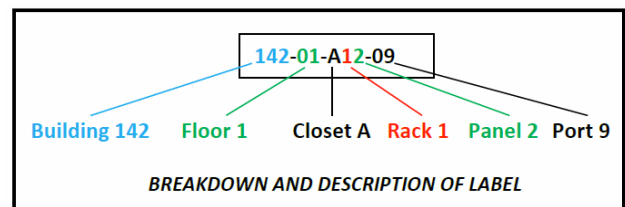
1. Cable ID tags shall be provided & printed by CCI
2. Contractor shall verify patch panel ports for cabling and notify CCI Office a minimum of (3) days before labels are needed.
3. Labels shall be placed at the following (4) locations:
  - b. Faceplate
    - i. Place above the top jack in the 106-style frame and below the bottom jack; remove all debris with denatured alcohol and allow to dry before applying label.
    - ii. Example of label placement on a typical faceplate...



- c. Cable jacketing at both cable ends
  - i. "Butterflied" placement 6" from the end of the cable jacketing at both the back of the patch panel and within the outlet box.
- d. Patch panel port
- 4. At cubicles or other office furniture blocking access to outlets:
  - e. An additional label must be placed on the crown of the faceplate (must be cleaned first, for proper adhesion), above the top jack, so that it can be seen from above, looking down between the wall and the furniture.
  - f. Patch cords must be of the same Category cable as the horizontal cabling and labelled on both ends to show the same label as the network outlet to which it is connected.
    - i. CMU Project Managers and their customers shall provide CCI and the communications cabling contractor a marked-up floor plan to show planned activation locations so that labelled patch cords can be installed before outlets are blocked by cubicles or office furniture.
- 5. New labeling scheme: We are transitioning to a new labeling scheme for new installations and will still support the existing labelling scheme to maintain existing outlets. The new labelling scheme is described below.
  - g. Here is an example of an outlet label at the at the user's location...

**142-01-A12-09**

- i. This example can be broken down as follows (referring to the characters from left to right) ...



1. The building # is "142"
2. The Communications Room is on floor "1"
3. The Communications Room ID # is "A"
4. The rack identifier # is "1"
5. The patch panel identifier # is "2"

6. The port # is "9"

**2.1.2. Testing**

1. It is the contractor’s responsibility to train their personnel on the use of the testing equipment according to tester manufacturer’s instructions and settings described below.
2. Copper UTP Horizontal Links
  - a. Contractor is to provide Panduit approved copper cable testers matching the table below...

Manufacturer	Tester	Reporting Software	Channel Adapter	PL Adapter
<b>AEM</b>				
<a href="https://aem-test.com/">https://aem-test.com/</a>	TestPro CV100	TestPro Software 1.2A	AD-Cat6A-CH	AD-Cat6A-PL
<b>FLUKE NETWORKS</b>				
<a href="#">Fluke Networks Firmware/Software Downloads</a>	DSX 600	Linkware	DSX-CHA004S	DSX-PLA004S
	DSX 602	Linkware	DSX-CHA004S	DSX-PLA004S
	DSX5000	Linkware	DSX-CHA004S	DSX-PLA004S
	DSX8000	Linkware	DSX-CHA801	DSX-PLA801
<b>Trend</b>				
<a href="#">Ideal Industries Firmware/Software Downloads</a>	LanTEK IV	IDC ver 1.10	R163052 or R163053	R163050 or R163051
	LanTEK III	IDC ver 1.10	R1611051	R1611053
	LanTEK II	IDC ver 1.10	0012-00-0656	0012-00-0656P
<b>SOFTING</b>				
<a href="#">Softing Firmware/Software Downloads</a>	WireXpert 500	eXport	WX-AD-6ACH2	WX-AD-6ALKIT2
	WireXpert 500 Plus	eXport	WX-AD-6ACH2	WX-AD-6ALKIT2
	WireXpert 4500	eXport	WX-AD-6ACH2	WX-AD-6ALKIT2
	WireXpert 4500FA	eXport	WX-AD-6ACH2	WX-AD-6ALKIT2
<b>VIAVI Solutions</b>				
<a href="#">Viava Firmware/Software Downloads</a>	Certifier (10G and 40G)	J-Reporter	NGC-4500-6ACH2	NGC-4500-6AL2

- b. All cables being terminated or re-terminated must be tested.
- c. Save failed results until problem is fixed. Failed tests in the tester can then be overwritten with the passing tests.
- d. With the RFQ submittal, the contractor will list the serial numbers of their main unit, their remote unit, and the calibration date (all must be current within 1 year when testing each project’s cables).
- e. To complete the Panduit warranty process, the contractor must submit cable test results to Panduit’s “Partner Portal” to obtain warranty...  
<https://partners.panduit.com> Provide proof of warranty submittal to CCI.
- f. Cable testers shall be set up to include the following:
  - ii. Test Limit = appropriate ISO Permanent Link certification Autotest
    1. Category-6A: “ISO11801 PL2 Class Ea (+All)”
    2. Category-6: “ISO11801 PL Class E (+All)”
  - iii. Record full test with graph

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- iv. Record contractor’s name, operator’s name, building name, building # and date/time of test
- v. Use manufacturer’s published NVP for the specific cables under test (choose manufacturer’s exact cable if listed in tester)
- vi. Name each test according to an abbreviation of the printed outlet labels (see the following example)

Printed Outlet Label	Equivalent Testing Label
R13@01-327-06 R13@01-BA001	R13-327-06

- h. All cables must ‘Pass’ the certification testing before acceptance
- i. Test results shall be submitted as projects/telecommunications rooms are completed by sending to CMU’s CCI Office via email, by dropping-off the memory card, or by scheduling a direct download at our office.
- j. For all approved cable testers other than Fluke, electronic PDF versions are acceptable. Paper copies are not acceptable. Cable tests shall be separate PDF files for each cable. Each file should be named with the specific cable’s ID. For example: “R13-327-06”.
- k. For Fluke testers:
  - i. Contractor shall use Fluke LinkWare Live service to download cable addresses and then upload (sync) the results.
  - ii. The following chart shows the three most common copper UTP cables to be tested on the CMU Campus and the appropriate settings in the Fluke DTX cable tester...

Cable	Typical Location	*	Tester Settings	
			Test Limit	Cable Type
Systimax Category-5e (plenum)	Existing, re-terminated cable		ISO→ISO11801→ ISO11801 PL Cass D (permanent link)	Manufacturer→ SYSTIMAX→ PowerSUM 2061
Panduit Category-6A (plenum)	New workstation cable and Wireless access points or Data center 10Gig (usually pre-terminated)		ISO→ISO11801→ ISO11801 PL Cass E (+All) (permanent link)	Manufacturer→ Panduit→ TX6A UTP Vari-MaTriX HD CMP
Panduit Category-6A (plenum)	Wireless access points or Data center 10Gig (usually pre-terminated)		ISO→ISO11801→ ISO11801 PL2 Cass Ea (+All) (permanent link)	Manufacturer→ Panduit→ TX6A UTP Vari-MaTriX HD CMP
CATV Coax (RG-6 Quad) (CommScope #2227V)	High frequency cable TV		Coax→Test Limit→ CATV Coax	Coax→Cable Type→ RG-6/U (75 Ohms)

### 3. Optical Fiber

- i. Contractor must clean ***every*** fiber port/end-face before ***every*** mating of fiber connectors including tester patch cords and launch cables
  - i. Contractor must supply and use the following cleaning tools...
    1. IBC™ Brand Cleaner SC for 2.5mm connectors (#9392)
    2. IBC™ Brand Cleaner LC for 1.25mm connectors (#9393)
    3. IBC™ Brand Cleaner for MPO style connectors (#7104)



- m. All strands in every installed cable shall be tested with CMU's Fluke® OptiFiber tester for Power Meter and OTDR (for cabling between buildings) results as follows:
- n. The tester shall be set up to include the following:
  - i. The official CMU strand name
    - 1. Testing names can be pre-loaded into tester by CMU
  - ii. Record full tests with plots
  - iii. Record of contractor's name and operator's name
  - iv. Record of date/time of test
  - v. Use cable manufacturer's published NVP for the cables under test
  - vi. OTDR Autotest:
    - 1. Two launch cables (one on each end of strand under test) with compensation
      - a. If CMU's launch cables are not available, contractor must provide.
    - 2. Dual-wavelength setting
    - 3. Uni-directional with main unit in Building Entrance Facility
  - vii. Power Meter:
    - 1. Use smart remote
    - 2. Set for correct connector type and number of adapters & splices
    - 3. "Bi-directional" (tester will prompt to swap connections halfway through the test)
  - I. Save failed results until problem is fixed; include/save picture of both end faces with any failing results (using OTDR's camera)
- o. Additional info:
  - i. ["Fiber Testing"](#) (Fluke Networks)
  - ii. [Fluke networks video on how to clean fiber connectors](#)
- II. YouTube Videos:
  - 1. [DSX 5000 Cable Analyzer™ - Setup: By Fluke Networks](#)
  - 2. [DSX 5000 Cable Analyzer™ - Running a Test: By Fluke Networks](#)
  - 3. [Getting Started with the CertiFiber® Pro Optical Loss Test Set](#)
  - 4. [Getting Started with the OptiFiber® Pro OTDR](#)

**v. Grounding**

- 1. Grounding Busbars
  - a. Provide grounding conductor (Telecommunications Bonding Backbone (TBB)) from building electric main (Primary Bonding Busbar or PBB; in the MDF) and a Secondary Bonding Busbar or SBB (Panduit # GB2B0306TPI-1) in the Telecommunications room(s)
- 2. Racks and Cabinets
  - a. Install **both** a horizontal and a vertical ground bar on each rack and feed the horizontal bar with a #6 AWG green copper conductor (Use Panduit parts; see parts list below)
    - i. Install both strips on the front (equipment mounting side) of rack with the horizontal bar on top of the vertical bar
- 3. Labeling
  - a. Telecommunications grounding—at grounding termination points, install Panduit grounding labels (Panduit # LTYK)

### 3. OUTSIDE PLANT

#### y. Design Criteria

##### i. Diverse Building Entrance Pathways

1. It is desired that new buildings have at least two diverse pathways/entrances for two diverse communication cabling feeds.

##### ii. Underground Pathways

1. Digging, trenching or direct burial activity at any depth requires advance permission from Facilities Management Services (FMS).
  - a. FMS may also require a PA One Call review.
2. Underground inter-building pathways shall be rigid PVC schedule-40 conduit, 4" minimum trade size and encased in concrete.
  - a. Underground communications conduits shall be completely encased with a minimum of 4" of non-air-entrained, 5000 psi wet mix concrete.
    - i. Use Carlon® conduit spacers in accordance with manufacturer's instructions (see Carlon® spacers)
  - b. Conduits and concrete shall be entirely below the local frost line
  - c. Contractor shall use red powder concrete die to color surface of the wet concrete
  - d. "Caution—Electric Line Buried Below" (or similar) plastic tape shall be installed above the concrete, parallel to the trench, at a depth midway between the top of the concrete and finish grade.
    - i. For trenches wider than 2', install additional runs of caution tape (one run for each 24" of width).
  - e. Contractor shall provide (via email) digital photos showing the underground conduit run both before and after concrete pour.
3. A minimum of two (2) conduits shall be provided. At least one conduit shall be left empty for future use.
4. Minimum burial depth of each conduit shall be in accordance with local ordinances and NEC Table 300.5.
5. In utility tunnels and similar spaces, cable ladders or the equivalent shall be used to secure all cabling. Product Number: Multi-Mount Cable Support Arm, Arm support # MM18, Arm # MM14. Made and manufactured by "Underground Devices, INC." or equivalent.
6. Unused conduits for future use shall have a durable pull rope tied-off to a trade-size sealing device.
7. GPS waypoints are to be recorded for new communications pathways. The waypoints are to be provided to CCI in electronic format. Waypoints will be plotted by FMCS for maintaining the campus map of all utilities.

##### iii. Enclosures

1. Consult with CMU CCI Office for design requirements

##### iv. Building and Manhole Entry/Exit

1. Lightning Protection
  - a. Appropriate lightning protection must be used on all metallic conductors of communications cabling entering a building.
    - i. Must be installed according to: local codes, recommendations of the cabling manufacturer and the manufacturer of the lightning protection device—whichever is more stringent.
    - ii. Must be grounded properly

2. Communications conduit entering buildings underground must enter through core drilled holes (for new construction, pre-cast holes appropriately sized for the Link-Seal® (see web pages below) product are required)
  - a. Holes through concrete must be smooth, round, and perpendicular (90 degrees) to the wall surface (vertically and horizontally).
  - b. Conduit within concrete holes must be straight and concentric—this excludes the oblong part of elbows and offsets.
3. The following modular/mechanical sealing product must be used (according to the manufacturer's directions):
  - a. Link-Seal® ([Link-Seal® webpage](#))
  - b. See product ordering/instructions ([Link-Seal® installation video](#))
    - i. The following is an example for our typical entry:
      1. 4" PVC conduit = 4.5" O.D. = 6" core hole = qty. of 10 links of #CS-300-C
  - c. The installing contractor (electrical) shall install the link-seals from the exterior of the building or manhole and warranty the system from leaks for a period of two years (regardless of manufacturer's warranty). If the system leaks within this two-year period, the contractor shall immediately install (at no cost to CMU) a 2<sup>nd</sup> set of link-seals® on the interior of the building or manhole.
    - i. Submit digital photographs of all completed Link-Seal® installations via email.
4. Abandoned penetrations must be hydraulically sealed.
5. Abandoned and unused conduits shall have fittings installed to prevent the entry of water and/or gases.

**z. Products**

**i. Cables**

1. Fiber
  - a. Glass
    - i. Singlemode
      1. Corning fiber code "E"
    - ii. No multimode necessary between buildings
  - b. Jacketing
    - i. Must be appropriate for the location (underground, aerial, etc.); must be plenum indoor/outdoor version (see "Fiber Optic Cable" section) if extending into building more than 50 feet.
  - c. The last two strands of every Singlemode backbone and riser cable shall be terminated at both ends via fusion splicing onto factory terminated and polished pigtails with angle-polished SC connectors.
2. Indoor/outdoor UTP (Category-6A)
  - a. Category-6A Indoor Outdoor Plenum 10UTP CAT6A Panduit PU06AS04BL-G
  - b. Category-6A Indoor Outdoor Plenum 10UTP CAT6A General Cable P/N 7141007
  - c. Category-6A OSP CAT6A General Cable P/N 8136100
  - d. Category-6A: use Superior-Essex #BBDN6A with manufacturer's recommended termination techniques.
  - e. Only if the above Category-6A is not available—get approval from CMU-CCI to use Category-6: Superior-Essex #BBDN6 with manufacturer's recommended termination techniques.
  - f. Grounding clips: the above cable is shielded. Use Electric Motion Inc. #R88 (A.K.A: "Rocket 88" clips) to ground cable shield.

3. Surge Protection for outdoor category cabling
    - a. Within interior of building and as close as reasonably possible to exterior penetration while providing future access, terminate indoor category cabling on ITW Linx model CAT6A-75 surge protector with proper ground as per ITW Linx instructions. On same surge protection device, also terminate outdoor category cabling and extend to outdoor endpoint. Surge protector is capable of passing Power over Ethernet (PoE).
  4. MTP (multiple twisted pair)
    - a. Outdoor type terminated on lightning protection devices at each building entrance
    - b. Underground Cable (Voice Backbone)
      - i. Cable shall be REA PE 39 24 AWG gel filled, solid copper, corrugated aluminum shield, black polyethylene jacket, with standard REA PE 39 color code. Cable shall conform to ANSI ICEA 7CFR-1755-390.
    - c. Transition Cable
      - i. Plenum CMP rated interior riser cable shall be Category-3 multiple pair 24 AWG solid annealed copper with a corrugated aluminum shield.
  5. CATV Coax (for existing installations only)
    - a. New Installations
      - i. No coaxial cable is to be included on new installations. CATV shall use the last two strands of the Singlemode fiber backbone.
    - b. Damage to existing cable
      - i. In the case of damage to existing coax backbone cable, CMU CCI Office reserves the right to have it replaced with fiber optic cable
    - c. Existing installations and retro-fit
      - i. Underground:
        1. 1/2" semi-flexible coaxial cable, jacketed, flooded
          - a. CommScope# P3-500-JCASS
          - b. Times Fiber# T10500JB
      - ii. Aerial:
        1. 1/2" semi-flexible coaxial cable, jacketed
          - a. CommScope# P3 500 JCAM109 (w/ messenger)
          - b. Times Fiber# T10500J
      - iii. Connectors
        1. For P3-500 and T10500 cable use either a Corning/Gilbert PN: GRS-500-CH-DU-03-T pin type connector or a Corning/Gilbert P/N: GRS-500-BAFF-DU-03 per the system design.
    - d. Splitter Specifications
      - i. 16-way
        1. 1 GHz bandwidth wall mount 16-way splitter/tap Toner P/N: XGVS-16 or approved equivalent
      - ii. 8-way
        1. 1 GHz bandwidth strand mount 8-way power passing tap Motorola P/N: FFT-8-XX or approved equivalent (XX tap value to be determined by Cable TV group prior to build)
- ii. **Conduit (See "Underground Pathways" above)**
  - iii. **Enclosures**
  - iv. **Splices**

1. The splice case shall be flame retardant.
2. The splice case shall be capable of either straight inline or butt splices option.
3. Splice cases shall be sized as appropriate (but no larger) for the size of the spliced cable.
  - a. K&B Building Riser Closure, 3M or equal.
4. The Contractor must have the appropriate 3M splicing tool for splicing 4000 series modules. No substitutions shall be allowed.
5. 25 pair splicing modules (3M MS2 4000-C/TR series splicing modules) shall feature an array of U-shaped, phosphor bronze contacts and stainless-steel cut-off blades.
6. Test entry ports on the front side of each module shall allow for individual testing of individual pairs
7. Modules shall be filled with a flooding compound.

**v. Miscellaneous**

1. Duct seal
  - a. Plastic perma-gum duct seal: Anixter P/N 009386, Blackthorn or equal

**aa. Procedure**

**i. Cable installation**

1. Inspect all conduit bends to verify proper radius. Comply with NEC Section 346-10 for minimum permissible radius and maximum permissible deformation.
2. Apply a chemically inert lubricant to all cable prior to pulling in conduit.
3. Do not subject cable to tension greater than that recommended by the manufacturer. Use multi-spool rollers where cable is to be pulled in place around bends. Do not pull reverse bends.
4. Verify that all conduit, cable tray and/or raceway has been de-burred and properly joined, coupled, and terminated prior to installation of cable. Verify that all conduit, cable tray and/or raceway is clear of foreign matter and substances prior to installation of cable.
5. Cable loops and bends shall not have a radius less than that recommended by the manufacturer.
6. All shielded cable shall be insulated. Do not permit shields to contact conduit, raceway, boxes, panels or equipment enclosures.
7. All cable shall be continuous and splice free for the entire length of the run between designated connections or terminations unless otherwise specified.
8. Do not obscure access to access doors, hatches, air dampers, valves, cable trays, junction boxes, pull-boxes conduit entries or similar areas of access.
9. Secure all cable run vertically for continuous distances greater than thirty (30) feet. Provide symmetrical conforming nonmetallic bushings or woven cable grips appropriate to weight of cable(s).

**ii. Termination and splicing**

1. At designated splices, maintain conductor, strand and binder color code across all splices.
2. Within buildings, make splices only in designated cable trays, terminal cabinets, on designated equipment backboards or where specifically shown on plans.
3. (see "Fiber Optic Cable" section)

**iii. Labeling**

1. Labeling for outside plant cabling and conduits will be provided by CCI and installed by the contractor. Labels shall provide details for "to"/"from" locations, type of cable, quantity of conductors or strands, installation date and other details determined by CCI to be of importance
2. Labels are to be installed...

- a. On each cable's jacket within manholes and handholes
- b. On each cable inside buildings and placed on cable jacket within 2 feet of building entrance or emergence from conduit
- c. On conduits within 2 feet of conduit termination.

**iv. Testing (see "Testing" section above)**

**v. Grounding**

1. IEEE C62.41 CAT C for lightning strikes
2. ANSI/IEEE C62.41-1991, 1996; Cascaded Protection
3. NFPA 780 Compliant System
4. Article 250 NEC and related articles
5. Antennas and Masts
  - a. NEC Art. 810
  - b. NFPA 780

## 4. Fiber Optic Cable

**bb. General**

- i. All multimode shall be the 50uM Laser-optimized OM3 type, except within the data centers—where OM4 shall be installed.
- ii. Pre-terminated (A.K.A.: "Pre-term") fiber shall 'one-shop' manufactured, tested, and certified with documentation. The contractor shall not substitute any components of the requested fiber system including the termination and testing components.
- iii. Field termination of fiber is not permitted. The fusion-splicing of factory-terminated and polished pig-tailed connectors is the preferred method.

**cc. Fiber in underground inter-building pathway**

- i. Indoor/outdoor, plenum, tight-buffered:
  1. 24-strand example: Corning # 024E8P-31131-29
  2. Singlemode only--unless CCI Office also requests 50uM Laser-optimized (OM3)

**dd. Backbone fiber between buildings**

- i. Indoor/outdoor, plenum, tight-buffered, armored Singlemode
  1. Indoor/outdoor armored plenum type is preferred. Outdoor type (OSP) is acceptable if less than 50-feet of cable is installed inside building or threaded conduit is used.
- ii. Connectors: duplex-SC is the default standard; verify with CCI prior to purchasing connectors and CCH panels.

**ee. Backbone fiber within a building**

- i. Indoor, plenum, tight-buffered, armored Singlemode + multimode (OM3) cables
- ii. Single-cable option: equivalent armored, hybrid (SM + 50uM Laser-optimized (OM3)) version of above cable. Check with CCI to see if CMU-supplied cable is available.
- iii. Connectors: duplex-SC is the default standard; duplex-LC is usually used in our data centers; verify with CCI prior to purchasing connectors and CCH panels.

**ff. Horizontal Fiber and/or point-to-point fiber (to be routed in a manner similar to Category-6A)**

- vi. No innerduct required
- vii. MIC® Tight-Buffered Cable, Plenum, 2 F, 50 µm multimode (OM2)
  1. Or equivalent Hybrid version of above cable.
- ii. Use armored plenum version of for critical systems
- iii. For outlet, use Corning #WMO (marked-up cutsheet)

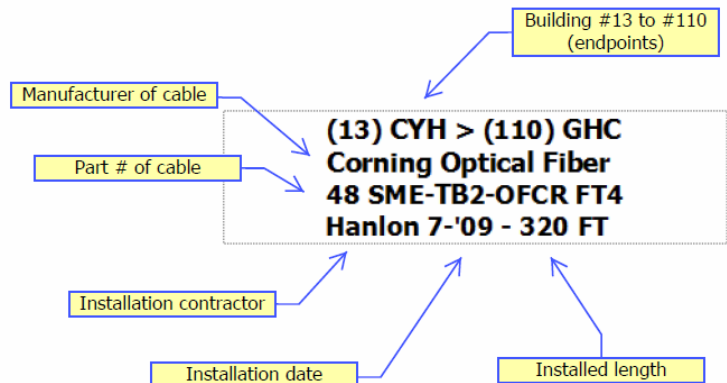
**gg. Termination and Splicing**

- i. All fiber shall be factory terminated or fusion spliced onto factory terminated and polished pigtails. The contractor shall inquire as to whether CMU CCI intends to have the fiber factory pre-terminated or if fusion-splicing of pigtails is required and mention the chosen method on the bid quote (RFQ response).

- ii. Indoor location of terminations and splices
  - 1. Terminating and splicing shall occur in vendor approved enclosures in racks or at the horizontal outlets.
- iii. Outdoor location of terminations and splices
  - 1. Shall occur in vendor approved weather-proof enclosures in manholes, on utility poles, or on building exteriors.

hh. **Labeling of fiber optic cable and panels**

- i. The following graphic shows an example of a typical fiber optic cabling label and explains the fields:



- ii. Contractor shall provide and install these labels in the following locations:
  - 1. On cable jackets, 1 to 2-feet from point-of-entries into fiber cabinets. Clear packing tape will need to be installed (wrapped around) these labels to secure them.
  - 2. On both the inside and outside of the fiber cabinet doors—so that the fiber cables can be identified both before and after opening the doors.
  - 3. On cable jackets inside all junction boxes.

**5. Common hardware and materials**

- iii. No substitutions shall be made without written approval via email.
- iv. This list may be updated periodically and is binding at the time RFQ's or bids are submitted.
- v. See the following table for commonly used hardware info...

**(See next page)**

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**5.1.1. Hardware Part Numbers for CMU CCI**

Panduit Item	Purpose	Part #	Hyperlink	Qty.	Unit Cost
Panduit Category-6A Jack (black)	Network outlet for wireless AP's and links between communications rooms	CJ6X88TGBL			
Panduit Duplex Yoke	To mount jacks in electrical style faceplates	CF1062EIY			
Panduit Blank Inserts	To close port openings for future outlets	CMBEI-X			
Panduit Keystone Jack (black)	For use in generic outlet openings (floor boxes, furniture plates, etc.)	NK6X88MBL			
Panduit Angled Modular Patch Panel	Installed in cabling racks in TRs	CPPA24FMWBLY			
Panduit Category-6A Plenum Cable (blue)	Standard network outlet cable	PUP6AHD04BU-G			
Panduit Wall Phone Plate	For wall phones	KWP6PY			
Panduit Horizontal Cable Management	At the top and mid-rack positions	PR2HF2			
Panduit Vert. Cable Management with door	Standard for communications rooms ( <i>not for data center use</i> ); size is cable density-dependent, check with CCI. In general, use 8" version between adjacent racks and 6" version at the end rows of rack/s.	PR2VFD06 PR2VFD08			
Panduit Vert. Cable Mgmt. Loop	For angled panel use without proper vertical management (temporary)	CMVDR2 (192 cables) CMVDR1 (96 cables)			
Panduit 2-post rack	Standard rack	R2P			
Panduit Vert. ground strip for rack	To ground rack or cabinet, mounts on rail	RGS134-1Y			
Panduit Horiz. ground bar for rack	Threaded with screws	RGRB19U			
Panduit 2" x 12" TGB	Telecommunications Grounding Busbars	GB2B0306TPI-1			
Panduit 4-post rack	Standard 4-post rack	R4P			
Hammond Manufacturing plastic j-box	Use as the outlet housing for Fire Alarm and HVAC panels	1554H2GYCL			
CPI 18" universal tray		10250-718			
CPI 24" universal tray		10250-724			
CPI ladder support bracket		11408-001			
CPI radius drops-center exit		12101-701			
CPI radius drops-side exit		12100-712			
CPI Butt-splice kit		11301-701			
CPI ladder tray spool (pkg of 25)		11392-712			
Corning 6-str SM		006E88-31131-29			
Corning 6-str 50uM LOMMF		006T88-31180-29			



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Corning 6-str SM armored plenum		006E88-31131-A3			
Corning 12-str 50uM LOMMF armored plenum (OM3)	12-str SM Freedom indoor/outdoor: 012E8P-31131-A3	012T88-33180-A3			
Corning 48-str 50uM LOMMF		048T88-61180-29			
Corning PCH-02U	2 rack-units, holds 4 CCH connector panels	PCH-02U			
Corning PCH-04U	4 rack-units, holds 12 CCH connector panels	PCH-04U			
Corning SC APC Splice Cassette	Closet Connector Housing (CCH) Pigtail Cassette, loaded with CCH panel and factory-terminated pigtails, 12 F, SC Duplex, SM/APC, single fiber splicing	CCH-CS12-D9-P00RE			
Corning SC APC Adapter Panel	Closet Connector Housing (CCH) Panel, 12 F, SC Duplex, Single-mode (OS2), Angle Polish Connector	CCH-CP12-D9			
SC APC Pigtails	12F SC APC Pigtail Kit, 2 Meter	FK12-004401G4131AA002M			
<b>Data Center Hardware</b>					
CPI Mini-rack for ladder tray		13394-708			
CPI horiz cable guides		11154-001			
Corning Edge 1RU housing		EDGE-01U			
Corning Edge 2RU housing		EDGE-02U			
Corning Edge 12-str OM4 module		ECM-UM12-05-93Q			
Corning Edge 12-str SM module		ECM-UM12-04-89G			
Panduit 4-post rack		R4P			
Panduit 2-post rack		R2P			
Panduit complete network cabinet		XG84222BS0041, XG84222BS0001			
Panduit 8" vert manager *	<i>* For use in data center only</i>	PR2VD08			
Panduit 10" vert manager *	<i>* For use in data center only</i>	PRV10PRVFD10			
Panduit QuickNet® angled patch panel Panduit 10" vert manager door	For data center racks	QASP24BLPED10B1			
Panduit QuickNet® flat patch panel Panduit QuickNet® angled patch panels		QPP24BLQASP24BL			
Panduit mid-rack manager Panduit QuickNet® flat patch panel	2RU height	PRZHF2QPP24BL			
Panduit mid-rack manager Panduit mid-rack manager	4RU height	PRZHF4NCMHAEF2			

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Panduit horizontal grounding strip (put spare screws in bar) Panduit mid-rack manager		RGRB19UNCMHAEF4			
Panduit vert grounding strip Panduit horizontal grounding strip (put spare screws in bar)		RGS134-1YRGRB19U			
Panduit strain relief Panduit vert grounding strip		SRB19BLRGS134-1Y			
General Cable CAT5E ARMM 50- pair Panduit strain relief		2019001SRB19BL			
Panduit WYR-Grid Basket Tray; 18" General Cable CAT5E ARMM 50- pair		WG18BL102019001			
Panduit WYR-Grid Basket Tray; 24" Panduit WYR-Grid Basket Tray; 18"		WG24BL10WG18BL10			
Panduit WYR-Grid Waterfall; bottom Panduit WYR-Grid Basket Tray; 24"		WGBTMWFBLWG24BL10			
Panduit WYR-Grid Waterfall; side Panduit WYR-Grid Waterfall; bottom		WGSWF4BLWGBTMWFBL			
Panduit WYR-Grid Connector; Straight splice Panduit WYR-Grid Waterfall; side		WGSPL1218BLWGSWF4BL			
Panduit WYR-Grid Connector; straight splice Panduit WYR-Grid Connector; Straight splice		WGSPL2430BLWGSPL1218BL			
Panduit WYR-Grid Connector; intersection splice Panduit WYR-Grid Connector; straight splice		WGINTSPBLWGSPL2430BL			
Panduit WYR-Grid Bracket; wall mount Panduit WYR-Grid Connector; intersection splice		WGWMTB1830BLWGINTSPBL			
Panduit WYR-Grid Bracket; trapeze 18" Panduit WYR-Grid Bracket; wall mount		WGTBS18BLWGWMTB1830BL			
Panduit WYR-Grid Bracket; trapeze 24" Panduit WYR-Grid Bracket; trapeze 18"		WGSTBS24BLWGTBS18BL			
Panduit WYR-Grid Sidewall; 2" Panduit WYR-Grid Bracket; trapeze 24"		WGSW2BLWGSTBS24BL			

