

## 1. INTRODUCTION

- 1.1. \*\*\* **Note:** For convenience, this document makes extensive use of hyperlinks that, if clicked on, 'jump' to other locations either in this document or on the web. These hyperlinks are identified by blue, underlined text which changes your mouse pointer or triggers a pop-up message with instructions to use the link. For 'internal' links, press [Alt] + [Left Arrow] to return to original view. 'Best effort' is made to keep these links up-to-date. It is the responsibility of the users of this site to verify the external information presented. \*\*\*

## 2. GENERAL REQUIREMENTS

- 2.1. 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.
- 2.2. All references in this document to "approval" shall mean approval by the Cable Plant 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.
- 2.3. 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 CableTV services.
- 2.4. Carnegie Mellon University's 'master wiring plan' for data and voice communication specifies Category 6 for horizontal Unshielded Twisted Pair (UTP) applications. This specification may at times include the use of Category 5e & 6A UTP when conditions call for it, and when the Cable Plant Office Manager specifically approves that usage.
- 2.5. The Contractor shall install all UTP wiring and related equipment as outlined in the TIA/EIA specifications.
- 2.6. 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 us for specifics.
- 2.7. 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.
- 2.7.1. Warranty periods will not start until the contractor(s) has given CMU a useable, tested, and labeled system.
- 2.8. 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 (CableTV).
- 2.9. The scope of work varies from the intra-building installation of Cat 5e 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.
- 2.10. 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).
- 2.11. The University is actively phasing out all "IBM" wiring and support equipment (IBM type 1 and type II cabling, IBM distribution panels, etc.). No IBM wiring or support equipment shall be installed, reinstalled, or re-located under any circumstances (should be replaced with minimum of Cat5e UTP, 1 data + 1 voice).
- 2.11.1. Any and all IBM cabling being replaced with newer cables must be totally removed by the end of the project; if IBM cable is in-service, the contractor must schedule a 'cut-over' time for the voice and/or data services.
- 2.12. The Contractor shall obtain approval in advance from the Cable Plant 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.
- 2.13. The Contractor shall comply with all of the University's Special Conditions as they apply to this work.
- 2.13.1. Contact the [CMU Environmental Health and Safety Office](#) (EH&S) at (412) 268-8182 for their [hot work/dust permit requirements](#) and other guidelines.
- A. For asbestos information, see: <http://www.cmu.edu/ehs/facilities-construction/asbestos-management-program.html>

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- 2.14. Prior to beginning, the tasks described below the Contractor shall meet with the Cable Plant Manager and establish a schedule of work.
- 2.15. It shall be the Cable Plant Manager's responsibility to arrange the disconnection and reconnection of all voice, data, and CableTV services affected by any work.
- 2.16. 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 Cable Plant Manager in writing/email of discrepancies, conflicts or omissions promptly upon discovery.
- 2.17. 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.
- 2.18. Codes, Standards and Safety
  - 2.18.1. All work shall conform to the latest NEC.
  - 2.18.2. 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.
  - 2.18.3. All work shall be performed by qualified personnel and in a safe, neat manner showing craftsmanship.
    - A. All electrical work (above 90 VAC), grounding & bonding, ladder tray installation and rack construction must be performed by journeymen electricians.
  - 2.18.4. 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.
- 2.19. Bid Submittals
  - 2.19.1. CMU reserves the right to reject any or all bids without explanation
  - 2.19.2. Split (separate) price for Communications Cabling bid into the following:
    - A. Pathway (conduits, cable tray, supports, waterfalls, tray fittings, etc)
    - B. Power (for Data contract work)
    - C. Communications (Fiber & Copper cabling, workstations, racks, etc)
    - D. Alternate #1, #2, #3, etc.
  - 2.19.3. With bid, submit:
    - I. Contractor company info on letterhead
    - II. Cutsheets for materials contractor plans to use
    - III. Task schedule showing estimated completion dates
    - IV. The first three pages of this document in order to establish which revision the contractor has used for pricing
      - a. The contractor should also store a complete print-out or an electronically saved version.
    - B. For Projects over \$100K, also include:
      - I. Insurance and Liability info
      - II. List of (3) recent projects most resembling currently proposed project with customers' contact info.
      - III. Brief resume and contact info of contractor's RCDD assigned to this project
  - 2.19.4. Subcontractor info (must be CMU-approved for contracted work).
  - 2.19.5. Copy of project's latest RFQ and scope.
  - 2.19.6. Upon request, the contractor should be able to provide cut sheets, MSDS sheets for materials used.
- 2.20. If the bid is directly for CMU Cable Plant Office, deliver bid materials in sealed envelope to Cyert Hall at date and time specified in RFQ.
- 2.21. AS-BUILT DOCUMENTATION
  - 2.21.1. Upon completion of the project, the Contractor shall provide the Cable Plant Manager with the following documents, in format(s) acceptable to the Cable Plant Manager:
    - A. UTP Cable test results, Coaxial Cable test results and Fiber Optic Cable test results
    - B. As-Built plans in AutoCAD format. (The Cable Plant Manager will supply the Contractor with a copy of the base floor plan AutoCAD file upon request.)
- 2.22. QUESTIONS

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2.22.1. If a designated contact has not been defined in a project, use the contacts listed below for all questions:

- A. Pete Bronder, Cable Plant Office Manager, 412-268-8582, [pb0q@andrew.cmu.edu](mailto:pb0q@andrew.cmu.edu)
- B. David Zumbo, Cable Plant Office Sr Consultant, (412) 268-7760, [zumbo@andrew.cmu.edu](mailto:zumbo@andrew.cmu.edu)
- C. Jason Dickerson, Cable Plant Office Consultant, (412) 268-3339, [jasonld@andrew.cmu.edu](mailto:jasonld@andrew.cmu.edu)

### 3. QUICK LINKS (read "[INTRODUCTION](#)" before proceeding)

- A. Testing: [main section](#)
- B. Fiber Optics: [cable](#), [testing](#), terminations
- C. CaTV: cable, testing, terminations
- D. Copper UTP
  - I. See [Panduit® part numbers](#)
  - II. Limited retrofits (need prior Cable Plant approval)
    - a. Systimax Cable Cutsheets: [Cat5e](#), [Cat6](#), [Cat6a](#)
    - b. Systimax Patch Panels Cutsheets: [Cat5e Angled](#), [Cat5e PatchMax](#), [Cat6 Angled](#), [Cat6a Angled](#)
- E. Abandoned cables and conduits
  - I. [Abandoned indoor cables and pathways](#)
  - II. [Abandoned outdoor conduits](#)

## 4. INSIDE PLANT

### 4.1. Design Criteria

#### 4.1.1. Drawings

- A. New racks: [plan view](#); [realistic view](#); [isometric view](#)
- B. [Old rack elevation](#) (for retro-fitting)

#### 4.1.2. Wiring Closets

- A. Closet-to-closet interconnects shall be Cat6a plenum UTP, panel-to-panel, Systimax system
- B. Existing IBM racks
  - I. New panels can be installed in these racks
  - II. To make room, the existing IBM panels can be: un-attached from the rack, swung out of the way, suspended in-place without disconnecting any patch cords.
- C. New Racks
  - I. See Inside Plant Grounding section below
- D. Lighting
  - I. Lighting levels in the wiring Communication Room shall be at least 50 foot-candles at 5 foot above the finished floor at both the 19-in. racks and CableTV equipment board.
  - II. Use motion detector type light switches (w/override).
- E. Surge-suppression receptacles

#### 4.1.3. Voice Riser

- A. Use type A.P.M.M.
- B. To calculate the number of voice pairs needed between a Telecom Room (TR) and the Building Entrance Facility (BEF), use the following equation:
  - I. Number of pairs in copper voice riser = number of copper UTP horizontal voice cables extending out from the TR (round-up to the next standard cable size)
    - a. Example: 51 voice cables extending from telecommunications room would require a 100-pair voice backbone feed.

#### 4.1.4. Outlets

- A. Quantity:
  - I. [Residence halls](#)
    - a. The rule for student rooms is that there must be at least one

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data outlet for every student in a room or suite of rooms (at each student's desk area).

- b. Voice outlets shall be provided in common areas such as 'buggy rooms', dining rooms, lobbies, and kitchens.
- c. Unless specifically directed otherwise by CMU Housing Services Department (provide email), install (1) CATV outlet per bedroom, living room, recreation/bar area, etc.
- d. Computer clusters and must be wired accordingly.

### II. For offices

- a. The general rule is to install a minimum of one data/voice outlet for each occupant of an office. In cases where modular furniture is used, one data/voice outlet per workspace.
- b. Install (1) CATV outlet per lounge, kitchen/dining area, etc.

III. Note that even if the occupant does not want a data/voice outlet, a minimum number of 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.

### IV. 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

B. The standard 'horizontal drop' for new outlets shall consist of the following:

- I. 1" EMT conduit in wall cavity
- II. 4-11/16" X 2-1/8" deep junction box with 2-gang plaster ring
- III. Exceptions:

C. Wall phones (1-gang with 3/4" EMT)

D. Rental spaces (ask Cable Plant Office)

E. Outlets installed in existing walls

F. Fiber horizontal outlets (surface mount over 1- or 2-gang opening)

G. Floor Boxes

- I. Telecommunications outlets may only be installed in the following recessed devices:

i.i.i. Round poke-through boxes

i.i.ii. [Wiremold Evolution series \(example: #6ATCPBK\)](#)

b. Square, in-concrete type

i. [T&B # 668-S](#) or equivalent

c. Firestop cables entering floorbox (removable)

#### 4.1.5. **Wireless Access Points---** All University Buildings are also served with Wireless Data, and adequate provisions for such service as noted:

- A. Locations for Access Points for 802.11 Wireless LAN service are determined in the planning phase. This is relevant for all new campus buildings, major renovations and for smaller campus, building renovations whose wireless infrastructure will require redesign.
- B. Designs shall provide for a minimum of one Access Point for 1500 square feet of interior space, rounded up to the nearest whole number (subject to change during review by CMU Network Operations).
- C. Each AP location will have two Cat6 data outlets installed. The AP's will receive their power over the data cables (aka: PoE) therefore no 120 VAC power is needed.
- D. The communications contractor shall install the AP brackets (supplied by CMU Network Svcs, contact Randy Monroe (Manager of Network Operations-CMU Computing Svcs) at [monroe@andrew.cmu.edu](mailto:monroe@andrew.cmu.edu)

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- E. The exact height and location will be determined by CMU Network Operations.
  - I. Send pdf floorplan of project to Randy Monroe (Manager of Network Operations-CMU Computing Svcs) at [monroe@andrew.cmu.edu](mailto:monroe@andrew.cmu.edu)

### 4.1.6. Point-to-point links

- A. Some campus users have the need for direct, point-to-point cabling links between rooms. This cabling can share current pathways only if the following conditions are met:
  - I. These cables **are not** to be used to extend regular services from existing outlets (in such cases, new outlet(s) should be installed)
  - II. Cables must be our specified brand(s) (Systemax™ for copper UTP) and have a black jacket color
  - III. Cables must be installed in a manner according to our regular standard and be installed by one of our Cable Plant Office approved cabling contractors
  - IV. Cables must terminate in a separate faceplate from regular voice/data cables
  - V. Cable Plant 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

- VI. Cables must be tested according to the "Testing" section in this document
- B. A wide variety of services can be run over Cat6 UTP cable including video, sound, CaTV, S-video, high def video, etc., and adhering to our recommendations will help to ensure the following:
  - I. Interference and cross-talk onto current voice/data cabling will be limited
  - II. Cables can be tested, verified and results stored in our current database
  - III. Cables can be given addresses and documented on our AutoCAD & Archibus drawings
- C. Fiber point-to-point links **shall not be** zip cord (see "[Fiber Cables](#)")

### 4.1.7. Pathways

- A. Above suspended ceiling
  - I. Office: J-hooks
  - II. Corridor: basket tray
- B. Visible, in corridor
  - I. Priority given to aesthetics ([Chalfant Series 6](#))
- C. Data Center or equipment room
  - I. [CPI universal tray](#)
  - II. [Panduit FiberRunner](#)
- D. Communications cabling pathways must avoid elevator shafts and elevator machine rooms
  - I. For applications directly related to elevator operation (such as elevator phones), contact CMU FMS for written approval (send email request to Don Coffelt at [dcoffelt@andrew.cmu.edu](mailto:dcoffelt@andrew.cmu.edu)).

### 4.1.8. 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

- A. See NEC Art. 800.25 and similar sections

### 4.1.9. Asbestos

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- A. For asbestos information, see: <http://www.cmu.edu/ehs/facilities-construction/asbestos-management-program.html>

### 4.2. Materials

#### 4.2.1. Cables

- A. Copper UTP horizontal links: Plenum, Panduit® certified warranted system
- B. Fiber Optic: Plenum, Corning certified warranted system (see "[Fiber Optic Cable](#)" section)
- C. CaTV horizontal drops: [CommScope® #2227V](#) plenum RG-6 cable with [T&B #SNS1P6U](#) connectors on both ends
- D. No cable shall be painted

#### 4.2.2. Outlets

- A. Yokes (106-style frames)
  - I. Panduit # CF1062EIY ([Duplex Yoke](#))
  - II. [Blank inserts](#), to match yoke color
- B. Surface Raceway
  - I. Surface raceway containing wiring of more than 90V potential must separate that wiring from communications wiring using a grounded metallic barrier (if raceway is metallic) (Wiremold specified or equivalent).
    - a. Dual Chamber metallic raceway, [Wiremold P/N: 4000B base](#)
      - i. 4000D, divider sections; 4000C cover plate; 4047B device mounting straps and duplex receptacle device plate; V4048R device plate
      - ii. For CATV, use #4047XX or #4007C-1 with 1-gang stainless wallplate.
        - ii.i. Use female bulkhead F-connector with nuts and lock washers both sides.
    - b. Dual Chamber plastic raceway, Wiremold P/N: V5000B,
      - i. 5000C cover; 5007C-1 device plate; 5007C-1A; 5507D, face plate
- C. CaTV
  - I. F-type F/F bulkhead installed in a stainless (must be metal) blank wallplate secured with nuts and lock washers on front and back of wallplate
    - a. Toner P/N: WP-81-SS Metallic or equivalent
- D. Fiber work area outlets (see "[Fiber Optic Cable](#)" section)

#### 4.2.3. Ladder and Basket Tray

- A. Size for maximum of 40% fill along entire length
- B. FLEXTRAY Basket Tray or equivalent
- C. Basket tray to be sized based on the number of cable being supported with a maximum 40% fill factor for future installs.
- D. Basket tray can be used as a vertical raceway.
- E. 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.
- F. Cable drop-outs must be used where cable exits tray down.
- G. Minimum of 2" depth for basket tray

#### 4.2.4. Communications Room Hardware

- A. Rack systems and hardware: Panduit™
- B. Fiber Optic Panels
  - I. Shall be Corning #PCH
  - II. SC housing adapters (bulkheads) shall be installed in the connector plates with their key slots facing up.
- C. Communications backboard
  - I. All communications backboards shall be 3/4" plywood, AC grade.
  - II. Backboard shall be painted off-white with fire retardant paint on all sides and edges—DON'T PAINT CERTIFICATION STAMP!

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- III. Backboard shall be mounted with the "C" side against the wall.
- D. D-rings
  - I. 2" metal 'D' ring. Allentel P/N GB13A, CPI or equivalent.
  - II. 3" metal 'D' ring. Allentel P/N GB13B, CPI or equivalent.
  - III. 5" metal 'D' ring. Allentel P/N GB13C, CPI or equivalent.

### 4.2.5. Fire-stopping

- A. Removable fire-stopping shall be used at all locations required by local codes
  - I. Pillows:
    - a. SpecSeal Product P/N: SSB26: 9" lengths or equivalent
  - II. Cable Tray through Wall Penetrations:
    - a. Pensil Series P/N: PEN 200 Foam or equivalent
  - III. Putty:
    - a. SpecSeal Series P/N: SSP Putty or equivalent

### 4.2.6. Miscellaneous

- A. J-hooks
  - I. Minimum size 1-5/8" (Erico "Caddy" P/N: CAT21 or equivalent)

### 4.2.7. Substitutions

- A. 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

## 4.3. Procedure

### 4.3.1. Removing outlets/cables

- A. Contractor must get email approval from Cable Plant Office to remove cable prior to any disconnection/cutting

### 4.3.2. Cable installation

- A. Observe manufacturers' installation guidelines including limits on pulling force & bend radius
  - I. Breakaway swivels with having not more than 200 lb breaking strength must be used for pulling [fiber optic cable](#).

### B. Routing & Support

- I. Do not obscure access to access doors, hatches, air dampers, valves, cable trays, junction boxes, pull-boxes conduit entries or similar areas of access.
- II. 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).
- III. J-hooks, minimum 1-5/8" width shall be used as a raceway from basket tray to workstation where applicable, and staggered to avoid an antenna affect (see 2.10.6)
- IV. 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			
Minimum Separation Distance			
Condition	<2KV	2-5KV	>5KV

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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.

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

### 4.3.3. Termination

- A. UTP
  - I. As per manufacturer's instructions (as part of a warranted system)
- B. CaTV
  - I. only use [CommScope® #2227V](#) plenum RG-6 cable
  - II. for connectors, use [T&B #SNS1P6U](#) (with **RED** plastic collar)
  - III. for cable stripping and connector installation, use T&B #CST596711(stripping), T&B snap-n-seal tool #SNSUTL
    - a. Alternatively use the T&B all-in-one tool #IT1000
- C. Fiber Optic Cable
  - I. Use factory terminated/polished pigtails or complete pre-term solution (as part of Corning warranted system)

### 4.3.4. Labeling

- A. Cable ID tags shall be provided by the Cable Plant Manager.
- B. Contractor shall verify patch panel ports for cabling and notify Cable Plant Office a minimum of (3) days before labels are needed.
- C. Labels shall be placed at the following (4) locations:
  - I. Faceplate
    - a. Place above the top jack in the 106-style frame and below the bottom jack
  - II. 7" from **each end** of each cable
  - III. Patch panel port

4.3.5. Testing

- A. It is the contractor’s responsibility to train their personnel on the use of the Fluke Networks® testing equipment according to instructions for the testing equipment.
- B. Copper UTP Horizontal Links
  - I. All cables being terminated or re-terminated must be tested.
  - II. All cables/outlets shall be tested with CMU’s or the contractor’s Fluke DTX-1800 copper tester (owned or rented). CMU’s tester may or may not be available for use.
  - III. Save failed results until problem is fixed. Failed tests in the tester can then be overwritten with the passing tests.
  - IV. With the RFQ submittal, the contractor will list the serial numbers of their main unit, their remote unit, and the calibration date (must be current (< 1 year) when testing this project’s cables)
  - V. The tester shall be set up to include the following:
    - a. Test Limit = appropriate ISO Permanent Link certification autotest (“ISO11801 PL max Class E” for Cat6 cable)
    - b. Record full test with graph
    - c. Record contractor’s name and operator’s name
    - d. Record date/time of test
    - e. Use manufacturer’s published NVP for the cables under test (choose manufacturer’s exact cable if listed in tester)
    - f. 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	R13-327-06
R13@01-BA001	

- VI. All cables must ‘Pass’ the certification testing before acceptance
- VII. Test shall be submitted, as projects/telecommunications rooms are completed, to CMU’s Cable Plant Office via email, by dropping-off the memory card, or by scheduling a direct download at our office (no paper copies)
- C. Optical Fiber
  - I. Contractor must clean every fiber port/end-face before every mating of fiber connectors including tester patch cords and launch cables
    - a. Contractor must supply and use Fluke Networks® cleaning kit # [FT525](#) according to manufacturer’s instructions.
  - II. 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:
  - III. The tester shall be set up to include the following:
    - a. The official CMU strand name
      - i. Testing names can be pre-loaded into tester by CMU
    - b. Record full tests with plots
    - c. Record of contractor’s name and operator’s name
    - d. Record of date/time of test
    - e. Use cable manufacturer’s published NVP for the cables under test
    - f. OTDR Autotest:
      - i. Two launch cables (one on each end of strand under test) with compensation

- i.i. If CMU's launch cables are not available, contractor must provide.
- ii. Dual-wavelength setting
- iii. Uni-directional with main unit in Building Entrance Facility
- g. Power Meter:
  - i. Use smart remote
  - ii. Set for correct connector type and number of adapters & splices
  - iii. "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 endfaces with any failing results (using OTDR's camera)
- II. Additional info:
  - a. "[Fiber Testing](#)" (Fluke Networks)
  - b. [Fluke OptiFiber® demo](#)

#### 4.3.6. Grounding

- A. Racks and Cabinets
  - I. 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)
    - a. Install both strips on the front (equipment mounting side) of rack with the horizontal bar on top of the vertical bar

## 5. OUTSIDE PLANT

### 5.1. Design Criteria

#### 5.1.1. Underground Pathways

- A. Digging, trenching or direct burial activity at any depth requires advance permission from Facilities Management Services (FMS) (send email request to Don Coffelt at [dcoffelt@andrew.cmu.edu](mailto:dcoffelt@andrew.cmu.edu)).
  - I. FMS may also require a PA One Call review.
- B. Underground inter-building pathways shall be rigid PVC schedule-40 conduit, 4" minimum trade size and encased in concrete.
  - I. Underground communications conduits shall be completely encased with a minimum of 4" of non-air-entrained, 5000 psi wet mix concrete.
    - a. Use Carlon® conduit spacers in accordance with manufacturer's instructions (see [Carlon® spacers online pdf](#))
  - II. Conduits and concrete shall be entirely below the local frost line
  - III. Contractor shall use red powder concrete die to color surface of the wet concrete
  - IV. "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.
    - a. For trenches wider than 2', install additional runs of caution tape (one run for each 24" of width).
  - V. Contractor shall provide (via email) digital photos showing the underground conduit run both before and after concrete pour.
- C. A minimum of two (2) conduits shall be provided. At least one conduit shall be left empty for future use.
- D. Each conduit in use shall have a quantity of three (3) MaxCell® 3-cell Red Thread inner-duct (Part number MXC-3456- RD) installed, or equivalent.
- E. Minimum burial depth of each conduit shall be in accordance with local ordinances and NEC Table 300.5.
- F. In utility tunnels and similar spaces, cable ladders or the equivalent shall be used to secure all cabling, inner-duct, etc. Product Number: Multi-Mount Cable

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Support Arm, Arm support # MM18, Arm # MM14. Made and manufactured by "Underground Devices, INC." or equivalent.

- G. Unused conduits for future use shall have a durable pull rope tied-off to a trade-size sealing device.

### 5.1.2. Enclosures

- A. Consult with CMU Cable Plant Office for design requirements

### 5.1.3. Building and Manhole Entry/Exit

- A. Lightning Protection
  - I. Appropriate lightning protection must be used on all metallic conductors of communications cabling entering a building.
    - a. Must be installed according to: local codes, recommendations of the cabling manufacturer and the manufacturer of the lightning protection device—whichever is more stringent.
    - b. Must be grounded properly
- B. 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)
  - I. Holes through concrete must be smooth, round, and perpendicular (90 degrees) to the wall surface (vertically and horizontally).
  - II. Conduit within concrete holes must be straight and concentric—this excludes the oblong part of elbows and offsets.
- C. The following modular/mechanical sealing product must be used (according to the manufacturer's directions):
  - I. Link-Seal® ([Link-Seal® webpage](#))
  - II. See product ordering/instructions ([Link-Seal® product info webpage](#))
    - a. The following is an example for our typical entry:
      - i. 4" PVC conduit = 4.5" O.D. = 6" core hole = qty of 10 links of #CS-300-C
  - III. 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.
    - a. Submit digital photographs of all completed Link-Seal® installations via email.
- D. Abandoned penetrations must be hydraulically sealed.
- E. Abandoned and unused conduits shall have fittings installed to prevent the entry of water and/or gases.

## 5.2. Products

### 5.2.1. Cables

- A. Fiber
  - I. Glass
    - a. Singlemode
      - i. Corning fiber code "E"
    - b. No multimode necessary between buildings
  - II. Jacketing
    - a. 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.
  - III. 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.
- B. MTP (multiple twisted pair)

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- I. Outdoor type terminated on lightning protection devices at each building entrance
- II. Underground Cable (Voice Backbone)
  - a. 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.
- III. Transition Cable
  - a. Plenum CMP rated interior riser cable shall be Category 3 multiple pair 24 AWG solid annealed copper with a corrugated aluminum shield.
- C. CaTV Coax (for existing installations only)
  - I. New Installations
    - a. No coaxial cable is to be included on new installations. CATV shall use the last two strands of the singlemode fiber backbone.
  - II. Damage to existing cable
    - a. In the case of damage to existing coax backbone cable, CMU Cable Plant Office reserves the right to have it replaced with fiber optic cable
  - III. Existing installations and retro-fit
    - a. Underground:
      - i. 1/2" semi-flexible coaxial cable, jacketed, flooded
        - i.i. [Commscope# P3-500-JCASS](#)
        - i.ii. [Times Fiber# T10500JB](#)
    - b. Aerial:
      - i. 1/2" semi-flexible coaxial cable, jacketed
        - i.i. [CommScope# P3 500 JCAM109 \(w/ messenger\)](#)
        - i.ii. [Times Fiber# T10500J](#)
    - c. Connectors
      - i. 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.
  - IV. Splitter Specifications
    - a. 16-way
      - i. 1 GHz bandwidth wall mount 16-way splitter/tap [Toner P/N: XGVS-16](#) or approved equivalent
    - b. 8-way
      - i. 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 CableTV group prior to build)

### 5.2.2. Conduit (See "Underground Pathways" above)

### 5.2.3. Enclosures

### 5.2.4. Splices

- A. The splice case shall be flame retardant.
- B. The splice case shall be capable of either straight inline or butt splices option.
- C. Splice cases shall be sized as appropriate (but no larger) for the size of the spliced cable.
  - I. K&B Building Riser Closure, 3M or equal.
- D. The Contractor must have the appropriate 3M splicing tool for splicing 4000 series modules. No substitutions shall be allowed.
- E. 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.

- F. Test entry ports on the front side of each module shall allow for individual testing of individual pairs
- G. Modules shall be filled with a flooding compound.

**5.2.5. Miscellaneous**

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

**5.3. Procedure**

**5.3.1. Cable installation**

- A. Inspect all conduit bends to verify proper radius. Comply with NEC Section 346-10 for minimum permissible radius and maximum permissible deformation.
- B. Apply a chemically inert lubricant to all cable prior to pulling in conduit.
- C. 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.
- D. 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.
- E. Cable loops and bends shall not have a radius less than that recommended by the manufacturer.
- F. All shielded cable shall be insulated. Do not permit shields to contact conduit, raceway, boxes, panels or equipment enclosures.
- G. All cable shall be continuous and splice free for the entire length of the run between designated connections or terminations unless otherwise specified.
- H. Do not obscure access to access doors, hatches, air dampers, valves, cable trays, junction boxes, pull-boxes conduit entries or similar areas of access.
- I. 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).

**5.3.2. Termination and splicing**

- A. At designated splices, maintain conductor, strand and binder color code across all splices.
- B. Within buildings, make splices only in designated cable trays, terminal cabinets, on designated equipment backboards or where specifically shown on plans.
- C. (see "[Fiber Optic Cable](#)" section)

**5.3.3. Labeling**

- A. Provide labeling from information supplied by the Cable Plant Office

**5.3.4. Testing (see "[Testing](#)" section above)**

**5.3.5. Grounding**

- A. IEEE C62.41 CAT C for lightning strikes
- B. ANSI/IEEE C62.41-1991, 1996; Cascaded Protection
- C. NFPA 780 Compliant System
- D. Article 250 NEC and related articles
- E. Antennas and Masts
  - I. NEC Art. 810
  - II. NFPA 780

**6. Fiber Optic Cable**

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

- 6.1.1. Indoor/outdoor, plenum, tight-buffered:  
[http://catalog2.corning.com/CorningCableSystems/media/NAFTA/Spec\\_Sheet/LAN-492-EN.pdf](http://catalog2.corning.com/CorningCableSystems/media/NAFTA/Spec_Sheet/LAN-492-EN.pdf)
  - A. Singlemode only unless Cable Plant Office also requests 50uM LOMMF

**6.2. Backbone fiber within a building**

- 6.2.1. Indoor, plenum, tight-buffered, armored:  
[http://catalog2.corning.com/CorningCableSystems/media/NAFTA/Spec\\_Sheet/LAN-124-EN.pdf](http://catalog2.corning.com/CorningCableSystems/media/NAFTA/Spec_Sheet/LAN-124-EN.pdf)
- 6.2.2. Non-innerduct option: equivalent armored, hybrid (SM + 50uM LOMMF) version of above cable.

**6.3. Horizontal Fiber and/or point-to-point fiber (to be routed in a manner similar to Cat5e)**

- 6.3.1. No innerduct required
- 6.3.2. [http://catalog2.corning.com/CorningCableSystems/media/NAFTA/Spec\\_Sheet/LAN-88-EN.pdf](http://catalog2.corning.com/CorningCableSystems/media/NAFTA/Spec_Sheet/LAN-88-EN.pdf)
- 6.3.3. Or equivalent Hybrid version of above cable.
- 6.3.4. Use armored plenum version of for critical systems
- 6.3.5. For outlet, use [Corning #WMO \(marked-up cutsheet\)](#)

**6.4. Termination and Splicing**

- 6.4.1. All fiber shall be factory terminated or fusion spliced onto factory terminated and polished pigtails.
- 6.4.2. 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.
- 6.4.3. Indoor location of terminations and splices
  - A. Terminating and splicing shall occur in vendor approved enclosures in racks or at the horizontal outlets.
- 6.4.4. Outdoor location of terminations and splices
  - A. Shall occur in vendor approved weather-proof enclosures in manholes, on utility poles, or on building exteriors.

**7. Common hardware and materials**

- 7.1. See the following table for common Panduit® items:

**Panduit Part Numbers  
for CMU**

Panduit Item	Purpose	Part #	Hyperlink
Cat6 Jack (black)	Data outlet	CJ688TGBL	<a href="#">Cat6 Jack (black)</a>
Cat6 Jack (ivory)	Voice outlet	CJ688TGEI	<a href="#">Cat6 Jack (ivory)</a>
Cat6 Jack (gray)	Point-to-point links	CJ688TGIG	<a href="#">Cat6 Jack (gray)</a>
Duplex Yoke	To mount jacks in electrical style faceplates	CF1062EIY	<a href="#">Duplex Yoke</a>
Blank Inserts	To close port openings for future outlets	CMBEI-X	<a href="#">Blank Inserts</a>
Angled Modular Patch Panel	Installed in cabling racks in TRs	CPPA24FMWBLY	<a href="#">Angled Modular Patch Panel</a>
Cat6 Plenum Cable (blue)	Data outlet	PUP6004BU-UY	<a href="#">Cat6 Plenum Cable (blue)</a>
Cat6 Plenum Cable (white)	Voice outlet	PUP6004WH-UY	<a href="#">Cat6 Plenum Cable (white)</a>
Cat6 Plenum Cable (gray)	Point-to-point links	PUP6004IG-UY	<a href="#">Cat6 Plenum Cable (gray)</a>
Cat6 Retrofit Jack (black)	Use in existing labeled Systemax faceplates/yokes	CJA688TGBL	-----
Cat6 Retrofit Jack (ivory)	Use in existing labeled Systemax faceplates/yokes	CJA688TGEI	-----
Wall Phone Plate	For wall phones	KWPY	<a href="#">Wall Phone Plate</a>
Wall Phone Jack (Keystone)	For wall phones using Cat6 cable (VoIP & PoE)	KJ688TPEI	-----
Vert. Wire Mngmnt Loop	For angled panel use without proper vertical management (temporary)	CMVDR1S (32 cbls) CMVDR1 (96 cbls)	<a href="#">CMVDR1S</a> (32 cbls) <a href="#">CMVDR1</a> (96 cbls)

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- 7.2. See the "[CMU Cable Plant common materials](#)" list for information and hyperlinks to product web pages.
- 7.2.1. No substitutions shall be made without written approval via email.
  - 7.2.2. This list may be updated periodically and is binding at the time RFQ's or bids are submitted.

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