

## **DIVISION 27 – COMMUNICATIONS**

### **27 00 00 COMMUNICATIONS**

#### **Design Process**

Telecommunications systems include vertical and horizontal copper and fiber optic wiring as well as the associated termination hardware on both ends. The system includes pathways and conduits; equipment racks; frames; wire management systems; communication rooms; and the electrical, mechanical, and environmental equipment required to support them.

Pricing for voice and data projects that are released for bid should be broken out separately from security, audiovisual, building control and other low voltage systems.

These specifications are intended to allow the Office of Information Technology (OIT) to meet the telecommunications requirements of the University over the lifetime of the buildings. OIT shall be consulted and included in meetings with the University of Minnesota Project Manager, architects, and/or consultants and electrical designers prior to and at each stage of the project (i.e., Schematic Design (SD) and Design Development (DD)) to ensure that present and future voice and data service requirements can be met.

Projects must use the products specified by these standards. To that end, any project requesting a non-standard installation of cabling infrastructure, voice/data jacks, or other items not specified in these standards shall submit a written explanation of the requested variance to OIT for review (send request to [NTSprojects@umn.edu](mailto:NTSprojects@umn.edu)). OIT **MUST** provide prior written approval for any deviations from these standards. If an exception was not requested and approved by OIT, the vendor will be responsible for the cost of replacing the unapproved product.

CPPM, Facilities Management and U of M Construction Project Managers should be the first line to enforce the standards on contractors. These departments are managing projects for the benefit of the University and shall ensure that all bidders for the work are following the same standards and requirements. OIT will provide guidance and investigative effort to help ensure standards are followed and will provide evidence of issues needing enforcement.

The standards herein apply to the technologies in use at the time of the latest update to this document. The implementation of newer technologies shall require adherence to the standards written at the time of that implementation. Contact OIT at the beginning of the project process to verify that the project conforms to the latest version of these standards.

Construction specifications are a vital component of an Information Technology system. Information Technology systems shall adhere to these standards in order to be functional in a wide variety of communications applications. Materials and work specified herein shall comply with the applicable requirements of:

- National Electrical Code (NEC-2023)
- Uniform Building Code (UBC)
- Uniform Fire Code (UFC)
- Minnesota State Power Limited Laws
- Federal Communications Commission (FCC)
- Building Industry Consulting Services International (BICSI)
- TIA, EIA, TIA/EIA

- ANSI, CABO/ANSI, ANSI/NFPA
- IEEE
- BICSI TDMM
- NFPA

- NEMA
- ISO/IEC
- TIA TSB~88 Bulletin
- OSHA

**\*\* RENOVATIONS\*\***

All new buildings and major renovations require the installation of the OIT specified Category 6A cabling. Renovations are unique and will be looked at on a case-by-case basis by OIT. Design for new construction will differ from design for retrofit of existing facilities. When an area of a building is undergoing renovation the standards in their entirety must be followed. The following renovation standards shall be followed, or exceptions shall be drafted to the contrary:

- ❖ The renovation shall install the same brand (manufacturer) of jacks that are currently installed in the building. Project shall also use same brand of jacks on both ends of the cable (example: Panduit, Commscope, Leviton).
- ❖ The renovation shall install the same color of horizontal cabling that is currently installed in the building.
- ❖ All renovations shall include full wireless coverage for the area being renovated. OIT will provide the wireless design for all projects and renovations.. The cost of installing the wireless shall be covered by the project.
- ❖ The project manager needs to ask for an exception if the work deviates from the standards.
- ❖ In situations where there is more than one (1) IDF in which horizontal cable could be run to, OIT will make the final determination on which IDF to use.
- ❖ Any project where room numbers change, the project is responsible for correcting the jack ID to match room number changes.
- ❖ OIT will determine the number of network switches to provide service for any project.
- ❖ Per the NEC, abandoned horizontal cabling for voice and data shall be removed at the project's expense.
- ❖ If an exception is not asked for in the design phase, or the final end product is not what was designed/agreed upon, OIT reserves the right to not activate service until the violation is corrected.

**27 01 00 Operation and Maintenance of Communications Systems**

**27 05 00 Common Work Results for Communications**

**27 05 13 Communications Services**

Telecommunications rooms are special-purpose rooms that have specific requirements due to the nature, size, and complexity of the equipment and wiring housed in these rooms. There are two types of telecommunications rooms, each supporting critical functions as part of the building wiring and telecommunications systems. The two types of rooms are:

**Main Distribution Frame (MDF)**

The main equipment room is the main room in a building into which all outside facilities are routed and terminate. This room serves as the primary telecommunications room and entrance facility. All other communications rooms (IDF's) within the building are fed with backbone cables from the MDF.

**Intermediate Distribution Frame (IDF)**

An IDF is an enclosed and secured space specifically intended for housing telecommunications cables, termination hardware, cross-connect facilities, and equipment for voice and data facilities.

The following standards apply to all telecommunications rooms:

- ❖ **PROHIBITED:** Using telecommunications rooms as a route for other facilities to pass through.
- ❖ **PROHIBITED:** Using boiler rooms, air exchange rooms, janitorial closets, electrical distribution closets, or areas with water heaters and wet sinks for communications. Telecommunication rooms shall be dedicated solely to OIT telecommunications.
- ❖ **PROHIBITED:** Placing telecommunication rooms in or near areas of high electromagnetic interference (EMI) or radio frequency interference (RFI). Both adversely affect the system performance and the reliability of electronic equipment.
- ❖ **PROHIBITED:** Non-OIT resources shall not be located in telecommunications rooms.
- ❖ MDF and IDF room dimensions are to be measured from the final dimensions. This means the room dimensions after the drywall and 3/4" plywood is installed.
- ❖ **The MDF/IDF must be in its finished stage before any copper or fiber cables are terminated, or before any data switches are installed. This means rooms are free of dust and debris, painting is completed, and floors are treated. The contractor is responsible for dust, debris, and moisture. After switches are installed, the door must be kept closed and always locked.**
- ❖ Communications rooms shall be directly accessible from the hallway.
- ❖ Fire suppression systems for all these rooms shall be two-stage water systems; no Halon or gas systems shall be used. Pipes shall be insulated to prevent condensate formation. Fire suppression system pipes shall not be installed directly over equipment, but rather they shall be placed near the walls with the manifold pipes in ceiling corners.
- ❖ All MDF and IDF rooms shall be secured with an electronic proximity card key access reader approved by University of Minnesota Access Services and OIT.

- ❖ All walls shall be lined with 8-foot high by 4-foot wide by 3/4-inch thick, unpainted, fire-retardant, CD grade or better plywood backboard, mounted with the smooth side out starting at 4" above the finished floor (AFF).
- ❖ No mechanical/electrical equipment or conduits shall be installed on or across the plywood or impair the routing of cable trays or telecommunications cabling.
- ❖ No water or sewage pipes shall pass through a telecommunications room.
- ❖ OIT shall perform all cross connects and circuit activations in all telecommunications rooms, including MDF and IDF rooms. This includes all associated voice and data hardware and equipment.
- ❖ All floor penetrations shall be sleeved to a height of 2-3" (AFF).
- ❖ Cooling systems installed in MDF/IDF must be installed in a manner that does not impact OIT equipment or the use of the space. Cooling systems shall not be installed above telecommunications racks or equipment.

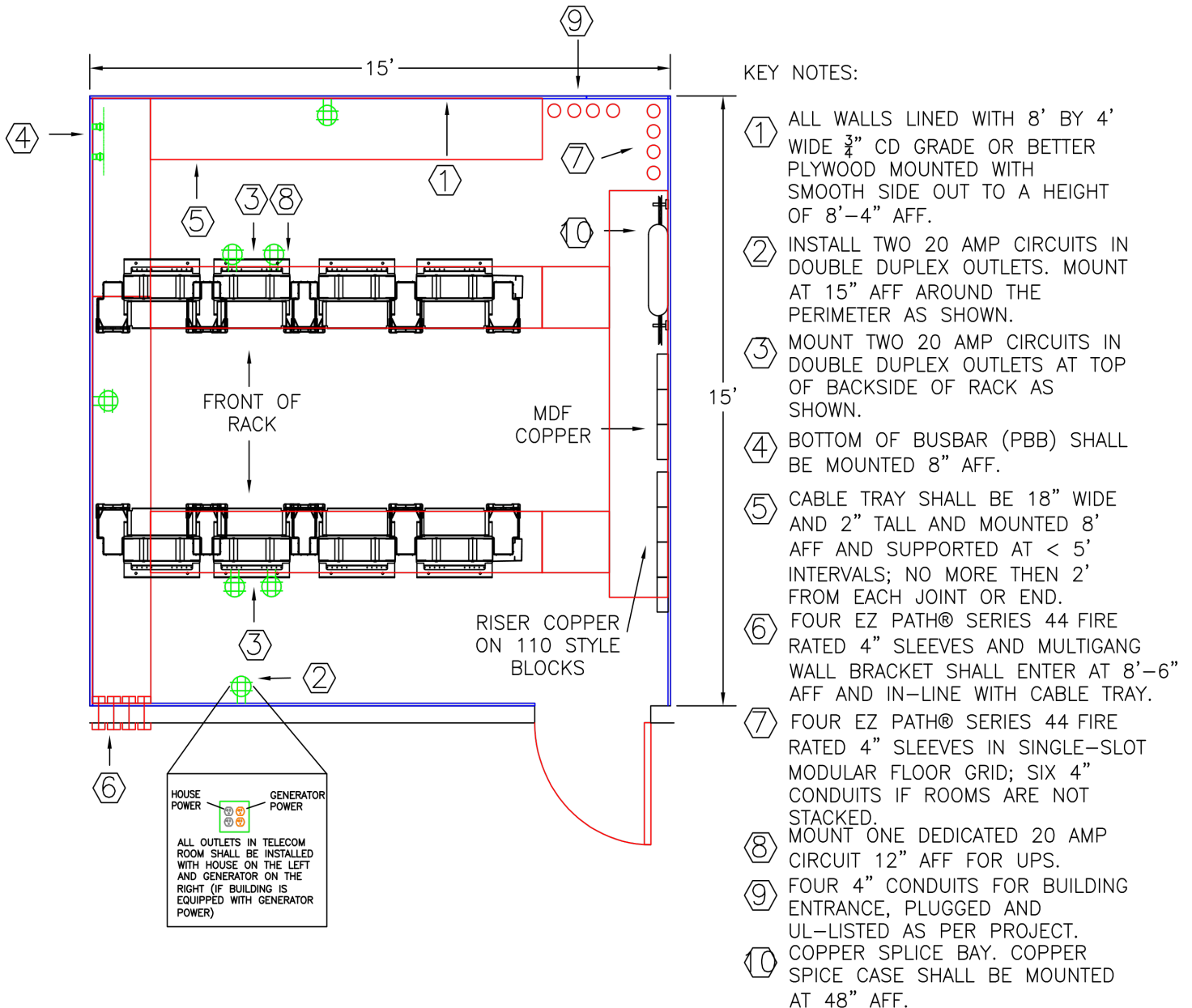
### **Electrical Power Requirements**

Power to telecommunications rooms shall be installed using dedicated circuits to these areas. UPS system equipment shall be incorporated only if identified and budgeted in the project in consultation with OIT during the design phase of the project.

### **Main Equipment Room (MDF)**

#### **Introduction**

- ❖ Main equipment facilities shall be installed in a separate and secure room. The main equipment room shall serve as the primary copper and fiber-optic cable distribution center for the building. All voice and data distribution shall emanate from this room.
- ❖ The MDF shall be square in shape. Triangle, L-shaped, and curved walls are not acceptable.
- ❖ The minimum size for a MDF is 15 feet by 15 feet.
- ❖ The MDF shall be environmentally controlled by HVAC 24 hours a day, seven days a week. The rooms shall maintain a positive pressure with a minimum of one complete air exchange per hour, and a minimum capacity of 12000 BTU/hr. **The temperature in a MDF must not exceed 78 degrees Fahrenheit.**
- ❖ Rooms shall be spaced so that no horizontal communications cabling run exceeds 90 meters.
- ❖ Because building requirements are unique, OIT will provide the project MDF rack layout drawings.
- ❖ See Figure A for MDF layout.



**Figure A: MDF Room**

## Intermediate Distribution Facility (IDF)

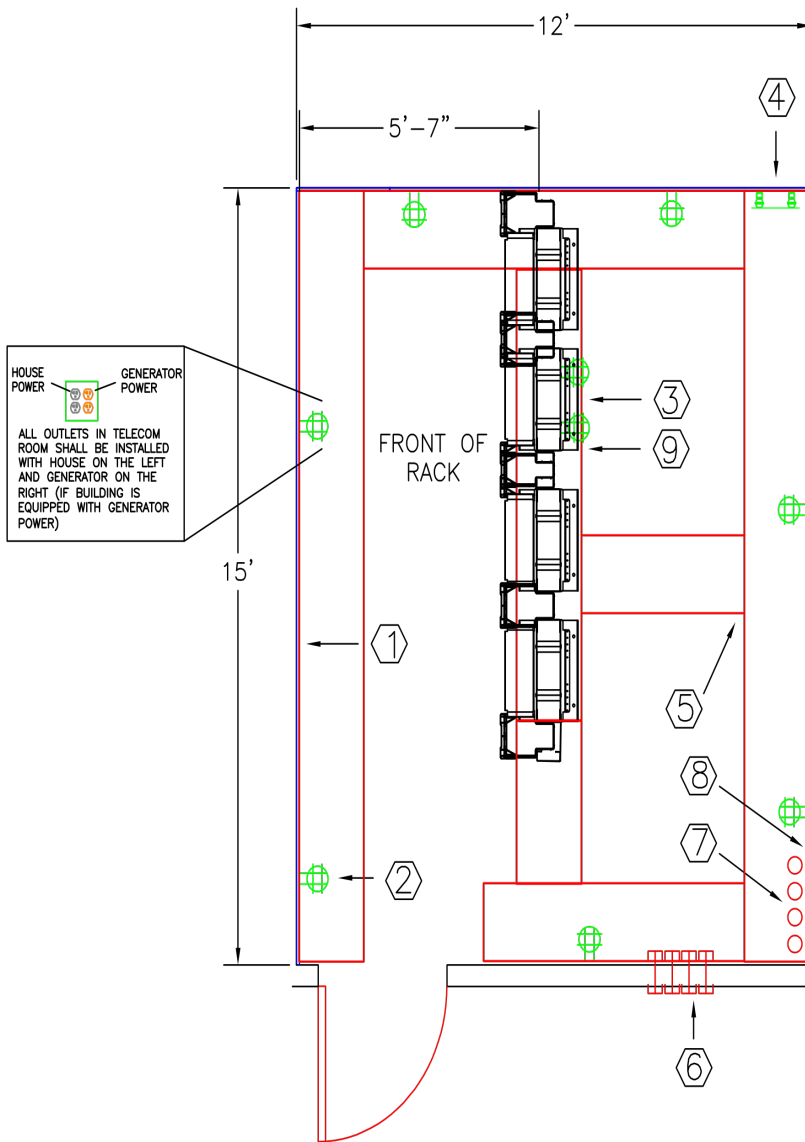
### Introduction

- ❖ The minimum size for a communications room is 12 feet by 15 feet.
- ❖ The IDF shall be rectangular in shape. Triangle, L-shaped, and curved walls are not acceptable. There shall be a minimum of one IDF per floor, vertically aligned with the other IDFs. See Figure C for IDF layout.
- ❖ Rooms shall be spaced so that no horizontal communications cabling run exceeds 90 meters.
- ❖ The IDF shall be environmentally controlled by HVAC 24 hours a day, seven days a week. The rooms shall maintain a positive pressure with a minimum of one complete air exchange per hour, and a minimum capacity of 12000 BTU/hr. **The temperature in an IDF must not exceed 78 degrees Fahrenheit.**
- ❖ Riser cables shall be distributed in one or more riser shafts enclosed in a series of vertically aligned closets beginning in the lowest level of the building and extending throughout the height of the building. These shafts shall be aligned vertically to facilitate cable pulling. IDFs and pathways are intended for exclusive use by OIT.
- ❖ IDFs shall be interconnected to each other by an EZ-Path modular Floor Grid System having four EZ-Path Series 44 pathways installed. If IDFs cannot be aligned vertically, six conduits of 4-inch size or 4-inch by 24-inch cable tray shall be placed between the IDFs for exclusive OIT use. These conduits and/or cable trays must also be fire-stopped with a UL-classified fire stop system. The sleeves/EZ-Paths shall be located at the left edge of the terminal board, as close to the wall as possible. Sleeves/EZ-Paths shall never be placed in the center of the terminal board.
- ❖ All conduits shall have a continuous 1250-pound tensile strength pull tape installed. Pull tape in each conduit shall be secured to prevent pullout. The pull tapes must be re-pulled each time an additional cable is installed.
- ❖ The last 12 rack units (RUs) of every telecomm rack shall be left open and not have any equipment or patch panels installed. The only exception to this rule is for the installation of UPSs, and grounding busbars.
- ❖ See Figure B for IDF room layout.
- ❖ See Figure C for IDF rack layout.

## Building Standards Division 27 Communications

KEY NOTES:

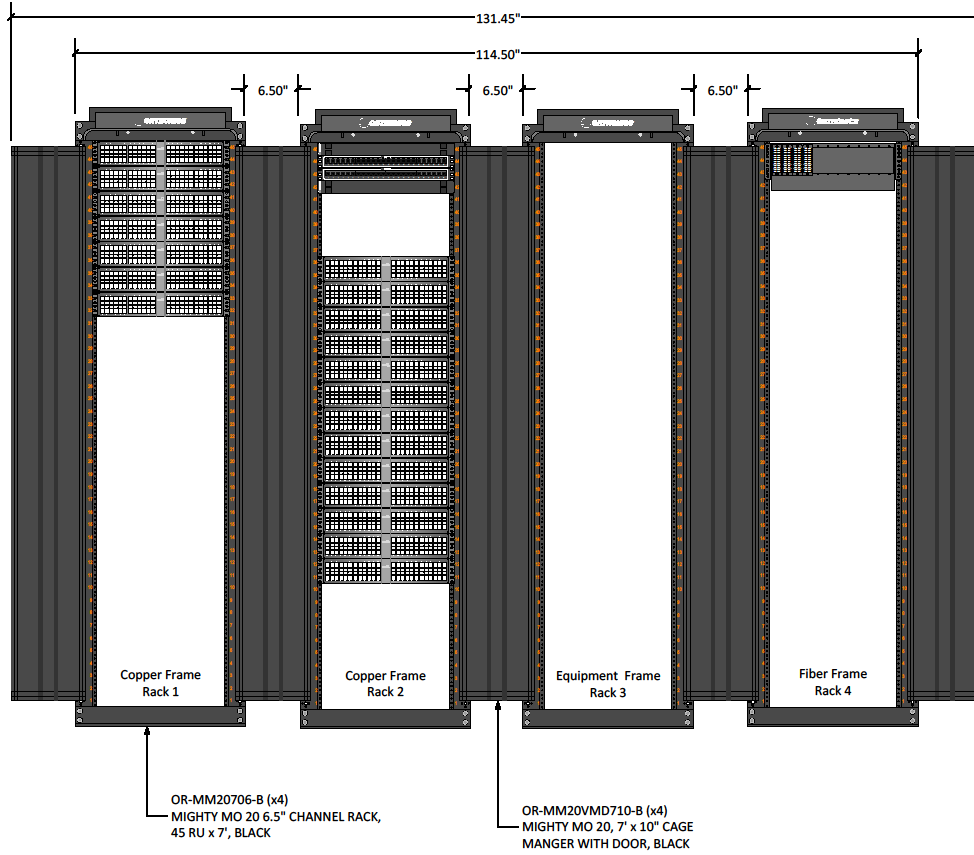
- ① ALL WALLS LINED WITH 8' BY 4' WIDE  $\frac{3}{4}$ " CD GRADE OR BETTER PLYWOOD MOUNTED WITH SMOOTH SIDE OUT TO A HEIGHT OF 8'-4" AFF.
- ② INSTALL TWO 20 AMP CIRCUITS IN DOUBLE DUPLEX OUTLETS. MOUNT AT 15" AFF AROUND THE PERIMETER AT 6' INTERVALS.
- ③ MOUNT TWO 20 AMP CIRCUITS IN DOUBLE DUPLEX OUTLETS AT TOP OF BACKSIDE OF RACK AS SHOWN.
- ④ BOTTOM OF BUSBAR (SBB) SHALL BE MOUNTED 8" AFF.
- ⑤ CABLE TRAY SHALL BE 18" WIDE AND 2" TALL AND MOUNTED 8' AFF AND SUPPORTED AT < 5' INTERVALS AND NO MORE THEN 2' FROM EACH JOINT OR END.
- ⑥ FOUR EZ PATH® SERIES 44 FIRE RATED 4" SLEEVES AND MULTIGANG WALL BRACKET SHALL ENTER AT 8'-6" AFF.
- ⑦ FOUR EZ PATH® SERIES 44 FIRE RATED 4" SLEEVES IN SINGLE-SLOT MODULAR FLOOR GRID; SIX 4" CONDUITS IF ROOMS ARE NOT STACKED.
- ⑧ 18" WIDE AND 2" TALL CABLE TRAY MOUNTED TO PLYWOOD. RISER CABLE SECURED TO TRAY AT 3' INTERVALS.
- ⑨ MOUNT ONE DEDICATED 20 AMP CIRCUIT AT 12" AFF FOR UPS.



**Figure B: IDF Room**

# Building Standards

## Division 27 Communications



NOTE:  
 NOT SHOWN IN VIEW -  
 OR-MM20EPN706-B (x1) END PANEL NARROW FOR ONE SIDE ONLY (To be mounted on left side of Rack #1)  
 OR-MM20EPS-B (x1) END PANEL SUPPORT BRACKET FOR ONE SIDE ONLY (To be mounted on left side of Rack #1)

RACK 1	RACK 2	RACK 3	RACK 4
Legrand Rack: MM 20, 6" Channel rack. OR- MM20706-B Legrand Vertical Manager: MM 20, 10"W Cage w/ door. OR-MM20VMD710-B Leviton Patch Panel: 49256-H48 Leviton Category 6A jacks: 6A10G-RO6	Legrand Rack: MM 20, 6" Channel rack. OR- MM20706-B Legrand Vertical Manager: MM 20, 10"W Cage w/ door. OR-MM20VMD710-B Leviton Horizontal Cable Management: 1 RU 491RU HFO Leviton Patch Panel: 49255 H24 Leviton Category SE Jacks: 5G108-RGS Leviton Patch Panel: 49256-H48 Leviton Category 6A Jacks: 6A10G-RO6	Legrand Rack: MM 20, 6" Channel rack. OR- MM20706-B Legrand Vertical Manager: MM 20, 10"W Cage w/ door. OR-MM20VMD710-B	Legrand Rack: MM 20, 6" Channel rack. OR- MM20706-B Legrand Vertical Manager: MM 20, 10"W Cage w/ door. OR-MM20VMD710-B Panduit Rack Mount Fiber Enclosure: FRME4 Panduit Fiber adaptor panel: FAP6WAGDSCZ



## Figure C: IDF Rack Layout

### 27 05 43 Underground Ducts and Raceways for Communications Systems

#### Entrance Facilities

The entrance facility is the location where the pathways for communications services penetrate the building to connect to the voice and data systems within the building. OIT shall designate the shortest practical route for the communications cable to connect from the building to the point of connection with the University telephone and network cabling systems. Conduit shall be installed within the facility from the point of entry to the Distribution Equipment Facility or MDF.

Diverse facilities entrances are dependent on building usage/requirements for all new buildings. If a diverse entrance is required, the installation shall include a minimum of two 4-inch conduits.

#### Underground Conduit

- ❖ Design of outside plant pathways will be coordinated with OIT. The location of a building will determine the design.
- ❖ The conduit requirements for entrance facilities are four 4-inch rigid steel conduits that extend from the property line (or steam tunnel) to a telecommunications main equipment room (MDF). Elbows shall be long-sweep rigid steel to prevent abrasion during cable installation.
- ❖ Conduits shall be installed at least 36" below grade.
- ❖ Securely fasten all building entrance conduits to the building to withstand movement during cable installation.
- ❖ All conduits entering a building must be sloped away from the building, with a minimum of 3-inch fall per 100 feet of conduit.
- ❖ Test all conduits after installation by pulling a full-size test mandrel through the conduit to verify that none are blocked or crushed.
- ❖ Watertight conduit sealing plugs shall be used to seal unused conduits.
- ❖ All conduits shall have a continuous 1250-pound tensile strength pull tape installed. Pull tape in each conduit shall be secured to prevent pullout. The pull tapes must be re-pulled each time an additional cable is installed.
- ❖ No conduit run shall extend more than 500 feet without a maintenance hole installed as a pull point.
- ❖ No section of conduit shall have more than 180° of bends without a maintenance hole installed as a pull point.
- ❖ **90-degree condulets (LB's) and electrical elbows are not acceptable in any OIT pathway.**

## Maintenance Holes

Standard pre-manufactured concrete maintenance hole with interior dimensions of 8' by 8' by 7' high shall be product of Oldcastle Precast®, Oldcastle Greenline® (Aircraft Vault), or prior approved equal. The maintenance hole shall include the following features:

1. Knockout slots with conduit terminators as required or pre-drilled holes for cable duct
2. Five-to-six-inch concrete wall thickness
3. Cable racking struts
4. Cable rack hooks (quantity of 48 in each maintenance hole, 7 ½" 32 each and 10" 16 each).
5. Vault ladder
6. 1-1/4" diameter ground rod sleeve located in corner of vault.
7. Vault frame and 32" steel cover (with "Fiber Optic" label). Maintenance hole cover bolt threads shall be compatible with 5/8" bolts supplied by OIT.
8. 12" diameter sump in center of vault floor (note: provide a minimum of 18" of pea-sized screened stones under the floor sump hole to facilitate better drainage).
9. 38" diameter access at top center of vault
10. A minimum of 4 pulling irons
11. Factory end bells shall be used where conduits penetrate maintenance hole walls.
12. Furnish and install an 8' galvanized stainless steel ground rod through the base of the maintenance hole in the ground rod sleeve in the corner of the maintenance hole (leave one foot of rod above floor of maintenance hole).

## 27 05 26 Grounding and Bonding for Communications Systems

### Bonding and Grounding

The grounding system shall be intentional, visually verifiable, and adequately sized to handle expected currents safely.

### Busbars

- ❖ Each telecommunications room in a building shall have a grounding busbar, installed in a lower corner of the plywood backboard at 8 inches above the finished floor.
- ❖ The MDF shall house the **Primary Bus Bar (PBB)**, and each other IDF shall house a **Secondary Busbar (SBB)**.
- ❖ Busbars shall be TIA 607 pattern, electrotin plated and predrilled to accept standard two-hole lugs. The PBB shall be a minimum of 20 inches long. The SBB shall be a minimum of 12 inches long. Currently approved busbars are Panduit GB4 series for the MDF and GB2 series for the IDF, or a substitute that has been approved by OIT through the exceptions request process.

### **Telecommunications Bonding Backbone**

- ❖ The telecommunications bonding backbone (TBB) shall be sized according to TIA 607 specifications, and the bend radius on any necessary bends on this cable shall be greater than 8 inches.
- ❖ Connections to the TBB at every floor except the top floor shall be made via copper compression H-TAP and a conductor no smaller than the TBB. On the top floor the connection shall be made with a two-hole lug.

### **Cables**

- ❖ Each metallic armored cable in a building shall be grounded at one end only via a bond attached to the cable armor. The bond shall be Electric Motion Company's EM 2BBx bond or a substitute that has been approved by OIT through the exceptions request process.
- ❖ ARMM riser cables shall be grounded and bonded in accordance with ANSI-J-STD-607-A.

### **Rack Grounding (Fiber Optic Building Entrance Cable)**

- ❖ The telecommunications rack that houses the fiber optic building entrance cable in the MDF shall have a grounding busbar installed on the back side in the bottom rack unit (RU) location. Busbars shall be predrilled to accept standard two-hole lugs and be Panduit part number RGRB19Y or a substitute that has been approved by OIT through the exceptions request process.

### **Pathway Grounding**

- ❖ Any metallic component, including equipment, ladder racks, enclosures, cable trays, etc., shall be bonded to the grounding system. Individual segments of ladder rack and basket tray must be bonded together to make them electrically continuous. All bonding and grounding components must be approved by the cable support system manufacturer. Any metallic conduit that carries a grounding conductor and is greater than 3 feet long shall have both ends bonded to the conductor with a bonding jumper no longer than 12 inches, fastened with a compression HTAP to the conductor on one side and to the conduit on the other.

### **Equipment Grounding**

- ❖ Some telecommunications equipment have specific grounding requirements, verify, and follow the grounding recommendations of the manufacturer.

### **Compression Fittings**

- ❖ Lugs and HTAPs shall be manufactured of tin-plated copper and fastened via irreversible compression (crimped). Lugs shall have spacing to fit Burndy (or a substitute that has been approved by OIT through the exceptions request process.) GB series predrilled busbars and a window to allow for inspection of the crimp. HTAPs shall be contained in clear covers that allow inspection of the die marks to ensure that the proper die was used.
- ❖ Approved lugs:
  - Burndy YAZ series
  - CPI
  - Electric Motion Company CCL Series
  - Or a substitute that has been approved by OIT through the exceptions request process.

- ❖ Approved HTAPS:
  - Burndy YH series (when used with clear covers)
  - Or a substitute that has been approved by OIT through the exceptions request process.

### Testing and documentation

The grounding system shall be documented with an As-Built one-line diagram in AutoCAD format and given to OIT.

To ensure that bonding connections from the busbar to infrastructure within the telecommunications spaces are of low resistance and that the impedance to ground is as low as possible, the following checks shall be performed:

- ❖ **Lugs:** Visually check that the conductor is visible in the window of the lug to ensure that it is fully inserted, and that the lug is properly crimped. Check that the lug is fastened through both mounting holes, that the connection is tight.
- ❖ **HTAPs:** Ensure that the mark left on the HTAP indicates that the appropriate manufacturer-recommended die was used for that HTAP, and that the connection is protected by a clear cover that allows visual inspection.
- ❖ **Racks:** Visually check that the racks have been assembled with paint-piercing washers or are constructed to make such measures unnecessary (i.e., welded).
- ❖ **Conduits:** If a bonding conductor is routed through a metallic conduit more than three feet long, ensure that both ends of the conduit are bonded to the conductor with a suitable method, avoiding sharp bends in the cable. **Looping the conductor itself through the conduit bonding collar is prohibited.**

### Measurements:

- ❖ Ensure that the resistance of the following connections is less than 0.1 ohms:
  - Lug to HTAP for any connections to Common Bonding Network
  - Rack bonding lug to any rack section (the paint-piercing washers make good test points)
  - Bonding lugs to busbar, cable tray, and cable bond
- ❖ Measure the resistance to ground of the grounding electrode conductor with a fall of potential ground resistance tester or properly utilized clamp-on ground resistance tester and ensure that measurements of resistance to ground are:
  - Less than 5 ohms to satisfy code, safety and minimum performance requirements.
  - Less than 1 ohm to ensure highest performance.

## 27 05 28 Pathways for Communications Systems

### Raceway/Tray Systems

The general requirements for raceway/tray systems are as follows:

- ❖ Communication tray systems shall be for exclusive use by OIT.
- ❖ The systems shall be designed for no more than 40% fill.
- ❖ When installing new cable(s) to existing tray, new tray shall be installed beyond 34% capacity.

- ❖ The systems shall be metallic and continuous, and all separate pieces shall be bonded with a connector listed for the purpose wherever they are joined.
- ❖ Cable trays must be properly bonded and grounded.

### **Cable Management**

Horizontal and vertical management must be designed to properly support Category 6A cables without compressing or kinking the cables.

## **27 05 28.29 Hangers and Supports for Communications Systems**

### **J-Hooks**

The use of J-Hooks to support horizontal wiring in lieu of continuous conduit or a combination of conduit and wire basket tray is **not** allowed by OIT and will only be considered through the exception process. Proposed J-Hook placement design must be submitted by the exception requestor and include J-Hook specifications and manufacturers statement that the design and materials will not degrade the performance of the cable being supported throughout the life of the cable. When designing the layout for the J-Hooks, the designer shall ensure that other building components (e.g., lighting fixtures, HVAC ducting etc.) do not restrict access for the cabling. A 3-Dimensional AutoCAD view of the proposed J-hook design showing the entire proposed route must be submitted for OIT approval.

If an exception request has been approved by OIT for the use of J-hooks, the project must install extra-large (minimum of 4" width) **Cablofil CJ64H** J-hooks to support loose, random cable bundles. J-hooks shall be spaced randomly between 3 and 4 feet apart to prevent system degradation due to sagging.

Buildings designed with an open ceiling design will not be allowed to use J-Hooks. The one exception to this rule would be in mechanical spaces.

## **27 05 28.33 Conduits and Backboxes for Communications Systems**

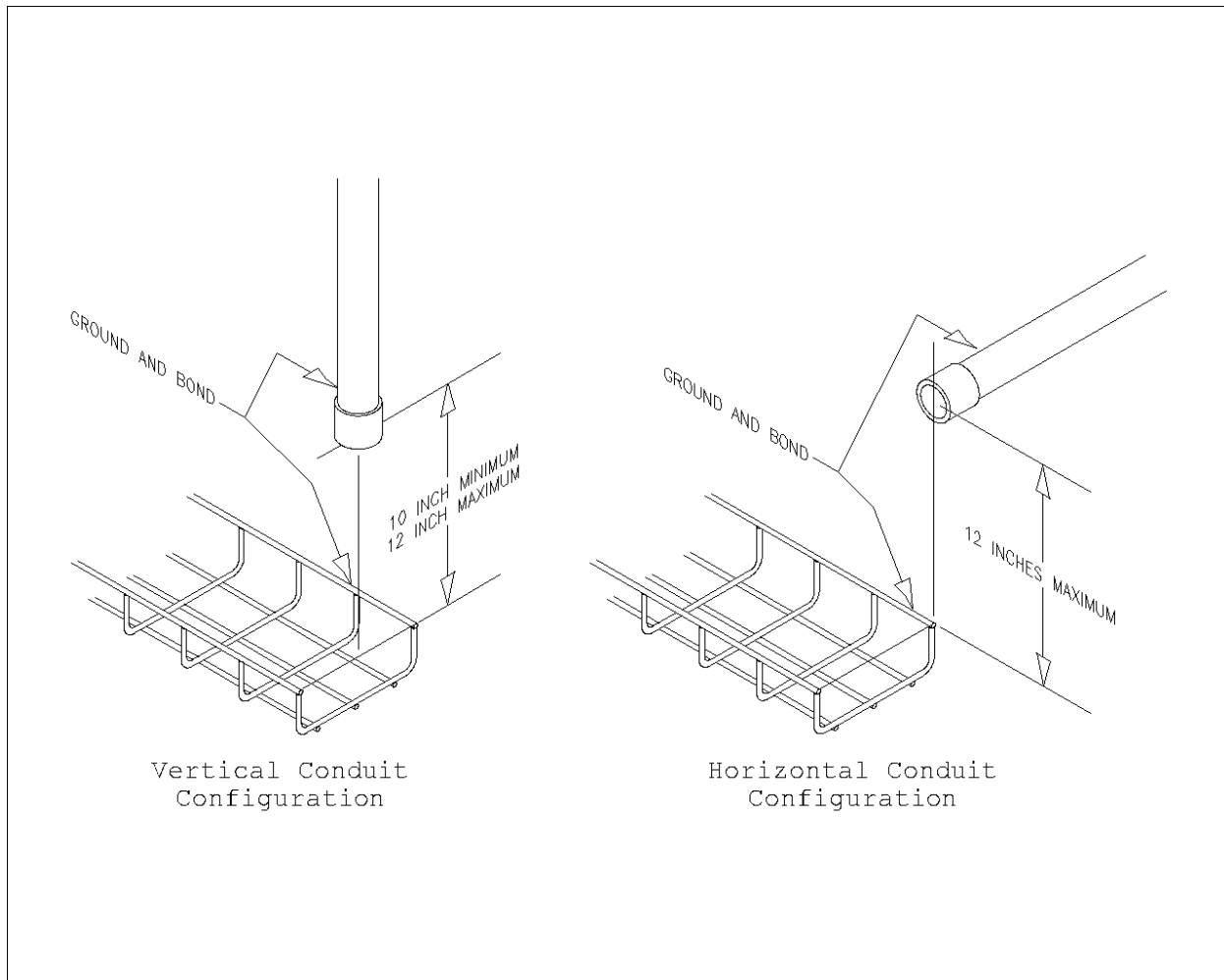
- ❖ **PROHIBITED:** Sharing the outlet and conduit pathway with other non-OIT telecommunications facilities.
- ❖ **PROHIBITED:** Daisy chaining of conduit from outlet to outlet.

### **Conduit**

Conduit sizes shall be adequate for the cable needed to serve voice and data instruments. The minimum size for conduit is 1 inch, if the Cat6A cable that is specified in these standards is installed.

## Outlets

- ❖ Telecommunication outlets shall be 4-inch by 4-inch by 2-1/2 inch boxes with a minimum 1-inch inside diameter continuous metallic conduit provided to the nearest IDF or ceiling raceway system, as long as the Cat6A cable that is specified in these standards is installed.
- ❖ Standard telecommunications outlets shall be installed at a minimum of 15 inches above finished floor and at the same height as the electrical. Standard telecommunications outlets for wall phones shall be 48 inches above a finished floor and shall use a Leviton Stainless Steel Wall-Phone Wallplate (Recessed) part number 4108W-1SP. All measurements are from the floor to the center of the outlet.
- ❖ Floor-mounted telecommunications outlets used for modular furniture shall be a Walker RCI RC3 flush poke-through unit, or a substitute that has been approved by OIT through the exceptions request process.
- ❖ Telecommunications outlets shall not be placed in a back-to-back location but shall be separated by a minimum of 12 inches. Telecommunications outlets in fire-rated walls shall be separated by 24 inches.
- ❖ Telecommunications outlet boxes shall be used solely for low voltage wiring for telecommunications.
- ❖ All wall outlet boxes shall be equipped with two-gang cover plates. Only outlets designated for wall telephones shall be equipped with a one-gang cover plate.
- ❖ In MDFs electrical quad (4x4) outlets shall contain one 20 AMP house duplex outlet (left side) and one 20 AMP generator duplex outlet (right side). Orange or red receptacles shall be used to designate generator outlets. No more than three duplex receptacles shall be dedicated per branch circuit. Circuits will alternate between neighboring outlets, to avoid having the same branch circuits next to each other.
- ❖ Electrical conduit shall be placed in the drywall with a cut out in the plywood backboard to allow for access to the outlets around the perimeter of the room. Electrical outlets will be installed in the plywood backboard at a height of 15 inches above finished floor.
- ❖ Two electrical outlets shall be placed on the back side of the 7-foot telecommunications racks. 1900 style boxes containing two duplex receptacles shall be used for this application. They shall be center mounted between the racks to avoid covering the equipment mounting holes. They shall be installed at 15 inches and 69 inches above finished floor.
- ❖ Compliance to this standard requires that the ends of rigid or flex conduit shall:
  - Have a bushing.
  - Lie within the side and end planes of the cable tray.
  - Lie within the tolerances illustrated (Figure D)
  - Be anchored to a rigid support.
  - Be grounded and bonded to the cable tray with a minimum 6 AWG copper conductor.
  - Use insulated metallic bushings for attached metallic conduits. Ground and bond the conduits to the tray.



**Figure D: Conduit to Cable Tray Configurations**

### **27 05 28.36 Cable Trays for Communications Systems**

#### **Raceway/Tray Systems**

- ❖ The tray shall be wire basket style in MDF, IDFs, and horizontal pathways.
- ❖ The wire basket-style tray shall be U shaped and constructed of round wire mesh. The basket tray shall be installed trapeze-style or wall-mounted. It shall not be center hung.
- ❖ End-of-tray cable waterfalls shall be used where wire drops down to preserve bend radii and prevent abrasions and cuts from metal tray edges.
- ❖ The tray shall have a minimum of 6-inches of clearance on all sides. Cable tray shall be properly bonded and grounded to avoid EMF and RFI interference.
- ❖ The tray shall maintain 18-inch clearance from sprinkler heads and shall meet the National Fire Code. The complete cable tray system shall meet OIT approval.

### **27 05 28.39 Surface Raceways for Communications Systems**

#### **27 06 00 Schedules for Communications**

**27 08 00 Commissioning of Communications**

**27 10 00 STRUCTURED CABLING**

**27 11 00 Communications Equipment Room Fittings**

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

**Equipment Racks**

- ❖ The rack system is to be installed per OIT requirements and shall be a Legrand Mighty Mo 20. The part numbers are as follows:
  - Legrand Mighty Mo 20, 6” rack: OR-MM20706-B
  - Legrand Vertical Manager: OR-MM20VMD710-B
  - Legrand End Panel: OR-MM20EPN706-B
  - Legrand End Panel Support Bracket: OR-MM20EPS-B

- ❖ Equipment racks shall be securely mounted to the floor with expansion anchors, and properly bonded and grounded.

**27 11 19 Communications Termination Blocks and Patch Panels**

**Wall Termination of Copper Wiring**

**In MDF rooms**

- ❖ Riser copper cabling shall be terminated on 110 termination blocks. 110 blocks shall be mounted to the plywood and installed so they are vertically plumb and securely fastened. The top jumper trough, installed above the 110 blocks shall be 5 1/2 feet above finished floor, and the lowest block shall be no lower than 36” above finished floor.

**In IDF rooms**

- ❖ 25 pair riser copper cabling shall be terminated using grey Leviton GigaMax Cat 5e QuickPort connectors, 5G108-RG5, and inserted in a Leviton 24 port patch panel, 49255 H24, on the equipment rack. The 25<sup>th</sup> pair will not be terminated at the patch panel. Consult with OIT for riser cable sizing requirements on a per building basis.

**Patch Panels for Horizontal Cabling**

- ❖ Patch panels shall be a Leviton 48 Port Angled Quickport Patch Panel 49256-H48. Patch panels must utilize individual jacks, not 110 style punch down.

**27 11 23 Communications Cable Management and Ladder Rack**

**27 11 26 Communications Rack Mounted Power Protection and Power Strips**

- ❖ Rack Mounted Power Strips shall be TrippLite part # IBAR12/20 ULTRA Surge Suppressor.

**27 13 00 Communications Backbone Cabling**

**Design Considerations**

- ❖ The intrabuilding backbone shall be comprised of both copper and optical fiber.



- ❖ Intrabuilding backbone fiber and copper cables shall be sized to include 50% spare for future use. Consult with OIT for cable sizing requirements on a per building basis.
- ❖ Intrabuilding backbone cables comprised of steel or metallic parts shall be grounded on both ends of the cable to the **Primary Bus Bar (PBB) and the Secondary Bus Bar (SBB)**. Intrabuilding Backbone Pathways
- ❖ Intrabuilding backbone cabling shall be distributed using a series of conduits, cable trays, sleeves, and slots. All wall and floor penetrations shall be properly firestopped. Firestopping methods and materials shall meet approval of the Authority Having Jurisdiction (AHJ).

### **27 13 13 Communications Copper Backbone Cabling**

- ❖ The intrabuilding copper backbone cable(s) shall be 100 ohm unshielded, balanced, twisted-pair, Category 3 riser-rated cable with 24 AWG round solid conductors. It shall also be armored. Cable must meet the needs of the building plus capacity for 50% growth.
- ❖ The cable shall be UL® tested and listed.
- ❖ Copper backbone riser cable specifications are as follows:
- ❖ **Communications Riser:** Category 3 Copper Cable ARMM (Alpeth, Expanded polyethylene polyvinyl chloride, 24 AWG, ALVYN)
- ❖ **Communications Plenum:** Category 3 Copper Cable 24 AWG Plenum Rated
- ❖ **Consult with OIT for copper pair count requirements to each IDF.**

### **27 13 13.13 Communications Copper Cable Splicing and Terminations**

- ❖ The cable shall be continuous without splices, unless otherwise specified by OIT.
- ❖ Intrabuilding copper backbone cables shall be properly secured to the walls to prevent horizontal movement.
- ❖ See Section 27 11 19 Communications Termination Blocks and Patch Panels for termination requirements.

### **27 13 13.23 Testing of Copper Backbone Cabling**

- ❖ Perform visual inspection to ensure that all cables are terminated on the punch down block in proper color code order.
- ❖ Test all pairs for continuity and tip and ring polarity.
- ❖ Test results shall meet or exceed the appropriate tests requirements as specified in the ANSI/TIA/EIA-568 specifications.
- ❖ Test results shall be submitted to OIT.

### **27 13 23 Communications Optical Fiber Backbone Cabling**

- ❖ The intrabuilding optical fiber backbone cable(s) shall be a 48 strand 8.3 μm singlemode cable.
- ❖ All backbone fiber optic cabling shall use Corning glass.
- ❖ Optical fiber riser shall be type OFNR (optical fiber non-conductive riser).
- ❖ Intrabuilding fiber backbone cables shall be properly secured to the walls to prevent horizontal movement.
- ❖ Where used in plenum spaces, optical fiber shall be type OFNP (optical fiber non-conductive plenum).
- ❖ Singlemode cable jackets shall be yellow in color. Optical fiber backbone riser cable specifications are as follows:

**Fiber Riser Cable:**

- ❖ Superior Essex: 48 strand 8.3 μm singlemode 43048R101

**Fiber Riser Cable Plenum Rated:**

- ❖ Superior Essex: 48 strand 8.3 μm singlemode 44048R101

**Fiber Cable Outside Plant:**

- ❖ Superior Essex
  - 48 strands of singlemode, double jacket, single armor (part number 1A048R101)

**Fiber-Optic Enclosures**

- ❖ Fiber optic enclosures shall be Panduit product FRME4. Fiber adaptor panels shall be Panduit product FAP6WAGDSCZ (SC APC) for singlemode.
- ❖ Enclosures shall be labeled per OIT specifications.

**Intrabuilding Backbone Riser Cable Testing**

Any cable that fails shall be re-terminated and tested again.

- ❖ The pass or fail condition for the cable being tested is determined by the results of the required individual tests. Any fail result yields failure for the cable being tested.
- ❖ OIT reserves the right to conduct, using Contractor equipment and labor, a random re-test of up to five percent (5%) of the cable plant to confirm documented test results. For individual installations, provide one of each of the following:
  - As-Built AutoCAD one-line prints in native AutoCAD format files (R2022 or greater)
  - A copy of all copper and fiber optic test results, along with the (licensed) software tools required to view, inspect, and print any selection of the test reports.
  - Warranty information and any vendor certification of the installed infrastructure

**27 13 23.13 Communications Optical Fiber Splicing and Terminations**

- ❖ The intrabuilding optical fiber backbone cable(s) shall be installed with a service loop of 25 feet at each end.
- ❖ Intrabuilding fiber backbone cables shall be properly secured to the walls to prevent movement.
- ❖ **PROHIBITED:** Using traditional nylon cinch-style tie wraps to bundle cables. Only Velcro™-style fasteners are acceptable.
- ❖ All fiber optic cables are to be continuous without splicing from MDF to IDF, unless otherwise specified by OIT.
- ❖ Fiber optic terminations are to be fusion spliced using AFL SC-style Fuse-connect™ connectors. Splicing of pigtails is not allowed. The singlemode cable shall be terminated with SC Angle Polished Connectors (APC).

### 27 13 23.23 Testing of Fiber Backbone Cabling

- ❖ Testing shall be performed on all fiber strands.
- ❖ Contractor shall perform loss testing.
- ❖ The fiber optic cables shall be tested utilizing a power meter and stabilized light source. Loss testing shall be performed in both directions (from MDF to IDF, and from IDF to MDF).
- ❖ Each fiber shall be tested using a Fluke DTX Cable analyzer or OIT approved equivalent.
  - Singlemode fiber wavelength testing shall be at 1310nm and 1550nm.
- ❖ Test results shall meet or exceed the appropriate tests requirements as specified in the ANSI/TIA/EIA-568 specifications.
- ❖ Cables that do not meet specifications shall be removed and replaced at the contractor's expense.
- ❖ Test results shall be submitted to OIT.

### 27 13 33 Communications Coaxial Backbone Cabling

#### 27 13 43 Communications Services Cabling

#### 27 15 00 Communications Horizontal Cabling

#### Horizontal Wiring Facilities

- ❖ **PROHIBITED:** Splitting copper pairs within a 4 pair cable between jacks
- ❖ **All horizontal copper terminations are to be to the T568B wiring scheme.**
- ❖ Only Velcro™-style hook and loop fasteners are acceptable.
- ❖ Horizontal wiring technicians and installers shall be certified by the manufacturer of all horizontal wiring and termination components that they will be installing.

- ❖ Telecommunications outlets shall be wired with unshielded, twisted pair (UTP) 24 AWG wire with suitable insulation and sheath material. The wire shall be type communications riser cable (CMR) or communications plenum cable (CMP) (UL) it shall be OIT approved.
- ❖ **The current position of OIT on horizontal cabling requires the installation of Category 6A cable.**
- ❖ Horizontal cabling shall be pulled to the nearest IDF on the same floor, as determined by OIT.

### OIT Outlet Labeling Scheme (Jacks)

Each jack location in an outlet facility shall be labeled in accordance with OIT jack-labeling practices. The labeling follows a standard format, indicating the room followed by the location within the room.

The general requirements for outlet facilities include the following:

The jack naming standard is:

**-XXXXX-XX**  
*5 characters – 2 characters*

**The first set of characters is the room identifier.** These characters indicate the Room Number that a jack is located within. These should always be 5 characters in length. We use “0” (zero) to fill any unnecessary place holders. For example, if the jack is in room 12, the five characters would be entered as 00012. Some of the variations from the numeric room number (according to the database standards) are as follows:

- OS – indicating outside of room \_\_\_\_ (i.e.: OS146 indicates the jack is outside of room 146).
- 0C – indicating a cubicle area in room \_\_\_\_ (i.e.: 0C210 indicates the jack is in a cubicle in room 210).
- HL or 0H – indicating a hallway area near room \_\_\_\_ (i.e.: HL532 indicates the jack is in the hallway outside of room 532).

**The last set of characters is the specific jack identifier.** These two characters specifically identify a jack within a room. The jack labeling scheme begins with AA, incrementing to AB, etc. so that each jack within a room has its own unique identification.

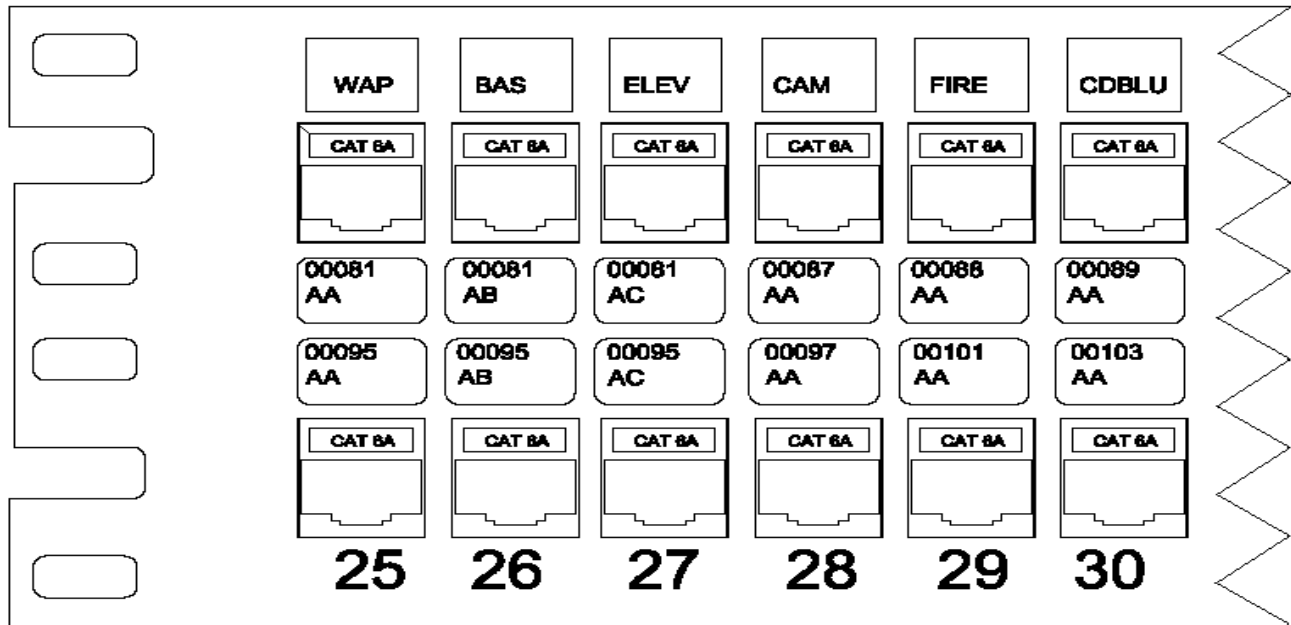
Any time we must deviate from the Jack Naming Standard (such as payphones or outside phones) typically the floor should be 00.

- ❖ The prefix field is always 5 digits.
- ❖ Rooms within a larger room may be designated as Room 0100A, and their jacks may thus be labeled as 0100A-AA.
- ❖ For larger rooms, it may be necessary to continue the labeling sequence beyond AZ so that the next installed jack would be labeled BA, BB and so on, and if necessary, continued throughout the alphabet (CA, CB and so on).
- ❖ The official U of M Facilities management (FM) room numbers shall be used to determine the labeling.
- ❖ The labeling information that OIT installs upon the voice and data jacks are used within the OIT database and forwarded to the police for location information to the response of emergency 911 staff (police, fire, etc.). Therefore, it is imperative that this information be kept current. If the room numbers are to be changed during the project, charges will be incurred to pick up this additional labor and to process the order so as to retain accuracy for the Life/Safety 911 database. Please contact your OIT liaison to coordinate these efforts.
- ❖ Jacks shall be neatly labeled with a printed self-adhesive label that OIT has approved in advance. The labels shall be typed/printed and are not to be drawn by hand.
- ❖ As-Built drawings that show jack numbers and locations shall be submitted to OIT upon completion of the project/building.

❖ Jacks installed for a purpose other than desktop or Voice over IP (VoIP) shall be labelled with a secondary ID, directly above or below the jack with a label stating the purpose of the jack. Some examples are listed below:

WAP	Wireless Access Point
ELEV	Elevator
BAS	Building Automation System
ELEC	Electrical Panel
FIRE	Fire Alarm Panel
CAM	Camera
CDBLU	Code Blue Phone
ODWAP	Outdoor Wireless Access Point
ODCAM	Outdoor Camera

See Figure E for patch panel labeling.



**Figure E Patch Panel Labelling**

### 27 15 13 Communications Copper Horizontal Cabling

#### Horizontal Copper Wire

- ❖ Category 3 and Category 5 wiring is no longer recommended for installation. Cables shall be Category 6A.
- ❖ Copper wiring specifications are as follows or OIT-approved substitute:
  - Green Cat6A plenum
    - Superior Essex 10 Gain XP part number **6B-272-5B**
  - Green Cat6A PVC
    - Superior Essex 10 Gain XP part number **6B-272-5A**

**NOTE:** When horizontal cable is to be installed in an outdoor application (i.e., security cameras, parking garages etc.) an outside plant rated Cat 6A cable must be used. Belden part number CNS-2148A.

- ❖ Each cable in the IDF from the jack shall be tagged with the current grid designation from the current architectural drawings.
- ❖ Horizontal cables shall be terminated in order according to jack number.
- ❖ Horizontal cables must be installed sequentially according to room number in the patch panel.
- ❖ All copper cable shall be continuously supported by conduit or cable tray.
- ❖ To facilitate future cable installations, install a nylon pull cord in each conduit simultaneously with the pull-in of cable.

### Category 6A Wiring Testing

- ❖ Tests shall be conducted according to TIA-568-C.
- ❖ Any cable that fails or Pass \* these tests shall be re-terminated and tested again. If the cable does not meet specifications after being re-terminated, replace the cable, terminate, and test again.
- ❖ The test results for each link shall be recorded in the memory of the field tester upon completion of the test.
- ❖ The test results saved by the tester shall be submitted to OIT. A guarantee shall be made that the results of the measurement shall be submitted unaltered—that is, as saved by the tester at the end of each test. The guarantee shall also specify that the results cannot be modified at a later time.
- ❖ The test results for the completed job shall be stored and submitted to OIT, along with the (licensed) software tools required to view, inspect, and print any selection of the test reports.

### Jacks

- ❖ Jacks shall be mounted in a 106-type frame; a mounting frame (Leviton 41087 QIP). The jack cover plate shall be 302 stainless steel. Each copper outlet shall contain the following jacks:
  - Category 6A Leviton product code number 6110G-RV6(Green)
- ❖ The number of wires installed to each communication outlet shall be determined in consultation with OIT. OIT recommends a minimum of two Category 6A cables at each copper outlet, and one cable per wall phone location.

### 27 15 23 Communications Optical Fiber Horizontal Cabling

#### Horizontal Fiber Optic Wire

- ❖ Each strand of fiber shall be housed in its own buffer tube throughout the length of the fiber cable. Each cable in the terminal room from the jack shall be tagged with the current designation from the current architectural drawings. Consult with OIT to determine the amount of slack in the terminal room from the location of the jack.
- ❖ The fiber optic cable **MUST** be manufactured with Corning Glass.
- ❖ The number of fiber strands installed to each communication outlet shall be determined in consultation with OIT.

- ❖ Labeling shall be performed in consultation with OIT.

### **Small Form/Modular Style Fiber Standards**

Fiber optic terminations are to be fusion spliced using AFL SC-style Fuse-connect™ connectors. Splicing of pigtailed is not allowed. The singlemode cable shall be terminated with SC Angle Polished Connectors (APC).

### **27 15 33 Communications Coaxial Horizontal Cabling**

- ❖ PROHIBITED: Sharing the outlet and conduit pathway with other non-OIT telecommunications facilities.
- ❖ PROHIBITED: Daisy chaining of conduit from outlet to outlet.
- ❖ PROHIBITED: Daisy chaining of horizontal cabling.

### **Conduit and Outlets**

- ❖ Coaxial outlets shall have a single gang box with a minimum 3/4-inch inside diameter continuous metallic conduit home run to the nearest IDF or ceiling raceway system.
- ❖ Conduits shall have pull boxes at 100-foot intervals and not exceed two 90-degree bends between pull points.
- ❖ All conduits shall have bushings at each end.
- ❖ Standard coaxial outlets shall be installed at a minimum of 15 inches above the finished floor and at the same height as the electrical. All measurements are from the floor to the center of the outlet.
- ❖ To facilitate future cable installations, install a nylon pull cord in each conduit simultaneously with the pull-in of cable.

### **Coaxial Cable**

- ❖ Cable shall be quad shielded RG6, or a substitute that has been approved by OIT through the exceptions request process, which meets all fire codes including plenum space and is equal to or exceeds Belden 1189A specifications. Cable runs shall not exceed 300 feet from the IDF.
- ❖ Cables shall be terminated into a stainless-steel faceplate with the appropriate F barrel extending from the face of the plate.
- ❖ Cables shall be installed and terminated in a neat and workman like manner in the IDFs at the splitter with sufficient length to connect to the wall mounted splitter equipment.
- ❖ Cables shall be labeled at both ends, and on the faceplate following the OIT Labeling Scheme.

### **Faceplates and Connectors**

- ❖ Faceplates shall be stainless steel.
- ❖ Connectors shall be RG6 male compression style F-connectors.



## Splitters

- ❖ All video splitters/amplifiers shall be identified and budgeted in the project in consultation with OIT. Video splitters/amplifiers will be installed on a plywood lined wall inside the IDFs.

## Testing

- ❖ Cable must be tested for continuity, opens and shorts. Based on the needs of the building, additional testing may be required.

## 27 15 43 Communications Faceplates and Connectors

## 27 16 00 Communications Connecting Cords, Devices and Adapters

## 27 20 00 DATA COMMUNICATIONS

### 27 21 00 Data Communications Network Equipment

### 27 21 33 Data Communications Wireless Access Points

OIT is responsible for the installation and maintenance of all wireless access points. The project is responsible for the installation of the horizontal infrastructure and cable necessary to support the wireless access points. The total number of access points and their locations cannot be finalized until a wireless survey is completed. In addition to providing general coverage, special considerations need to be made for large public areas, classrooms, and conference rooms.

- ❖ A 1” conduit shall be run from a closet to a pull-box or cable tray, and then from the pull-box/cable tray to where the Access Point will be installed.
- ❖ Each floor must be independently designed so wireless is not stacked on top of each other, creating the “silo effect.”
- ❖ The use of Wiremold is authorized, as long as it is installed in a neat and workmanlike manner and meets all fire code requirements.
- ❖ Install a 4” square (not round) extension box, Thomas and Betts part # 521711.
- ❖ Install a 4” square 1 gang  $\frac{3}{4}$  rise plaster ring part # 52C14.
- ❖ One Cat 6A cables shall be installed to each access point location.
- ❖ Mount the Access Point on the underside of the ceiling tile, even with or below fluorescent lights or other obstructions. The Access Point will be installed on the ceiling, never installed on a wall.
- ❖ **Access Points shall not be installed on any ceiling that is higher than 30’ from the finished floor.**
- ❖ Every Access Point must be documented on a floor plan with the Jack ID.
- ❖ Indoor access points shall be horizontally mounted on the ceiling, in a standard electrical box (Thomas and Betts part # 521711) mounted to support a 31.7-ounce (0.9 kg) device no more than 15 feet above the intended users.

- ❖ Outdoor Access Points require AC power. If not wall mounted, they require a 2” mast, height dependent on obstructions. All outdoor installations shall have an appropriate drip loop on connections and shall be grounded with connectors and wire listed for the purpose. **All outdoor installations shall install outdoor rated Cat 6A cable.**
- ❖ **Access Points shall not be installed in metal enclosures.**
- ❖ Access Points shall not be painted, this voids the warranty.
- ❖ The Cat 6A cabling shall be tested in accordance with TIA-568-C, and tested in the same manner as all other horizontal cabling (see Section 27 15 13)
- ❖ Any installation deviating from these standards must be approved by OIT.

**27 22 00 Data Communications Hardware**

**27 24 00 Data Communications Peripheral Data Equipment**

**27 25 00 Data Communications Software**

**27 26 00 Data Communications Programming and Integration Services**

**27 30 00 VOICE COMMUNICATIONS**

**27 31 00 Voice Communications Switching and Routing Equipment**

**27 32 00 Voice Communications Telephone Sets, Facsimiles and Modems**

**27 33 00 Voice Communications Messaging**

**27 34 00 Call Accounting**

**27 35 00 Call Management**

**27 40 00 AUDIO-VIDEO COMMUNICATIONS**

**27 41 00 Audio-Video Systems**

**27 42 00 Electronic Digital Systems**

**27 50 00 DISTRIBUTED COMMUNICATIONS AND MONITORING SYSTEMS**

**27 51 00 Distributed Audio-Video Communications Systems**

**27 52 00 Healthcare Communications and Monitoring Systems**

**27 53 00 Distributed Systems**

**27 53 19 Internal Cellular, Paging, and Antenna Systems**

NFPA 72 requires cellular service availability in all spaces. The Distributed Antenna System (DAS) service on campus is in flux and the project must consult with OIT to make sure the systems to be installed are compliant. **OIT recommends the use of Wi-Fi Calling for cellular calls on campus.**

OIT APPROVED PARTS LIST

<u>PART #</u>	<u>MANUF.</u>	<u>DESCRIPTION</u>
6110G-RV6	LEVITON	EXTREME CAT 6A JACK GREEN
41087 QIP	LEVITON	FRAME FLUSH MOUNT 4 PORT 106 IVORY
43080-2S4	LEVITON	QUICKPORT DUAL GANG SS 4 PT WALLPLATE
49256-H48	LEVITON	2RU 48 PORT ANGLED QUICKPORT PATCH PANEL
49258-TWB	LEVITON	TIE WRAP BAR
4108W-1SP	LEVITON	SS WALL-PHONE WALLPLATE, RECESSED
5G108-RG5	LEVITON	GIGAMAX CAT 5E QUICKPORT CONNECTOR GREY
49255 H24	LEVITON	QUICKPORT PATCH PANEL, 24 PORT, 1RU
6B-272-5B	SUP ESSEX	10 GAIN XP CAT6A PLENUM
6B-272-5A	SUP ESSEX	10 GAIN XP CAT6A PVC
1A048R101	SUP ESSEX	48 SM OSP DOUBLE JACKET SINGLE ARMOR
L3048K401	SUP ESSEX	48 SM 8.3 μm RISER
L4048K401	SUP ESSEX	48 SM 8.3 μm PLENUM
CNS-2148A	BELDEN	OSP CAT6A
FRME4	PANDUIT	OPTICOM BLACK RACK MOUNT FIBER CABINET
FAP6WAGDSCZ	PANDUIT	OPTICOM PANEL W/6 DUPLEX SM SC APC ADPT
RGRB19Y	PANDUIT	HORIZONTAL RACK MOUNT GROUNDING STRIP
GB4	PANDUIT	GROUNDING BUS BAR
OR-MM20706-B	LEGRAND	MIGHTY MO 20, 6" CHANNEL RACK
OR-MM20VMD710-B	LEGRAND	10" VERTICAL MANAGER
OR-MM20EPN706-B	LEGRAND	END PANEL
OR-MM20EPS-B	LEGRAND	END PANEL SUPPORT BRACKET
FUSE-SC9SMA-6	AFL	FUSECONNECT SC APC SM GREEN CONNECTOR
C189818	AFL	FANOUT KIT
IBAR12/20 ULTRA	TRIPPLITE	RACKMOUNT SURGE PROTECTOR
EZD44S2	EZ-PATH	FIRE RATED PATHWAY
EZDG444S2	EZ-PATH	SINGLE-SLOT MODULAR FLOOR GRID