DIVISION 27 - COMMUNICATIONS

ARCHITECTURAL REQUIREMENTS

TELECOMMUNICATIONS SPACES (TS)
The industry term “Telecommunications Spaces”, when used, shall refer to Equipment and Telecommunications Rooms, as well as, ADF, BDF and IDF.

EQUIPMENT ROOM (ER)
1. Houses the Area Distribution Frame (ADF), Building Distribution Frame (BDF), and/or Intermediate Distribution Frame (IDF).
2. In some cases may also serve as the Entrance Facility (EF).
3. Provides a controlled environment to house telecommunications equipment, termination hardware, splice closures, Main Telecommunications Grounding Busbar (MTGB) grounding and bonding facilities and protection apparatus.
4. Local Area Network (LAN) switches, video distribution equipment, wireless network equipment, 800MHz In-building Radio Equipment and large Uninterruptible Power Sources (UPS) are typically found in a campus ER.

ER’s shall be designed and provisioned per the requirements in ANSI/TIA/EIA-569-D.

TELECOMMUNICATIONS ROOM (TR)
1. Typically floor serving as opposed to building or campus serving. Every building is served by at least one TR or ER, with a minimum of one TR per floor.
2. Houses the Building Distribution Frame (BDF) and/or Intermediate Distribution Frame (IDF) on the UC Davis campus.
   a. The BDF is a building serving space providing a connection point between campus backbone cables and the building infrastructure system. The BDF may be floor serving when collocated with an IDF.
   b. The IDF provides a connection point between backbone and horizontal infrastructures, Work Area Outlet (WAO) locations.

TR’s shall be designed and provisioned per the requirements in ANSI/TIA/EIA-569-D.

DESIGN CRITERIA

TELECOMMUNICATIONS SPACES SHALL BE:
1. Dedicated to the building’s telecommunications function and related support facilities and shall not be shared with electrical, building services or any equipment other than those required in direct support of the telecommunications equipment and services. Nor shall they be located near potential sources of electromagnetic interference (EMI), radio frequency interference (RFI), or sources of mechanical vibration.
2. Located above water level and not in a place subject to any corrosive atmospheric or environmental conditions.
3. Located as close as practical to the center of the area served and preferably in the core area.
4. Shall avoid locations that limit expansion such as structural steel, stairwells and elevator shafts, outside walls or other fixed building walls.
5. The average horizontal cable run is 150 feet or less and no individual cable run shall exceed 295 feet; minimizing the length of the backbone and horizontal distribution cables. Building entrance cables shall not be exposed for a cable length distance of more than 50-feet or as allowed by the current California Electrical Code.
6. Be easily accessible and accessed directly from public hallways and not through offices or other utility spaces.
7. Have easy access to distribution cable pathways.
8. Vertically aligned (Stacked) within a multistory building. Horizontal pathways shall terminate in the TS located on the same floor as the area being served.
9. Meet Seismic Zone 4 requirements.

Equipment and piping not related directly to the support of the telecommunications function shall not be installed in, pass through, pass overhead or enter the telecommunications space. Pipes for sprinkler heads located within the room shall not be located directly above electronic equipment racks and/or cabinets.

ROOM SIZING
1. There shall be a minimum of one Telecommunication Space (TS) per floor. One additional TS for each area up to 10,000 sq. ft. shall be provided when the floor area to be served exceeds 10,000 sq. ft or the horizontal distribution distance to the workstation exceeds 295-feet. See Table 1.
2. If the floor area is over 10,000 sq. ft., then the TS size shall be increased, based upon 0.75 sq. ft. for every additional 100 sq. ft. of usable space the TS will support.
3. The sizes of all telecommunications spaces (ADF/BDF/IDF) listed are minimum requirements. Depending on the requirements and services performed by the building occupants, additional space may be required. Larger size buildings and building programs may require additional rows of equipment racks or cabinets. Contact the University’s Representative for specific instructions.

Table 1: Telecommunications Space Dimensions

<table>
<thead>
<tr>
<th>Serving Area</th>
<th>Minimum Room Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDF</td>
<td>9-feet wide by 12-feet long</td>
</tr>
<tr>
<td>BDF</td>
<td>10-feet wide by 15-feet long</td>
</tr>
</tbody>
</table>

TS LAYOUT (GENERAL)
1. See Figure 1b for recommended TS Layout
2. Lighting shall not receive power from the same electrical distribution panel breaker as the telecommunications equipment in the TS.
3. Door shall be fire rated as dictated by local code requirements. Double doors shall be 6-feet wide by 7-feet, 5-inches high without a doorsill and center post. TS doors that open to an outside environment shall be rated for exterior use and shall have a weatherproof
gasket to prevent vermin, water, dirt and dust from entering the room. A positive pressure type of HVAC system shall be installed in this type of TS. Contact the University’s Representative for keying and door handle specifications.

4. Floor loading capacity in the ER (ADF/BDF):
   a. Minimum distributed load rating of 100 lb/sq. ft. and a minimum concentrated load rating of at least 2000 lb/sq. ft.
   b. Minimum load rating of 50 lb/sq. ft.

5. Ceilings shall be open to the underside of the floor above and have a minimum clearance of 9-feet.

6. See Figure 1b for equipment and cross-connect field clearances in the TS.

7. A standalone HVAC unit shall be provided for the telecommunications space. The filters in the HVAC system shall have an ASHRAE dust spot rating of 85 percent or better. 6,000 BTU’s (1/2 Ton) per equipment rack. Temperature 68-72 degree Fahrenheit. Humidity between 30-55 percent.

8. The back wall of the Telecom Room, behind the equipment racks, shall be dedicated for low voltage security equipment. Contractor shall provide a submittal of the low voltage equipment conduit route that will be entering the Telecom Room. Conduits shall be installed in a clean, neat and organized fashion. The University’s Representative shall coordinate CR approvals on submittal, installation and field changes. See Figures 1a for example.

9. The security camera outlet cables are to be terminated on a wall mounted swing out bracket and 24 or 48 port patch panel next to the card reader security backboard. The POE switch will be wall mounted below the patch panel. The control NAMs for the low voltage security equipment located within the telecom room can share the patch panel for the camera outlets. Terminate the NAMs on the last ports available on the patch panel. NAMs will be patched over to the control panels.
1. Duplex convenience receptacle shall be placed every 6-feet and mounted at 18-inches AFF around the perimeter of the room, min of (2) 20 AMP dedicated circuits. No more than 4 outlets on one circuit. Alternate outlet circuits around room. Provide on emergency power, if available.

2. Mount 2 Duplex 20 AMP 120 VAC NEMA 5-20R dedicated branch circuits in quad box mounted at 15-inches AFF on back of each rack. Use min
of 24-inches of flex conduit to attach electrical service to the equipment rack to prevent shearing of conduit during a seismic event. Electrical EMT and/or flex conduit shall not pass through the overhead cable ladders. Provide on emergency power, if available.

3. Ladder rack shall be 18-inches wide and mounted at 7-feet-6-inches AFF. Do not attach to racks. Support ladder rack overhead, not the walls, with a min of 1/2-inch threaded rod.

4. Hoffman seismic 2-post open frame rack, or equal.

5. 6-inches D-rings cable manager, 1 pkg of 10 (ECM6DR10) per equipment rack.

6. Sleeves shall enter 2-inches without a bend at 8 foot-6-inches AFF and in-line with the overhead ladder rack.

7. Line all walls with 3/4-inches by 4-feet-feet by 8-feet void-free fire treated plywood and painted on all sides with two coats of white fire retardant paint. Tape off and expose one stamp per sheet of plywood. Start at 6-inches AFF.

8. A min of 2-feet-6-inches clearance shall be maintained at one end of row and 3-feet-6-inches in front of open frame racks. Allow min 36-inches aisle between each row of racks.

9. 110 Voice wall field.

10. Electrical panel (On emergency power, if available)

11. Overhead lights (On emergency power, if available) at min 8-feet-6-inches AFF. Minimum 50-feet candles measured at 3-feet AFF.

12. Entrance conduits shall enter 3-4-inches AFF without a bend.

13. Entrance door min 3-feet by 6-feet-7-inches w/ gasket to prevent dust. No glass viewing or louver panel in door. Provide CR Medco key core. Entrance door shall open outward when possible.

14. Floors shall be sealed concrete. Removable floors shall be of a tile type surface. Concrete and tile floors shall be sealed with an anti-static coating.

15. Provide Hoffman 6-inches Wide Double-sided CableTek Vertical with fingers, or equal, between the racks.

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NOTE: The type and location of the cross-connect fields may influence the optimal placement of pathways.

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Note to the Design Professional: In many cases, equipment and termination hardware may extend beyond racks and backboards. The clearance shall be measured from the outermost surface of these devices, rather than from the mounting surface of the rack or backboard.

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FIRE SAFETY AND PROTECTION REQUIREMENTS

1. Portable clean agent (Halotron or equivalent) fire extinguishers shall located within 50 feet of room. The size of the fire extinguisher shall be a minimum 2-A, 10-B, C rating.

2. Drainage troughs shall be placed under the sprinkler pipes to prevent leakage onto the electronic equipment. Provide a drain to route the water outside of the TS.

3. Under floor fire detection system shall be a cross-zone detection system. Placement of the detector may affect the way cables are routed under a raised floor. Provisions shall be made in the fire detection system design to reduce the possibly of false alarms and activation of a fire suppression system when ionization detectors are installed.
ELECTRICAL REQUIREMENTS
1. A sub-panel or at a minimum, all TS’s shall be provided dedicated electrical service in all ADF/BDF/IDF (ER/TR) rooms. The estimated electrical load for the telecommunications space shall not exceed 80 percent of the panel.
2. Dedicated power circuits from shared panel boards shall be provided with both transient voltage surge suppression and electrical high frequency noise filtering.
3. If a low number of telecommunications spaces are planned, one electrical panel may serve multiple telecommunications spaces as a design alternative. Consult the University’s Representative.
4. Sub-panels shall be located to conserve wall space and shall be connected to an emergency power source if available to the building.
5. HVAC systems shall not use the same electrical panel that is used to support telecommunications spaces.

EQUIPMENT RACK AND CABINET ELECTRICAL REQUIREMENTS
1. Reference Division 27 11 16, Communications Cabinets, Racks and Enclosures, Figure 23-25 for location of outlets on the equipment racks.
2. Duplex convenience receptacle shall be placed every 6-feet and mounted at 18-inches AFF around the perimeter of the room, min of (2) 20 AMP dedicated circuits. No more than 4 outlets on one circuit. Alternate outlet circuits around room.
3. Mount 2 Duplex 20 AMP 120 VAC NEMA 5-20R dedicated branch circuits in quad box mounted at 15-inches AFF on back of each rack. Use min of 24-inches of flex conduit to attach electrical service to the equipment rack to prevent shearing of conduit during a seismic event. Electrical EMT and/or flex conduit shall not pass through the overhead cable ladders.
4. Special considerations:
   a. ADF require standard 20 Amp, 120V AC NEMA 5-20R-spade receptacles.

DESIGN REQUIREMENTS
Work Area Outlets (WAO)
1. Power receptacles shall be installed near each WAO location (i.e. within 3-feet). Install WAO at the same height as the power receptacles. A minimum of one WAO location containing two Data NAMs (Network Access Module) or jacks shall be installed per work area.
2. For office areas, provide a minimum of two separate WAO locations. They shall be located to offer maximum flexibility for change within the work area (i.e. on opposing walls).
3. Provide a NAM for a clock in each classroom. The NAM shall be flush mounted on the front classroom wall at roughly 8’-6” AFF. Provide a single gang ring.
4. Provide a NAM for an IPTV location when a TV is required.

Open office area interior design, telecommunications distribution planning and power system distribution planning shall be coordinated to eliminate placement discrepancies.
Building Management WAO’s

1. A minimum of one WAO consisting of two Data NAMs shall be installed at the Fire Alarm Control Panel (FACP). NAM shall be located outside the FACP in a Hoffman 8-by inches by 6-by inches by 4-inches indoor rated box (Cat. no. AHE8X6X4) with a hinged cover, or equal. A conduit will need to be provided from the box to the FACP.

2. A minimum of one WAO of one Data NAM shall be installed for each elevator bay (incl. wheel chair elevator) in an accessible area outside and near the Elevator Control Room. The NAM is to be placed within a Hoffman 8-inches by 6-inches by 4-inches indoor rated box (Cat. no. AHE8X6X4) with a hinged cover, or equal. A conduit will need to be provided from the box to the elevator room control panel.

3. A minimum of one WAO of two Data NAMs shall be installed within the Building Management System (BMS) Control Panel.

4. A minimum of one WAO of two Data NAMs shall be installed for the Lighting Control Panel (LCP).

5. A minimum of one WAO of one Data NAM shall be installed within the Power Monitoring (PML) Control Panel.

6. A minimum of one WAO of two Data NAMs shall be planned for any Building Access Systems (card readers, cameras…) within the Security Control Panel.

Control NAMs shall be located outside the control panels in a Hoffman 8-by inches by 6-by inches by 4-inches indoor rated box (Cat. no. AHE8X6X4) with a hinged cover, or equal. Provide a 1-1/4 inch or larger conduit (dependent on number of cables) to the Hoffman box from the IDF or cable tray. A 1-inch conduit will need to be provided from the box to the control panel. Contractor to provide a patch cord from the control panel to the Hoffman box.

FACP, LCP & PML NAMs can all be placed within the same Hoffman hinged box, if all the systems are located within the same control room. Increase conduit size from the IDF/cable tray when sharing a box. A separate 1-inch conduit less than 20ft will need to be provided from the Hoffman box to each control box for a patch cord.

Note to Design Professional: Provide note on the drawings that the Contractor shall coordinate Building Management NAMs final locations with building systems and with the University’s Representative.

Courtesy, Pay, Text, Emergency and Wheel Chair Elevator Telephones

1. Comply with the most current American Disabilities Act (ADA) Accessibility Guidelines.
   a. Wall-mounted telephones shall not be installed above a counter top.
   b. If a Text Telephone is required, provide a shelf, a power receptacle at 18-inches AFF under the Text Telephone and a handset cord long enough to allow an acoustic coupler connection.

Slab on Grade

1. Shall meet the following minimum requirements:
a. Supporting conduits shall run beneath the slab and shall be PVC schedule 40 or better.
b. At no time shall the conduit run below the membrane barrier or be placed directly in the soil.
c. Conduits shall not contain more than two 90-degree bends and exceed more than 100-feet in length between pulling points.

Tenant Improvement Project
1. Abandoned cables, not identified or labeled for future use, increase the fire fuel load and shall be removed in accordance with the National Electrical Code.
2. Contact the University’s Representative for coordination of CR to survey the existing cable plant. There is a possibility that all or a portion of the existing installed cable may be reused.

Common Work Results for Communications
1. Work shall be designed and installed per the following most current edition:
   a. California Electrical Code (CEC)
   b. National Electrical Safety Code (NESC)
   c. California PUC General Orders 95 and 128
   d. ANSI/TIA-758-A Specifications for Outside Plant Construction.

2. Communications Resources Network Services and Engineering (NSE) office shall determine the best cable distribution method along the proposed cable route, consult the University’s Representative. The distribution shall be underground.

Grounding and Bonding for Communications Systems
The following standards shall apply:
1. ANSI J/STD-607-C, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications,
2. ANSI/TIA/EIA-606-B Administration Standards for the Telecommunications Infrastructure of Commercial Buildings.
3. BICSI guidelines
4. National Electrical Code (NEC)
6. California Electrical Code Article 800.

In the event of conflicting requirements, the most restrictive requirement shall prevail.

If the designer finds a conflict between a local safety code, BICSI guidelines and the manufacturer’s requirements, the conflict shall be resolved with the University’s Representative before proceeding.
TELECOMMUNICATIONS BONDING INFRASTRUCTURE

In addition to the normal electrical ground system, a Telecommunications Main Ground Busbar (TMGB) and a Telecommunications Ground Busbar (TGB) system are required per ANSI/EIA/TIA-STD-J-607-C.

1. A TMGB shall be in the ER (ADF/BDF) and shall be bonded to the nearest approved building grounding electrode (e.g., structural steel or ground rod) and the equipment grounding system (ac branch circuit panel board’s equipment grounding busbar) by exothermic welds.

2. In each TR (IDF), a TGB shall be installed and bonded to the electrical panel (may be located in a different room) serving the area where the TGB is installed, bonded to building steel and bonded in series to the main TMGB.

3. In a renovation or remodeling project where a suitable ground to the electrical service ground is not available, a grounding electrode shall be installed in accordance with the CEC Section 250-70.

4. Bonding conductors shall be green or marked with a distinctive green color, labeled and routed with minimum bends or changes in direction.

5. A grounding equalizer (GE) is not required.

6. The TGB shall be calculated for a size that conforms to the guidelines set by the NEC. Reference Table 2 Sizing of TGB.

7. Multiple busbars are used where multiple ERs, TRs and EFs exist in large buildings. Figures 3 & 4 illustrate a typical small and large (Multiple ER/TR within a Building) Grounding System Arrangement.

8. Provide a grounding riser diagram in the Drawings.

9. See Campus Standard Detail T03 Typical Telecommunication Grounding Busbar.

10. 2-hole compression ground lugs shall be used.

### Table 2 Sizing of Telecommunications Bonding Backbone (TBB) cable.

<table>
<thead>
<tr>
<th>Sizing of the TBB</th>
<th>TBB Size (AWG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBB length linear m (ft)</td>
<td></td>
</tr>
<tr>
<td>less than 4 (13)</td>
<td>6</td>
</tr>
<tr>
<td>4 - 6 (14 - 20)</td>
<td>4</td>
</tr>
<tr>
<td>6 - 8 (21 - 26)</td>
<td>3</td>
</tr>
<tr>
<td>8 - 10 (27 - 33)</td>
<td>2</td>
</tr>
<tr>
<td>10 - 13 (34 - 41)</td>
<td>1</td>
</tr>
<tr>
<td>13 - 16 (42 - 52)</td>
<td>1/0</td>
</tr>
<tr>
<td>16 - 20 (53 - 66)</td>
<td>2/0</td>
</tr>
<tr>
<td>greater than 20 (66)</td>
<td>3/0</td>
</tr>
</tbody>
</table>

All grounding and bonding connectors shall be listed by a nationally recognized testing laboratory (NRTL) as required by the NEC. Install per manufacturer’s guidelines.
TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB) & TELECOMMUNICATIONS GROUNDING BUSBAR (TGB)

The TMGB & TGB must be a predrilled copper busbar with holes for use with standard 2-hole sized compression lugs, have minimum dimensions of 6.3 mm (0.25 in) thick by 101 mm (4 in) wide and be minimum 20" (See Figure 2).

**Figure 2 Typical Telecommunications Main Grounding Busbar (TMGB)**

![Telecommunications Main Grounding Busbar (TMGB)](image)

**Figure 3 Small Systems (Single ER/TR within a building)**

![Small Systems (Single ER/TR within a building)](image)

NOTE: Small system installations shall meet ANSI J/STD-607-C.
Figure 4 Recommended Large System Arrangement (Multiple ER/TR within a Building)

IG systems are not recommended for voice and data equipment, regardless of intent. It defeats the purpose of an equipotential plane.

LABELING
All ground attachments shall be properly tagged and labeled in accordance with TIA/EIA-606-B.
TESTING
Test per TIA/EIA-607-C with an Earth Ground Resistance Tester used in the Two Point Test Method.

1. The installer / technician conducting these tests must be certified level VI by UIC ACCC TED.

These tests shall be recorded on documents provided by the University’s Representative.

<table>
<thead>
<tr>
<th>Pathways for Communications Systems 27 05 28</th>
</tr>
</thead>
<tbody>
<tr>
<td>CABLE SUPPORT (GENERAL)</td>
</tr>
<tr>
<td>The main routing and support systems for communication cables on the Campus are:</td>
</tr>
<tr>
<td>1. Cable tray system (Main pathway down corridors)</td>
</tr>
<tr>
<td>2. J-hooks and adjustable cable support (bags) (accessible false ceiling areas)</td>
</tr>
<tr>
<td>3. Conduit home runs (hard ceiling areas, inaccessible ceiling areas, in-floor boxes, masonry walls). Combined system shall be an overhead distribution method based on the use of a cable tray and J-hook system for routing and an EMT conduit stub-up to the WAO device boxes.</td>
</tr>
</tbody>
</table>

All cable trays shall be divided with a metal divider for shared space (See Cable Trays for Communications Systems Section 27 05 28.36) for more information. Each building cabling system (800 MHz radio, Access control, CCTV, etc.) shall have their own dedicated secondary J-hook cable support from the cable tray.

<table>
<thead>
<tr>
<th>Hangers and Supports for Communications Systems 27 05 28.29</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMUNICATIONS J-HOOKS</td>
</tr>
<tr>
<td>1. J-hooks shall be spaced at a maximum of 48-inches in the main bundle, 48 to 60-inches apart in the secondary bundles and within 6-inches of an EMT conduit stub-up.</td>
</tr>
<tr>
<td>2. Main cable bundle shall be made up of 4-inch saddle bags and supported on a minimum of 3/8-inch rod.</td>
</tr>
<tr>
<td>3. Secondary cable bundles shall be made of minimum 2-inch j-hooks with a closer. Support secondary cable bundles with pencil rod. Cable supports shall not exceed 30-percent fill ratio. Refer to manufacturer’s recommendations. Secondary pathway to 90 off cable tray and contain no more than 25 cables. Location of J-hooks shall be indicated on the Electrical Design and/or Telecommunications drawings.</td>
</tr>
<tr>
<td>4. Cables shall not be secured to the J-hook with cable ties or vinyl tape.</td>
</tr>
<tr>
<td>5. Contractor to provide drawings indicating Primary and Secondary pathways before installing cable to University’s Representative for approval.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conduits and Backboxes for Communications Systems 27 05 28.33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed interior conduits shall:</td>
</tr>
<tr>
<td>1. Be installed in the most direct and accessible route possible (parallel to building lines and located in and above accessible hallways).</td>
</tr>
<tr>
<td>2. Contain no more than two 90-degree bends in any dimensional plane or exceed 100-feet in length between pulling points or interior pull boxes. See Table 3.</td>
</tr>
</tbody>
</table>
3. A pull box is not to be used in place of a conduit sweep. See Figure 6
4. Stub up to an accessible ceiling area and within 6-inches of a J-hook or cable tray from a
device box.
5. Be reamed at both ends and have a plastic bushing installed on each end to prevent
damage during cable installation.
6. Have a pull string installed in all conduits with a minimum test rating of 200 lb.
7. Not be installed through areas in which flammable materials may be stored or over and
adjacent to boilers, incinerators hot water lines or steam lines.
8. All conduits shall be bonded and grounded in accordance with the CEC and ANSI-J-STD-
607-C, where applicable.
9. Interior conduits and/or sleeves shall be properly sized in accordance with TIA/EIA 569-
D, Table 4.

**Table 3 Conduit Bend Radiuses**

<table>
<thead>
<tr>
<th>Internal Diameter</th>
<th>Minimum Bend Radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 inches or less</td>
<td>6 times the internal conduit diameter</td>
</tr>
<tr>
<td>2 1/4 inches or more</td>
<td>10 times the internal conduit diameter</td>
</tr>
</tbody>
</table>

Wall-mounted riser conduits and/or sleeves entering a Telecommunications Space (ER/TR) shall
have a plastic spillway installed onto the end of the conduit to prevent kinking of the installed
cable bundle. BEJ ED, Inc. part number Bj-2049B-002, or equal.  www.bejed.com

**Table 4 Maximum Allowable Conduit Fill Based Upon 40% Allowable Fill**

<table>
<thead>
<tr>
<th>Trade Size **</th>
<th>Inside Diam. inch</th>
<th>5.6 mm (0.22)</th>
<th>6.1 mm (0.24)</th>
<th>7 mm (0.28)*</th>
<th>7.9 mm (0.31)</th>
<th>9.5 mm (0.35)</th>
<th>13.5 mm (0.53)</th>
<th>15.8 mm (0.62)</th>
<th>17.8 mm (0.70)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.04</td>
<td>10</td>
<td>9</td>
<td>6</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1-1/4</td>
<td>1.38</td>
<td>17</td>
<td>16</td>
<td>11</td>
<td>9</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1-1/2</td>
<td>1.61</td>
<td>23</td>
<td>21</td>
<td>15</td>
<td>12</td>
<td>8</td>
<td>2</td>
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<tr>
<td>2</td>
<td>2.06</td>
<td>39</td>
<td>36</td>
<td>24</td>
<td>20</td>
<td>14</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2-1/2</td>
<td>2.46</td>
<td>56</td>
<td>51</td>
<td>35</td>
<td>29</td>
<td>20</td>
<td>6</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>3.06</td>
<td>86</td>
<td>79</td>
<td>54</td>
<td>45</td>
<td>30</td>
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<tr>
<td>3-1/2</td>
<td>3.54</td>
<td>115</td>
<td>106</td>
<td>72</td>
<td>60</td>
<td>41</td>
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<td>7</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>4.02</td>
<td>149</td>
<td>136</td>
<td>93</td>
<td>78</td>
<td>52</td>
<td>14</td>
<td>12</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Typ 4-pair CAT5E cable</th>
<th>Typ 4-pair CAT6 (w/o divider) cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typ 4-pair CAT6A (w/ divider) or 4-pair ScTP</td>
<td></td>
</tr>
<tr>
<td>Typ 12-pair CAT3 unshielded or RG6 Quad shielded</td>
<td></td>
</tr>
<tr>
<td>Typ 25-pair CAT3 unshielded cable</td>
<td></td>
</tr>
<tr>
<td>Typ 50-pair CAT3 unshielded cable</td>
<td></td>
</tr>
<tr>
<td>Typ 50-pair CAT3 shielded ARMM cable</td>
<td></td>
</tr>
<tr>
<td>Typ 100-pair CAT3 unshielded cable</td>
<td></td>
</tr>
</tbody>
</table>

* The Outside Diameter of Superior 10Gain XP™ CMP, or equal
** Results will vary based on type of conduit installed within. All results are based on conduit runs that are less than 100ft with no bends. Figure a 15% derating factor to the conduit fill recommendations per 90-degree bend and/or up size the conduit.

**STRUCTURES TO SUPPORT VERTICALLY ALIGNED TELECOMMUNICATION SPACES**
1. Vertically aligned TS’s shall utilize sleeves and slots.
2. TS’s that are not vertically aligned shall be connected with conduits.
3. In a multistory building, grip brackets shall be specified to support the riser cable’s weight as it passes through the ER/TR.
4. Vertical cable runway shall be installed behind the sleeves and slots to allow for proper cable management.
5. Table 5 shows the conduit fill ratio requirements for riser cables.

Conduit shall be used to route the riser cables between the BDF/IDF located in the same ER/TR, if cable trays are not used to support the horizontal cabling. Conduit paths are tightly controlled pathways that shall be coordinated with other work during construction or remodeling.
1. Each 4-inch conduit shall be installed with a mule tape and contain a ground bushing on each end to ground the conduit and protect the cable.
2. Conduits that enter the ER/TR shall be placed near the corner and as close as possible to the wall where the backboard is mounted to allow for proper cable racking and to minimize the cable route inside the ER/TR.
3. Conduits located in the ceiling or wall shall protrude into the ER/TR 1 to 2 inches and a minimum 8 feet above the finished floor. Conduit shall not turn down.
4. Provide a conduit riser diagram in the Drawings. Reference Table 5 for details on conduit fill for riser cables.

Note: A 2-inch conduit shall be dedicated from the ER/TR to a sealed junction box or weather head on the roof of the building for the installation of an 800 MHz antenna cable. Installation type will be dependent on the location of the conduit roof penetration. Coordinate with University Representative. This conduit shall be grounded using a path other than the telecommunications ground provided in the ER/TR. See Figure 5.

Figure 5 Recommended 800 MHz Antenna Roof Penetration Finish
WORK AREA OUTLET (WAO) CONDUIT AND BACKBOX SIZE REQUIREMENTS

1. All WAO's shall have a minimum of one (1) 1-1/4 inch trade size Electrical Metallic Tubing (EMT) conduit installed from the device box to readily accessible ceiling space within 6-inches of an installed J-hook or cable tray. WAO's shall have a standard 5-inch square by 2-7/8-inch deep device box (RANDL Ind. ®, or equal) with a single gang mud ring installed flush mounted within the wall.

2. All Fiber to the Desktop (FTTD) WAO's shall have a 5-inch square by 2-7/8-inch deep device box (RANDL Ind. ®, or equal) in place of the standard size device box. A larger box is required to maintain the fiber optic bend radius. A dual gang mud ring shall be installed on the front to accommodate an 8-port faceplate if voice, data and/or video NAM's are planned for the same location.

3. Wall-mounted courtesy telephone device boxes shall be mounted per ADA requirements. An electrical outlet shall be provided at +18-inches to accommodate a TTY phone.

4. Floor-mounted WAO's shall have a minimum of one (1) 1-1/4 inch trade size Electrical Metallic Tubing (EMT) conduit installed from the device box to readily accessible ceiling space of the same floor within 6-inches of an installed J-hook or cable tray. Floor boxes shall not be looped or daisy-chained together with one single conduit, regardless of the size of conduit. Provide separate 1-1/4" conduit for AV, if AV is required in shared box.

5. The maximum allowable conduit fill requirements shown in Table 4 shall be adhered to when designing conduit installations for WAO device box and Wiremold®, or equal, locations.

6. Typical mounting height shall be +18-inches AFF or match the height of new and existing power receptacles, where appropriate.

7. WAO's located in hose or wash-down areas shall be installed at a height above the anticipated damp area and shall include a UL Listed NEMA rated water resistant cover.
Table 5 Maximum Fill Requirements for Riser Cable
*Internal diameters are taken from the manufacturing standard for electric metallic tubing and rigid metal conduit.

<table>
<thead>
<tr>
<th>Conduit</th>
<th>Area of Conduit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade Size (Inches)</td>
<td>Internal Diameter* (Inches)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1.05</td>
</tr>
<tr>
<td>1¼</td>
<td>1.38</td>
</tr>
<tr>
<td>1½</td>
<td>1.61</td>
</tr>
<tr>
<td>2</td>
<td>2.07</td>
</tr>
<tr>
<td>2½</td>
<td>2.47</td>
</tr>
<tr>
<td>3</td>
<td>3.07</td>
</tr>
<tr>
<td>3½</td>
<td>3.55</td>
</tr>
<tr>
<td>4</td>
<td>4.03</td>
</tr>
</tbody>
</table>

COMMUNICATION FLOOR POKE-THROUGH DEVICES:
1. All floor poke-through devices shall be indicated on the electrical and/or telecommunications drawings with the size of conduit to be installed. Cables shall terminate on the same floor they are installed on. No more than 6 cables within a floor box.
2. Suitable for use in air handling spaces in accordance with Sec 300-22(C) of the National Electrical Code.
3. Provide Wiremold Legrand® Evolution Series Poke-Thru Devices, or equal. Unit shall be fully recessed with die-cast aluminum spring-loaded slide doors; meet or exceed UL scrub water exclusion requirements; and meet ADA Standard 4.5 for floor surface level changes.

Pull Box Installation Requirements
1. Pull boxes shall be installed in easily accessible locations and accessible during working and non-working hours.
2. Pull boxes shall be placed in an interstitial ceiling space only if it is listed for that purpose and it is placed above a suitably marked removable ceiling panel.
3. Pull boxes shall not be in restricted and/or highly secured areas, such as X-Ray rooms, Clean rooms, etc.
4. Pull boxes are to be designed and installed per Figure 6.
Figure 6 Pull Box configurations

Reference Table 6 to select the proper size of pull box

Table 6 Sizing a Pull Box

<table>
<thead>
<tr>
<th>Maximum Trade Size of Conduit (Inches)</th>
<th>Size of Box</th>
<th>For Each Additional Conduit Increase Width (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Width</td>
<td>Length</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>1.25</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>1.5</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>36</td>
</tr>
<tr>
<td>2.5</td>
<td>10</td>
<td>42</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>3.5</td>
<td>12</td>
<td>54</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>60</td>
</tr>
</tbody>
</table>

Cable Trays for Communications Systems

COMMUNICATIONS CABLE RUNWAY AND TRAYS

Cable Runway shall be:

1. Used only in Telecommunications Spaces (TS).
2. Secured on 5-foot centers overhead using a standard trapeze type support system with 1/2-inch threaded rod in accordance with manufacturer specifications and applicable California Building and Electrical (CBC, CEC) Codes.
3. Cable tray not to be attached to the walls, secure overhead to a single plane.
4. UL Classified, gold zinc plated and minimum 18-inches wide with 9-inch rung spacing.
5. Installed with a minimum clearance of 12-inches above the cable ladder.
6. Meet the current requirements in TIA/EIA 569-D and applicable addendums
7. Grounded and bonded in accordance with ANSI/TIA/EIA-J-STD-607-C. All splices, T-Sections and bends shall be bonded together by UL Classified products. Cable runway and trays shall not be used as an equipment ground nor seismic support or bracing.
8. Meet Zone 4 or higher seismic bracing standards.

CABLE TRAYS:
1. Shall be steel wire basket or mesh suitable for hallways and false ceiling areas.
2. That are used to support horizontal cabling may be used to support riser cables provided the cable tray’s carrying capacity can accommodate the riser cables.
3. Shall be a minimum of 18-inches wide and 2-inches deep and contain a metal divider with 4-inches sectioned off for security low voltage. The use of carbon steel, electrozinc plated wire basket tray system is the preferred method of cable tray systems within the corridors. Plenum mesh type trays shall be used in plenum ceiling areas. Refer to manufacture fill charts for correct sizing.
4. Shall be secured on 10-foot centers and within 18-inches of a splice using a heavy duty wall support or a standard trapeze support system with 1/2-inch threaded rod in accordance with manufacturer specifications and applicable California Building and Electrical codes. Single center-mounted steel supporting rod and bottom “T” connector style of support shall not be used.
5. Provide swing bracing every 30 feet --per manufacturer requirements-- on continuous lengths over 39 feet. Cable trays shall meet Zone 4 or higher seismic bracing standards.
6. Shall be sized to accommodate future FTTD installations and building growth.
7. Shall be installed in accessible ceiling areas only and shall transition to a minimum of four 4-inch EMT conduits (one for security low voltage) when routed over fixed, hard and inaccessible ceiling spaces. Reference Figure 7.
8. Shall extend 4-inches into the TS (ER/TR) then utilize a manufacturer’s radius drop out (waterfall) to protect station cables from potential damage from the end of the tray. Where conduits drop down onto cable tray provide plastic spillways installed onto the end of the conduit to prevent kinking of the installed cable bundle. BEJED, Inc. part number Bj -2049B-002, or equal. www.bejed.com
9. Shall be grounded and bonded in accordance with ANSI/TIA/EIA-J-STD-607-C and manufacturers requirements (bonded to building steel approx. every 60 feet). All splices, T-Sections and bends shall be bonded together. Cable trays shall not be used as an equipment ground nor seismic support or bracing.
10. Penetrations through firewalls shall allow cable installers to firestop around the cables after they are installed. Tray-based mechanical firestop systems shall be used when a cable tray penetrates a fire barrier. All firestopping installations shall be labeled in accordance with ANSI/TIA/EIA 606-B.
11. Cables installed in cable trays shall not contain, nor be fastened with Velcro, tape or plastic type cable ties (tie-wraps).
12. Shall meet the requirements in TIA/EIA 569-D and applicable addendums.
CABLE TRAY AND RUNWAY CLEARANCES

1. Cable trays shall not be placed within 5-inches of any overhead light fixture and within 12-inches of any electrical ballast.
2. A minimum clearance of 12-inches above and 12 to 18-inches to one side of the cable tray shall be maintained always. All bends and T-joints in the cable trays shall be fully accessible from above (within one foot).
3. Cable trays shall be mounted no higher than 12-feet above the finished floor and shall not extend more than 4-feet over a fixed ceiling area.

Note: All cable trays and ladder racking, equipment racks and cabinets shall have seismic bracing as designed by a California Licensed Structural Engineer.

Underground Ducts and Raceways for Communications Systems

The University’s Representative shall coordinate conduit routes with Communications Resources.

UNDERGROUND CONDUIT CONSTRUCTION

General

1. Conduit shall be Polyvinyl-Chloride (PVC) Schedule 40 or 80 (dependent upon concrete encasement requirements), corrosion-resistant plastic with a 4-inch inside diameter for underground installations and Galvanized Rigid Steel (GRS) or PVC Externally Coated GRS for riser applications.
2. Spacers shall be used in the trench to support the conduits.
3. A solid core #10 AWG copper wire shall be installed externally along any conduit run for locating and tracing the conduit route.
4. Fabric multi-cell type of inner duct shall be considered for conduits planned for fiber optic cable installations.
5. All installed conduits shall be cleaned and verified with a flexible mandrel and a stiff brush. Mandrels shall be 12-inches in length and sized to within 1/4-inch of the inside diameter of the conduit.
6. All conduits shall be provided with mule tape with a minimum of 200 pound pulling tension.
7. All unused entrance conduits shall be capped/plugged with expandable type duct plugs, Jackmoon or equal, inside the building to prevent rodents, water or gases from entering the building.

8. Conduit stubs entering the building shall extend beyond the foundation and landscaping to prevent shearing of the conduit and allow for access. Conduit entering from a below grade point shall extend 4-inches above the finished floor in the ER/TR. Conduit entering from ceiling height shall terminate 4 inches below the finished ceiling.

9. All future conduit stubs shall be flagged for easy identification and a 3M®, or equal, electronic ball marker shall be placed.

10. All metallic conduit and sleeves shall be reamed, bushed and capped when placed.

11. The minimum depth of a trench shall allow for 24-inches of cover from the top of the conduit/cable to final grade. Warning tape containing metallic tracings shall be placed a minimum of 18-inches above the underground conduit/duct structure and direct-buried cable to minimize any chance of an accidental dig-up. Both ends of the metallic warning tape shall be accessible after installation.

12. MH's and PB's more than 30 inches below grade shall be equipped with permanent fixed steps or a fixed ladder.

13. There shall not be more than the equivalent of two (2) 90-degree bends (180-degrees total) between pull points, including offsets and kicks. Back-to-back 90-degree bends shall be avoided. All bends shall be manufactured long sweeping bends with a radius not less than 6 times the internal diameter of conduits 2-inches or smaller or 10 times the internal diameter of conduits larger than 2-inches. Bends made manually shall not reduce the internal diameter of the conduit. All branch conduits exiting a MH/PB shall be designed as Subsidiary conduits only (exit from the end wall of the MH/PB, not from the side wall). Lateral conduits entering/exiting MH/PB's are not allowed. The lowest conduit knock-outs shall be used first when adding new conduit to a MH/PB.

14. The University's Representative shall observe and inspect utilities trenching, excavation, backfilling and compaction as appropriate. Design shall include Contractor instructions to schedule all inspections prior to commencing trenching and backfilling operations. All installations are subject to satisfactory inspection by the University's Representative.

15. Conduits shall be secured with rebar when covering conduits with concrete.

16. All conduit bends and sweeps shall be concrete encased to prevent movement and "burn-through" by the pull rope during cable installations.

17. Concrete encasement shall comply with State of California, Department of Transportation standard specifications.

18. An orange colored additive shall be raked or trowel-worked into the wet concrete or cement slurry to identify the duct structure as communications.

19. Reinforcing bars within the concrete shall be sized accordingly for the load and stress at each location.

20. Contact the University's Representative for coordination with CR to inspect and approve all conduits prior to encasement.

21. Conduit shall be encased in concrete or cement slurry when the following conditions exist:

   a. Minimum conduit depth cannot be attained.
b. Conduits pass under sidewalks, roadways, driveways, railroad tracks and at bend points.

Note: The American Public Works Association has adopted orange for telecommunications cables.

Directional Boring
1. High-density polyethylene (HDPE) conduit to be used for directional boring.
2. A swivel shall be used always to prevent rotation of the product pipe.

Sizing Underground Conduit
The quantity and size of underground entrance conduits are based on the size of the building:
(3) 4-inch conduits are standard. (4 or more) 4-inch conduits shall be used down main pathways.

Conduit Separation Requirements
The minimum recommended separation between telecommunications conduit systems and outside surfaces of foreign structures are shown in Table 7. These clearances are required by the National Electrical Safety Code (NESC) for personnel safety and the protection of telecommunications equipment.

Table 7 Vertical and Horizontal Separations

<table>
<thead>
<tr>
<th>Adjacent Structure</th>
<th>Minimum Separation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power or another foreign conduit</td>
<td>3-inches of concrete, or 4-inches of masonry, or 12-inches of well-tamped earth</td>
</tr>
<tr>
<td>Pipes (gas, oil, water, etc.)</td>
<td>6-inches when crossing perpendicular 12-inches when parallel</td>
</tr>
<tr>
<td>*Railroad crossings (except street railways)</td>
<td>50-inches below top of rail 12-feet from the nearest rail if terminating on a pole 7-feet from the nearest rail if terminating on a pole at a siding</td>
</tr>
<tr>
<td>Street railway</td>
<td>3-feet below the top of the rail</td>
</tr>
<tr>
<td>UCD Campus Steam Lines</td>
<td>10-feet parallel and perpendicular (UCD campus requirement)</td>
</tr>
</tbody>
</table>

*Additional local requirements may apply.

All plastic underground piping shall be kept at a 10-foot distance from steam/condensate lines unless approved by the University’s Representative. When crossing is necessary within the 10-foot distance limitation, transition to galvanized rigid pipe for at least 10 feet on either side of the intersection. Communications conduits may also require a pipe insulation treatment be installed.

If required separation cannot be obtained, an engineered solution shall be submitted to the University’s Representative for coordination with CR, review and approval prior to the beginning of any installation work.
MAINTENANCE HOLES (MH) AND PULL BOXES (PB)

General Requirements

1. MH/PB’s are required where maximum cable reel lengths are exceeded, at the intersection of main and branch conduit runs and at other locations where access to the cable in a conduit system is required.
2. The maximum distance allowed between buildings and MH/PB's or between two MH/PBs' is 600 feet.
3. No more than (2) 90-degree bends between MH/PBs'.
4. MH's and PB's shall be constructed to withstand a minimum of ASSHTO-H20-44 full traffic loading.
5. All MH/PB covers shall be rated for heavy and constant vehicular traffic, regardless of placement location.
6. All hardware in MH/PB's shall be galvanized.
7. Pulling eyes shall be a minimum of 7/8-inches in diameter and located at opposite ends of each conduit entrance point.
8. All MH/PB covers shall be marked for easy identification (Communications) and have a permanently attached label indicating the assigned MH/PB number. (Contact the University's Representative for MH/PB number).
9. MH locations where the distance between the ceiling of the manhole and the street level exceeds 24-inches shall require the installation of permanent steps in the neck of the MH. These steps shall be installed in the neck rings at the same time as the MH is being installed, per manufacturer instructions. Steps shall not be cut and cemented in place after the installation of the neck ring.
10. MH's and PB's more than 30 inches below grade shall be equipped with permanent fixed steps or a fixed ladder.
11. Provide (4) L-Cable Racks PB and (8) L-Cable Racks per MH.

Where placement location is a roadway, driveway, bike path, fire line, loading dock or trash pickup area, provide only a MH.

See Figure 8 for an example of a typical MH, and Figure 9 for a typical PB.

Additional PB Requirements

1. All Pull Boxes (PB) shall be equipped with slip resistant covers with height adjustment brackets, torsion assist openings, guard bars and hex head type bolts.
2. PB’s shall not be placed in a main conduit route between two MH's. MH/PB's shall be placed at strategic locations in a conduit system to allow installers to pull cable through the conduit with minimum difficulty and to protect the cable from excessive tension.
3. Step rungs are to be installed within a pull box installed deeper than the standard 3-feet and extension rings are required to match grade. A minimum of a 4-feet by 6-feet by 3-feet box shall be installed. Coordinate the installation with the University's Representative.
MH/PB Conduit Entry Requirements:
1. If the total number of conduits being placed is significantly less than the capacity of the termination MH or cable entrance, conduit shall enter at the lower level. The upper space shall be reserved for future additions.
2. Conduit servicing buildings or other MH/PB’s shall be installed using the subsidiary conduit method. Lateral conduits entering/exiting MH/PB’s are not allowed.
3. 22-degree and 45-degree conduit angles are preferred. Regardless of depth, all bends and sweeps shall be concrete encased to prevent movement and “burning through” by the pull rope during cable installations.
4. Conduits installed between MH/PB’s and buildings and between other MH/PB’s shall be sloped per TIA 758-B to ensure proper drainage of water.
5. All conduits entering buildings shall be plugged with expandable type duct plugs, Jackmoon or equal, inside the building to prevent rodents, water or gases from entering the building. MH/PB conduits shall be plugged with duct seal material to prevent the entrance of water and gases.
Figure 8 Typical Maintenance Hole

PTS65—TST
MAN-HOLE
UCDAVIS TELEPHONE
(TRAFFIC RATED)
4'–6" x 8'–6" x
6'–6"
(INSIDE DIMENSIONS)

CAST IRON RING AND
COVER SB–30 FOR
STREET
6" RISER,
MODEL 3649–06
TWO 12" RISERS
MODEL 3646–12
STEP RUNG
2 TYP.

5 5/8"
5 5/8"
5 5/8"

38" ACCESS
OPENING

APPROX. WEIGHT:
3,550 LBS.

4 TON SWIFT LIFT PINS, 4 IN TOP
SLAB, 4 IN BOX FLOOR, 8 TOTAL

8'–6" CAST IN
UNISTRUT, 2 EACH
END WALL, 4 TOTAL

4 1/2" KNOCKOUT,
4 EACH END WALL,
4 EACH SIDE WALL,
16 TOTAL

4 5/8" DUCT
TERMINATOR, 12
EACH END WALL,
24 TOTAL

APPROX. WEIGHT:
18,000 LBS.

BOX DESIGN LOAD:
H–20 TRAFFIC
WITH 1' TO 5' EARTH COVER
KNOCKOUTS, DUCT TERMINATORS,
RACKING, AND LADDER PER CURRENT
SUREWEST TELEPHONE SPECIFICATIONS.

FOR COMPLETE DESIGN
AND PRODUCT INFORMATION,
CONTACT JENSEN PRECAST.

NOTE: JENSEN PRECAST BOX, OR EQUAL

11/13/04
J/P65—to:TST.png
© 2004 Jensen Precast
Figure 9 Typical Pull Box

**466TA PULLBOX**

4'-0"x 6'-6"x 3'-0"
(NOMINAL INSIDE DIMENSIONS)

*NOTE:* DESIGNED TO WITHSTAND H-20 WHEEL LOADINGS. SUITABLE FOR USE IN OFF-STREET LOCATIONS WHERE NOT SUBJECT TO HIGH DENSITY TRAFFIC.

**OPTIONAL RISERS (EXTENSIONS)**

<table>
<thead>
<tr>
<th>MODEL NO.</th>
<th>WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>466-R6</td>
<td>6&quot; 650 LBS.</td>
</tr>
<tr>
<td>466-R12</td>
<td>12&quot; 1190 LBS.</td>
</tr>
</tbody>
</table>

**ADJUSTABLE TORSION SPRING ASSISTED COVERS**

*4878AT–TRF, 790 LBS. (H-20 TRAFFIC)*

OR

*4878AT–PKY, 640 LBS. (NON-TRAFFIC)*

*4878AT–TRF–AG, 650 LBS. (H-20 TRAFFIC)*

OR

*4878AT–PKY–AG, 630 LBS. (NON-TRAFFIC)*

FOR COMPLETE DESIGN AND PRODUCT INFORMATION, CONTACT JENSEN PRECAST.

(Note: Jensen precast box, or equal)
Utility Poles for Communications Systems

Campus utilities are to be placed underground

Identification for Communications Systems

Labeling shall meet the requirements in this document and the ANSI/TIA/EIA 606-B, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, where applicable.

NAM NUMBERING, MATRIX AND LABELING REQUIREMENTS

NAM Numbering

1. Assign the NAM numbers to the floor plans. Communication Resources (CR) shall provide blocks of NAM numbers for voice, data and fiber to the desktop (FTTD) and master antenna television (MATV). Contact the University’s Representative.

NAM Matrices

1. The consultant shall provide a NAM Matrix spreadsheet (Data, MATV and FTTD), which identifies all NAM locations, TR and cross-connects.
2. Reference Tables 8, 9 and 10.
3. Specify that the Contractor shall use and update the NAM Matrices during the project construction.

Table 8 DATA NAM MATRIX

<table>
<thead>
<tr>
<th>CAAN/</th>
<th>DATA</th>
<th>NAM</th>
<th>BDF/IDF</th>
<th>NAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZONE</td>
<td>NAM #</td>
<td>ROOM #</td>
<td>TERM #</td>
<td>FLR #</td>
</tr>
</tbody>
</table>

Table 9 MATV NAM MATRIX

<table>
<thead>
<tr>
<th>CAAN/</th>
<th>MATV</th>
<th>NAM</th>
<th>BDF/IDF</th>
<th>NAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZONE</td>
<td>NAM #</td>
<td>ROOM #</td>
<td>TERM #</td>
<td>FLR #</td>
</tr>
</tbody>
</table>

Table 10 FTTD NAM MATRIX

<table>
<thead>
<tr>
<th>CAAN/</th>
<th>FTTD</th>
<th>NAM</th>
<th>BDF/IDF</th>
<th>NAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZONE</td>
<td>NAM #</td>
<td>ROOM #</td>
<td>TERM #</td>
<td>FLR #</td>
</tr>
</tbody>
</table>
NAM Labeling

1. Each 8-pin, 8-conductor module shall be assigned a unique 6-digit (7-digit for FTTD) NAM number. Use a pre-printed label or electronic label maker such as the Brother P-Touch®, or equal. The label shall contain black, Helvetica, Size 1 Font, block letters on a white background. When printing labels on a Desktop printer labels shall be black, Helvetica, size 10, block letters on a white background.

2. The NAM number shall be placed in the window area on the faceplate above and below the NAM in the space provided as shown in Figure 10.

3. When a surface mounted interface box is used, the top of the box shall be labeled as shown in Figure 12.

4. Fiber to the Desktop (FTTD) NAM's shall be labeled as shown in Figure 11.

5. Camera outlets will have a unique numbering scheme. Label CAM 01-XX.

Figure 10 Labeling Flush Mounted Double Gang Angled WAO

```
| 6xxxxx | 6xxxx | 6xxxxx | 6xxxx |
```

![Diagram of NAM labeling](image-url)
Figure 11 Labeling Flush Mounted Double Gang Angled FTTD WAO

Figure 12 Labeling Surface Mounted WAO
OUTSIDE PLANT AND RISER CABLE LABELING REQUIREMENTS

Fiber Optic Cable Termination Cabinet/Housing Labeling

1. Fiber optic termination housings shall be labeled using the manufacturer’s provided termination-housing labeling system. The panel shall be overlaid with one-piece, self-adhesive, full-size, laser printer generated label sheet adhered to the slide out metal panel or inside door of the enclosure, where applicable using an 8.5-inch by 11-inch laser printable adhesive backed sheet, part number Avery 5165 or equal. Reference Figure 13.

2. Fiber strand numbering shall be consistent with the Consecutive Fiber Numbering (CFN) sequence as identified in TIA/EIA 568-C.1. This fiber strand numbering sequence shall be accomplished at each terminated end of the fiber optic cable. The rolling of fiber optic strands, as identified in TIA/EIA 568-C.1 as Reverse Pair Positioning (RPP) shall not be used on the Campus.
Figure 13 Fiber Optic Closet Connector Housing Labels

Example A: 144SM Cable from CAAN: 4881 to CAAN: 4668 & multiple other locations using 568SC Duplex Closet Connector Panel.

<table>
<thead>
<tr>
<th>CAAN: 4881 BDF 1.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>4668</td>
</tr>
<tr>
<td>3845</td>
</tr>
<tr>
<td>4719</td>
</tr>
<tr>
<td>MH32-160NW</td>
</tr>
<tr>
<td>MH32-160NW</td>
</tr>
<tr>
<td>MH30-160NW</td>
</tr>
<tr>
<td>4861 6F/MH29-156NW6F</td>
</tr>
<tr>
<td>MH29-156NW</td>
</tr>
<tr>
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<thead>
<tr>
<th>IDF 1.1</th>
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<td>72</td>
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<td>84</td>
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</tr>
</tbody>
</table>

Example B: 72SM Cable from CAAN: 4021 ADF 3 to CAAN: 4343 BDF 0.1 using 568SC Duplex Closet Connector Panel.

<table>
<thead>
<tr>
<th>CAAN: 4021 ADF 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>4343</td>
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<tr>
<td>4343</td>
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</table>

<table>
<thead>
<tr>
<th>BDF 0.1</th>
<th>BDF 0.1</th>
<th>BDF 0.1</th>
<th>BDF 0.1</th>
<th>BDF 0.1</th>
<th>BDF 0.1</th>
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<tbody>
<tr>
<td>1</td>
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<td>3</td>
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<td>27</td>
<td>28</td>
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<td>5</td>
<td>6</td>
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<td>18</td>
<td>29</td>
<td>30</td>
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<tr>
<td>7</td>
<td>8</td>
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<td>12</td>
<td>23</td>
<td>24</td>
<td>35</td>
<td>36</td>
</tr>
</tbody>
</table>
Example C: 48SM Cable from CAAN: 3843 IDF 1.1 to CAAN: 4881 BDF 1.1 using 568SC Duplex Closet Connector Panel

<table>
<thead>
<tr>
<th>CAAN: 3843 IDF 1.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4881</strong></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td><strong>4881</strong></td>
</tr>
<tr>
<td>13</td>
</tr>
</tbody>
</table>

Source CAAN Number (Beginning of Fiber Strand)
Destination CAAN Number (End Point of Fiber Strand)
ADF/BDF/IDF Number (opposite terminated location of strand) (where applicable)

Fiber Optic Housings Connector Panels Labeling
1. Fiber strand number 1 (Blue) shall occupy fiber port number 1 in the upper most left position of the first duplex bulkhead connector installed in the connector panel placed in the first slot on the left side of the housing.
2. Fiber strand number 2 (Orange) shall occupy fiber port number 2, immediate right of fiber port number 1, of the same duplex bulkhead connector.
3. All remaining fiber optic strands shall be number consecutively left to right, top to bottom. Reference Figure 14.

**Figure 14 568SC Duplex Fiber Optic Connector Panel Numbering Sequence**

Fiber Optic Splice Shelf Labeling
1. Fiber optic splice shelves and drawers shall be labeled sequentially from top to bottom using an adhesive backed, labeling stock type of paper printed on a laser printer. Trim the paper to fit the inside door of the splice housing or shelf.
2. Identify in tabular form the splice tray, position number and the fiber strand spliced at that location. Labeling shall consist of the cable number, the fiber optic strand number and the strand type.
Fiber Optic Cable Sheath Labeling

1. Label Fiber optic cable sheaths located inside buildings within 12 inches of the fiber housing, the point at which the cable enters and/or exits the room and at one mid-point location when the cable is installed in a cable tray or ladder rack, as a minimum.

2. Fiber optic cables located in maintenance holes (MH) shall have their sheaths labeled in at least one location that is visible from grade level. MH’s and PBs containing splice closures shall be labeled on each side of the splice closure. Outside Plant (OSP) fiber optic cables shall contain an orange fiber optic warning tag with large black letters. Panduit type PCV-FOR, or equal. Reference Figure 15.

3. The fiber optic cable label shall consist of a plastic yellow and black type tag with a self-laminating cover for use with pre-printed labels and attaches with a plastic tie wrap. Panduit type PST-FO, or equal. Reference Figure 15.

4. See Figure 16 for Fiber Optic Cable Label Sequence (Cable Tag).

5. See Figure 17 for Fiber Optic Cable Label Sequence (MH/PB with Splice)

Figure 15 Fiber Optic Cable Sheath Labels
Figure 16 Fiber Optic Cable Label Sequence (Cable Tag)

Example 1

Example 2
Figure 17 Fiber Optic Cable Label Sequence (MH/PB with Splice)

1. Building entrance terminals shall be labeled with the name of the building, the building zone number, the building CAAN number, the cable pair numbers entering the terminal and the cable pair numbers exiting the terminal (if applicable). Reference Figure 18.

2. Labels shall be pre-printed using an electronic label maker such as the Brother P-Touch® or equal, or a laser printer. Electronic label maker labels shall be 18 point, "font 1" black block letters on a white background. Desktop printed labels shall be black, Helvetica, 10 Font, block letters on a white background.

Copper Cable Termination Housing Labeling

1. Building entrance terminals shall be labeled with the name of the building, the building zone number, the building CAAN number, the cable pair numbers entering the terminal and the cable pair numbers exiting the terminal (if applicable). Reference Figure 18.

2. Labels shall be pre-printed using an electronic label maker such as the Brother P-Touch® or equal, or a laser printer. Electronic label maker labels shall be 18 point, “font 1” black block letters on a white background. Desktop printed labels shall be black, Helvetica, 10 Font, block letters on a white background.
Figure 18 Building Entrance Terminal Label Sequence

Copper Cable Sheath Labeling

1. Copper cables located inside buildings shall have their sheaths labeled within 12 inches of the termination housing, the point at which the cable enters and/or exits the room and at one mid-point location when the cable is installed in cable tray or ladder rack, as a minimum.

2. Wiring jacks shall be left protruding from the faceplate for inspection by a UCD Representative of the jacks and labels prior to the installation into the faceplate.

3. Copper cables located in maintenance holes (MH) and pull boxes (PB) shall have their sheaths labeled in at least one location that is visible from grade level. Existing MH’s and PB’s containing splice closures shall be labeled on each side of the splice closure and shall be visible from grade level.

4. The copper cable label shall consist of a gray plastic type tag with a write-on surface attached with a plastic tie wrap. Provide Panduit type CM4S-L8, or equal. Reference Figure 19.

5. Reference Figure 20 for Copper Cable Labeling Requirements.
Commissioning of Communications 27 08 00

TESTING REQUIREMENTS FOR COPPER AND FIBER OPTIC HORIZONTAL CABLES

General
1. Test and document each horizontal cable segment separately.
2. Test each end-to-end cable link.
3. Design Professional shall develop testing specifications and requirements.

The Contactor shall perform testing on all installed cabling systems. All documented test results shall be provided to the University’s Representative for review and approval by CR.

Prior to testing, all cables shall be installed, terminated, labeled and inspected. The Contactor shall notify the University’s Representative 48 hours in advance and provide a testing schedule. The University’s Representative has the right to verify the set-up and procedures of testing instruments and be present during cable certification. The Contactor shall provide calibration...
certifications for testing equipment to be used, prior to commencement of testing. All testers are to have been calibrated within the last year of testing. All tests conducted before approval shall not be accepted.

UNSHIELDED TWISTED PAIR (UTP) HORIZONTAL VOICE AND DATA CABLE TESTING

1. Permanent Link test all UTP horizontal station cables with a Level III or later tester for full compliance with TIA/EIA 568-C.2, Category 6A specifications. Test using Cat 6A test cords, by same manufacturer as test equipment and save all graphs when testing. Contractor to test 110 voice terminal blocks with a 110 smart adapter probe test cord provided by the manufacturer of the test equipment.

Test results shall be provided for all conductors of each cable and shall meet Table 11 parameters.

### Table 11 Permanent Link Testing

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Category 6A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return Loss (dB)</td>
<td>17.3 dB</td>
</tr>
<tr>
<td>NEXT (dB)</td>
<td>40.4 dB</td>
</tr>
<tr>
<td>PSNEXT (dB)</td>
<td>38.4 dB</td>
</tr>
<tr>
<td>Insertion Loss (dB)</td>
<td>31 dB/100m</td>
</tr>
<tr>
<td>ACR (dB)</td>
<td>11.8 dB/100m</td>
</tr>
<tr>
<td>PSACR (dB)</td>
<td>9.8 dB/100m</td>
</tr>
<tr>
<td>ACRF (dB)</td>
<td>23.8 dB/100m</td>
</tr>
<tr>
<td>PSACRF (dB)</td>
<td>20.8 dB/100m</td>
</tr>
<tr>
<td>Propagation Delay</td>
<td>536.3 MHz</td>
</tr>
<tr>
<td>Delay skew (ns)</td>
<td>45ns/100m</td>
</tr>
</tbody>
</table>

Fiber to the Desktop (FTTD) Horizontal and Riser/ Backbone Fiber Cable Testing

Test all horizontal single-mode FTTD cables for full compliance with TIA/EIA 568-C.1 and C.3 (including addendums).

Field-testing instruments for single-mode fiber optic cabling shall meet the requirements of ANSI/TIA/EIA-526-7 using testing Method A and B. Reference TIA/EIA-568-C.3 for additional test requirements.

Fiber optic testing procedures:

**Link attenuation (Power Meter)**

1. All horizontal single-mode fiber optic cables shall be tested for link attenuation (i.e. power insertion loss) as referenced in TIA/EIA-568-C.1, Section 11.3 and/or per Table 12, which is ever more stringent. See Table 12 for proper fiber testing measures.
2. All strands shall be tested in a bi-directional method at both wavelengths with a Power Source and Meter capable of recording and plotting data.
3. TIA/EIA 568-C.1 and TIA/EIA 526-7 outlines the steps required to test single-mode fiber optic cable.
4. Ensure that all connectors (on both sides of the mating sleeve) are clean prior to testing. Do not use canned air to clean the connectors or mating sleeves.

**Optical Time Domain Reflectometer (OTDR)**

1. Horizontal cables shall be tested bi-directional and at both wave lengths for dB loss and end-to-end total installed distance with an OTDR. Each trace shall indicate the cable length and 2-Point dB loss between the A and B test trace cursors. Test using a manufactured and terminated Corning MM/SM or equal, as appropriate, glass launch cable. OTDR traces shall use the Medium Smooth setting and readings taken in feet.
2. Cables to be tested at the appropriate pulse width to accommodate short cable lengths (MM cable at maximum 5 ns/6.6 ft and SM maximum 20 ns/6.6 ft).

<table>
<thead>
<tr>
<th>Maximum Loss Measurements for Installed Fiber Optic Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mated Connector Loss:</td>
</tr>
<tr>
<td>Connector Loss:</td>
</tr>
<tr>
<td>Splice Loss: Fusion Multimode</td>
</tr>
<tr>
<td>Fibre Single-mode</td>
</tr>
<tr>
<td>Fiber loss: Multimode (Legacy)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Fiber loss: Single-mode</td>
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<tr>
<td></td>
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</table>

Test Result Documentation

Power meter fiber optic test results shall be provided by a tester-generated documentation in hard copy (paper copy) and soft copy (CD electronic copy). Provide in manufacturer software format.

OTDR fiber optic traces shall be provided in hard copy (paper copy) and soft copy (CD electronic copy) that is readable by Corning Cable Systems, GN Net Test or Fluke LinkWare software, or equal.

Test results shall be organized by NAM# and closet in an orderly fashion.

CD electronic copy shall have the latest version of software burned on it for viewing test results and a copy of the transmittal letter explaining any issues regarding the test results (skipped #’s, cause of failures, etc.).

CD shall have a computer generated label with:
1. Contractor’s Name
2. Date
3. UC Davis Bldg. name, CAAN and project number
4. Contents (Fiber/copper Test Results, etc.)

**Structured Cabling**

The University’s Representative shall coordinate with Communications Resources early during the utilities planning phase of the project since each site may have technical requirements requiring a modification of these specifications.

**Communications Entrance Protection**

**BUILDING ENTRANCE TERMINALS**

1. Outside Plant copper cables entering the ADF/BDF/IDF shall be terminated on wall-mounted building entrance protector terminal(s) equipped with digital solid state (4B1FS-240) protector modules; 4B1FS-240 includes heat coils for sneak current protection.

2. Building entrance terminals shall not be located directly above the room entrance conduits, slots or sleeves. Terminals shall be mounted in a location on the backboard that shall allow sufficient space for future cable and cross-connect installations.

3. Copper entrance cables up to and including 300 pairs shall be terminated on protected building entrance terminals equipped with a splice chamber and factory installed large 710-type splice modules in the splice chamber (field side) and 110 type terminations on the output (equipment side) and lockable cover; Circa model 1880ECS1-100, or equal. Cable shall be blocked with an approved manufactured seal to prevent the gel filled compound from escaping; See Figure 21.

4. Copper entrance cables 301 pairs and larger shall be terminated on individual 100 pair protected terminals equipped with a factory installed, 26AWG swivel cable stub in the splice chamber (field side) and on the output (equipment side): stub-in, stub-out configuration. Cable stubs shall be no shorter than 2 feet in length after installation. Circa model 2000-100, or equal; Figure 22.
5. Factory cable stubs shall be spliced with 25-pair 710-type splice modules to the outside plant copper. An indoor rated splice closure shall be securely mounted to the plywood backboard. Indoor closures shall not be encapsulated.

6. Contractor shall extend the copper backbone cable from the building entrance terminal to a separate 110-type termination block field. Reference Figure 23.

Figure 23 Building Entrance Terminal Layout
All terminals shall be labeled in accordance with Section 27 05 53 Identification for Communications Systems and properly grounded to the Telecommunications Grounding Busbar (TGB) in accordance with ANSI-J-STD-607-C.

**Communications Cabinets, Racks, Frames and Enclosures**

**EQUIPMENT RACKS AND DISTRIBUTION CABINETS**

Free standing equipment racks shall be used in all ADF/BDF/IDF locations that are secured by a lockable door. CH751 cabinet key core preferred.

Equipment racks shall meet the following requirements:

1. One piece 10 gauge welded steel. Nominal height is 7 feet (45U) by 27-inches wide. Fits 19 in. rack mount equipment. Rails shall be double sided and tapped on both sides with 12-24 UNC threads in EIA Universal 5/8 – 5/8 – 1/2 inch vertical mounting hole pattern that matches industry standards. Hoffman ESDR19FM45U with ECM6DR10, or equal.
2. UL 1863 Tested / Listed to 2,500 lbs. static load – max safety factor of 4 – tested to 10,000 lbs. Proof of conformance shall be supplied with submittal prior to work.
3. NEBS-Telecordia GR-63-CORE Zone 4, or equal: Tested with 500 lb of equipment installed. Dynamic shaker table tested and passed. Proof of conformance shall be supplied with submittal prior to work.
4. Approved and Stamped by a Certified State of California Structural Engineer to OSHPD (Office of Statewide Health Planning and Development), CBC (California Building Code) and UBC (Uniform Building Code). Proof of conformance shall be supplied with submittal prior to work.
5. Ground holes provided in multiple locations in accordance with Building Industry Consulting Services International (BICSI) guidelines. Ground symbol pressed into metal as required by NEC (National Electric Code).

Free standing cabinets shall be used only in locations that are not securable by a lockable door or meet environmental requirements. The University’s Representative shall approve these areas prior to the design or installation of these cabinets. Provide Hoffman ENC2178S, or equal.

Cabinets shall meet the same requirements as equipment racks listed above.
EQUIPMENT RACK AND CABINET DIMENSIONS

Table 13 Equipment Rack and Cabinet Dimensions

<table>
<thead>
<tr>
<th>Type of Termination</th>
<th>19” Equipment Rack Dimensions (H by W)</th>
<th>Distribution Cabinet Dimensions (H by W by D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADF</td>
<td>84-inches by 27-inches (3 each)</td>
<td>84-inches by 24-inches by 32-inches (3 each)</td>
</tr>
<tr>
<td>BDF</td>
<td>84-inches by 27-inches (4 each)</td>
<td>84-inches by 24-inches by 32-inches (4 each)</td>
</tr>
<tr>
<td>IDF</td>
<td>84-inches by 27-inches (3 each)</td>
<td>84-inches by 24-inches by 32-inches (3 each)</td>
</tr>
</tbody>
</table>

Note: Overall height of all standing equipment racks and cabinets shall not exceed 84 inches.

ELECTRICAL REQUIREMENTS

Refer to Section 27 00 00 Telecommunications Space Electrical Requirements and Figures 24-26.

EQUIPMENT RACK AND CABINET LAYOUTS

Area Distribution Frame (ADF)
Planning for a new ADF shall be coordinated with the Communications Resources, contact the University’s Representative.
Figure 24 Typical ADF Equipment Rack Layout:

4 11/16-inch square by 2 1/8-inch deep junction box, duplex dedicated 20-amp NEMA 5-20R space receptacles 15-inches A/F (one on each rack, rear facing)
BDF/IDF Equipment Racks

Figure 25 Typical BDF/IDF Equipment Rack Layout:

1. **Stack ID**
2. **4 11/16-inch square**
3. **by 2 1/8-inch deep**
4. **junction box**
5. **duplex**
6. **dedicated 20 amp**
7. **NEMA 5-20R spade receptacles**
8. **15-inches AFH (one on each rack, rear facing)**
9. **PCH-04 Riser Fiber**
IDF Equipment Racks

Figure 26 Typical IDF Equipment Rack Layout:

4 11/16-inch square by 2 1/8-inch deep junction box, duplex dedicated 20 amp NEMA 5-20R spade receptacles 16-inches AFF (one on each rack, rear facing)
**Communications Termination Blocks and Patch Panels**

**DATA PATCH PANELS**

1. UTP cable angled patch panels that provide data service to WAO’s shall meet the following specifications, Ortronics® Clarity 10G Angled, Part number OR-PHA6AU48 (48 port), or equal.
2. Patch panels shall meet specified performance requirements as listed in Table 14.
3. Patch panels shall be manufactured by an ISO 9001 Certified Manufacturer and be fully compliant with ISO/IEC/DIS-11801 standard and meet FCC specifications where applicable. These products shall also be UL® certified, where applicable.
4. Patch panels shall be labeled below the 8P8C module using an electronic label maker such as the Brother P-Touch®, or equal. The electronic label shall contain black, Helvetica, Size 1 Font, block letters on a white background as shown in Figure 27.
5. Camera locations shall be terminated on a wall mounted swingout bracket and patch panel.

UC Davis has adopted a Universal Wiring Scheme. All Work Area Outlets (WAO) consist of data service. WAO UTP cabling shall be terminated on a Cat 6A angled patch panel mounted within the patch panel equipment rack located within the Telecom Room.

**Table 14 500 MHz Data Patch Panel Specifications (UL certified testing laboratory)**

<table>
<thead>
<tr>
<th>Data Patch Panel Termination Hardware</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction (48 Port Angled Patch Panels)</td>
<td>Category 6A to 110 IDC, 568A wiring, 8P8C, high density angled, 6 port, rear cable management, front and rear designation strips, 19-inches (483mm) wide by 3.5-inches (89mm) high (48 port), Low emission IDC contacts, TIA/EIA 568-C.2 compliant and UL® Listed</td>
</tr>
<tr>
<td>Electrical Data (tested at 500MHz)</td>
<td>Return Loss: 14 dB</td>
</tr>
<tr>
<td></td>
<td>Attenuation: 0.45 dB</td>
</tr>
<tr>
<td></td>
<td>NEXT: 34 dB</td>
</tr>
<tr>
<td></td>
<td>FEXT: 29.1 dB</td>
</tr>
<tr>
<td>Active Live Channel Testing</td>
<td>0.17 errors per minute allowable</td>
</tr>
</tbody>
</table>

**Figure 27 Sample 48-port Angled Patch Panel.**
VOICE BACKBONE UTP CABLE TERMINATION BLOCKS

1. Voice backbone UTP cables that provide voice service to Work Area Outlets (WAO’s), cross-connects and Digital Loop Carrier systems shall be installed using the following products.
   a. Wall-mountable 110-type cross connect termination blocks with backboard shall support the appropriate Category 5e rating. Manufactured in 300 pair size kits to include 110-type blocks, 110-C type connecting blocks, jumper trough, bottom tray and labels. Termination kit shall be Ortronics® PT# 110-PA2-300FT, Systimax® or equal.
   b. Wall-mountable 110-type cross connect field shall facilitate cross connection and intermediate cross connection using 110 wall mount backboard channel and cross-connect wire or patch cords. The cross-connect hardware shall be of the same manufacturer as the 110-type patch panel to insure compatibility, function, fit and appearance.

2. The top of the 110-type block shall be mounted on a plywood backboard at a maximum height of 72-inches Above Finished Floor (AFF).

3. Electrical Specification:
   a. ANSI/TIA/EIA-568-C.1, C.2 and Category 5e compliant in both design and performance.
   c. 110-type connecting blocks shall be manufactured by an ISO 9001 Certified Manufacturer, and be fully compliant with ISO/IEC/DIS-11801 standard and meet FCC specifications where applicable. These products shall also be UL® certified, where applicable.

FIBER TO THE DESKTOP (FTTD) PATCH PANELS

1. FTTD patch panels that provide fiber service to WAOS shall be terminated using the following products:
   a. Corning Cable Systems® Pretium Connector Housings, Rack-mountable, PCH or equal.
   b. Corning Cable Systems® Pretium Wall-Mountable Housings, PWH or equal. Corning Cable Systems® Closet Connector Housing Panels, CCH-CP12-A9, Single-mode LC Adapter Duplex, or equal
   c. Corning Cable Systems factory made SM LC Ultra PC type pigtails, or equal.

2. All rack and wall-mounted fiber optic closet connector housings shall be labeled in accordance with Figure 13.

3. Housing and connector panels shall be of the same manufacturer as the fiber optic cable and connectors to ensure proper compatibility, fit, function, appearance and the highest campus wide system performance levels and warranty.
The building backbone consists of the riser cable and the supporting infrastructure within a building or cluster of buildings that connects the Telecommunications Spaces (ADF/BDF/IDF’s within the ER/TR’s). The building backbone shall be arranged in a Star Topology. Reference Figure 28.

Table 15 lists the color codes for cross connect fields. Table 15 shall be used to identify horizontal and riser cables in accordance with TIA/EIA 606-B.

### Table 15 Cross Connect Field Color Codes

<table>
<thead>
<tr>
<th>TERMINATION TYPE</th>
<th>COLOR</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>First level backbone</td>
<td>Blue</td>
<td>Terminations of building backbone cable connecting MC to IC’s</td>
</tr>
<tr>
<td>Horizontal</td>
<td>White</td>
<td>Terminations of horizontal cable in TS</td>
</tr>
<tr>
<td>Campus backbone</td>
<td>Green</td>
<td>Termination of backbone cable between buildings</td>
</tr>
</tbody>
</table>

**Figure 28 Star Building Backbone**
COPPER RISER CABLE SPECIFICATIONS

Riser cables shall meet the following requirements:

1. UL 444 and 1666, ANSI/TIA/EIA 568-C.2, FCC Part 68, Telecordia GR-111, Category 3, listed as CMR or CMP.
2. The type of riser cable shall be ARMM. ARMM riser cables shall be grounded and bonded in accordance with ANSI-J-STD-607-C requirements, as applicable.
3. Riser or plenum rated multi-pair copper cables shall be installed in horizontal (cable tray) installations between the BDF and IDF as required per building specifications.
4. The riser cable is labeled based on a cable number assigned by the University's Representative. The cable pair count shall also be included in the label.
5. Reference Division 27 11 19, Communications Termination Blocks and Patch Panels, for riser cable termination hardware.

Size Copper Riser Cable

1. The size of the riser cable is a function of the number of WAO’s supported by the IDF.
2. The minimum number of copper riser cable pairs required for each voice NAM = 2 pairs, three (3) or more voice NAMs = 1.5 pairs per NAM.
3. Riser cables shall be sized to the next larger, even pair size (i.e. 100, 200, 300, etc.).

OUTSIDE PLANT UTP COPPER CABLE

1. Filled core (waterproofing compound) cable shall be used for underground cable installations.
   a. PE-39 refers to filled cable with solid polyolefin insulation and is suitable for conduit and direct-buried applications. Cable shall meet ANSI ICEA 7CFR-1755-039 and 390 specifications.
   b. PE-89 refers to filled cable with formed polyolefin insulation and is suitable for conduit and direct-buried applications. Cable shall meet ANSI ICEA 7CFR-1755-089 and 890 specifications.
2. All outside plant cable shall be Plastic Insulated Conductors (PIC) and the cable jacket shall be marked with the cable length, cable code, date and manufacturer.
3. The minimum bend radius during installation is 10 times the outside diameter of the cable and 8 times the outside diameter after installation. Minimum bend radius shall be maintained during and after the installation phase.
4. OSP Copper cable shall have a 10-foot service loop prior to terminations at the ADF/BDF/IDF location. The University’s Representative shall approve the location of this service loop prior to cable installation and termination. OSP copper shall have a loop left in each Manhole/pull box.

Communications Copper Cable Splicing and Terminations

CABLE SPlicing METHODS AND SPLICE CLOSURES

Copper Cable Splice Methods

1. Copper telephone cables shall be spliced using a 710-type, 25-pair, large size, gray in color connector (710SC1-25, 710SD1-25, and 710TC1-25) for underground, direct-buried, aerial and building terminal splices. 710-type connectors shall be 3M-type or equal.
2. All splices shall be accomplished using the conductor fold-back method to ease future splicing and maintenance efforts.

Copper Cable Splice Closures
1. Copper cable splices (Aerial, Underground, and Direct-buried) shall be sealed using a bolt together, washer-less, stainless-steel type of closure with field adaptable/drillable/reusable 1, 2 and 3 section end plates to match the existing cable plant. Closure shall be Preformed Line Products® (PLP) or equal, no known equal.
2. The closure shall be sized to allow sufficient interior space for the fold-back method of splicing and to allow for the addition of future bridge spliced cables.
3. The closure shall be air pressure tested (flash-tested) upon installation and shall not be filled with encapsulant.
4. All splice closures shall be properly supported, racked and lashed to the MH racks. Closures shall be supported by their own individual cable steps, in addition to the steps used to support the cable itself.
5. All splice closures shall be properly grounded to the MH grounding and bonding system.
6. All splices shall be inspected by the University’s Representative prior to the completion and sealing of the splice.
7. All copper cables shall be labeled in accordance with Division 27 05 53 Identification for Communication Systems, outside plant and riser cable labeling requirements.

Communications Optical Fiber Backbone Cabling

FIBER OPTIC RISER CABLE
Riser cables shall meet the following requirements:
1. Conform to CEC Article 770 and comply with the State of California fire codes and the Campus Fire Marshal’s office.
2. The type of riser cable shall be UL listed OFNR/OFNP rated as required.
3. The cable shall be of the same manufacturer as the fiber optic termination equipment to ensure fit, function, system compatibility, performance and warranty. The cable shall be Corning Cable Systems® Infinicor™ MIC® type cable, or equal.
4. Reference Figure 15 for labeling requirements.
5. Reference Division 27 11 19 Communications Termination Blocks and Patch Panels for termination hardware.
6. Table 5 shows the maximum conduit fill ratio requirements for riser cables.
7. Reference Table 17 for fiber strand count.

OUTSIDE PLANT FIBER OPTIC CABLE
1. Loose Tube dry cable with water blocking technology cable by use of a water-swellable tape shall be used for underground installations. For outside plant applications, provide Corning Freedom® Loose tube fiber optic cable, or equal. Equipment shall be installed in accordance with the manufacturer’s instructions and refer to Figure 29.
Figure 29 Dielectric OSP Fiber Optic Cable

Note: Indoor/outdoor rated cable shall be installed in those locations where the indoor exposed cable distance from the entry point to the termination or splice location exceeds 50-feet.

2. Minimum bend radius shall be maintained during and after the installation phase. The minimum bend radius during installation is 15 times the outside diameter of the cable and 10 times the outside diameter after installation.

3. Buffer tube fan out kits shall be used per manufacturer’s requirements.

4. The recommended minimum number of fiber strands for each type of Telecommunication Space is shown in Table 17.

5. Fiber optic cable shall have a 30-foot service loop prior to terminations at the ADF/BDF/IDF location. The University’s Representative shall approve the location of this service loop prior to cable installation and termination. OSP fiber shall have a 50-foot service loop left in each Manhole and pull box. This slack shall be properly stored and lashed to the MH racks and shall not interfere with existing cables and splice closures.

Table 16 Single-mode Cable Specifications

<table>
<thead>
<tr>
<th>Single-mode Fiber Optic Cable Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Attenuation: (dB/km)</td>
<td>0.4 @ 1310nm</td>
</tr>
<tr>
<td></td>
<td>0.3 @ 1550nm</td>
</tr>
<tr>
<td>Gigabit Ethernet Distance Guarantee: (meter)</td>
<td>5000 @ 1310nm</td>
</tr>
<tr>
<td>Temperatures: (Operation)</td>
<td>-40 to +70°C (-40 to +158°F) All Dielectric</td>
</tr>
<tr>
<td></td>
<td>-40 to +70°C (-40 to +167°F) Armored</td>
</tr>
<tr>
<td>Maximum Tensile Load: Short Term</td>
<td>2700N (600 lbf)</td>
</tr>
<tr>
<td></td>
<td>890N (200 lbf) ALTOS®</td>
</tr>
<tr>
<td></td>
<td>600N (135 lbf) FREEDM®</td>
</tr>
<tr>
<td>Term: Long</td>
<td>RUS 7 CFR 1755.900</td>
</tr>
<tr>
<td>Approvals and Listings</td>
<td>ANSI/ICEA S-87-640 (ALTOS®), ANSI/ICEA S-104-696 (FREEDM®)</td>
</tr>
<tr>
<td>NEC Listing</td>
<td>Article 770</td>
</tr>
<tr>
<td>Manufacturer:</td>
<td>Corning Cable Systems® ALTOS®, FREEDM®, or equal.</td>
</tr>
</tbody>
</table>
Table 17 Recommended Size of OSP Fiber Optic Cable for building distribution

<table>
<thead>
<tr>
<th>Type of Telecommunications Space</th>
<th>Number of Fiber Strands Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADF</td>
<td>144 strands SM</td>
</tr>
<tr>
<td>BDF</td>
<td>72 strands SM</td>
</tr>
<tr>
<td>IDF</td>
<td>48 Strands SM</td>
</tr>
</tbody>
</table>

Communications Optical Fiber Splicing and Terminations 27 13 23.13

FIBER OPTIC CABLE SPLICE METHODS
1. Coordinate with the University’s Representative to confer with Communication Resources when designing the outside plant cable layout.
2. When a field splice is required, single-mode OSP fiber cables shall be fusion spliced only. Mechanical splices shall not be allowed. Heat shrink type fusion protectors with a strength member shall be used for all fusion splices.
3. The larger 24-strand 13-inch size splice trays shall be used for single-mode splices to allow additional space for retaining fiber loops and controlling bend radius.
4. Coordinate with the University’s Representative for inspection of all splices prior to sealing the splice.

FIBER OPTIC SPLICE CLOSURES:
1. Fiber optic cable splices shall be sealed using a hard plastic, bolt together, re-useable/re-sealable type of fiber optic cable closure. Closure shall be Preformed Line Products® Coyote®, Corning Cable Systems®, or equal.
2. Closure shall allow manufacturer’s recommended slack (typically 8 to 10 feet) within the closure to facilitate present and future fiber splicing and maintenance activities.
3. All splice closures shall be properly supported, racked and lashed to the MH racks. Closures shall be supported by their own individual cable steps, in addition to the steps used to support the cable itself.
4. All splice closures shall be properly grounded to the MH grounding system, when applicable.
5. All Fiber Optic cables shall be labeled in accordance with Division 27 05 53 Identification for Communication Systems.

FIBER OPTIC CONNECTORS
Fiber optic cable for outside plant and riser/backbone installations shall be fusion spliced to factory made 568SC Ultra PC Polish type pigtails at the ADF/BDF/IDF:
1. Corning Cable Systems® 568SC Ultra PC Polish, 3 meter Single-mode cable assembly, or equal.

CLOSET CONNECTOR AND SPLICE HOUSINGS
All fiber optic connectors, termination housings and hardware shall be of the same manufacturer as the installed cable to ensure campus wide network system compatibility, optimum performance, fit, function, appearance and warranty. The type and manufacturer of fiber optic connectors, termination housings and connector panels shall be Corning Cable Systems®, or
equal. If substitutions are requested by the consultant, then documented and demonstrated equivalency shall be provided to the University’s Representative for review.

1. Corning Cable Systems® Pretium Connector Housings (PCH), Rack-mountable, or equal:
   a. PCH-02U (up to 72 SC fibers)
   b. PCH-04U (up to 144 SC fibers)

2. Corning Cable Systems® Closet Connector Housings (CCH), Rack-mountable, or equal:
   a. CCH-02U (up to 72 SC fibers)
   b. CCH-04U (up to 144 SC fibers)

3. Corning Cable Systems® Closet Splice Housings (CSH), Rack-mountable, or equal:
   a. CSH-03U (288 fibers)
   b. CSH-05U (528 fibers)

4. Corning Cable Systems® Pretium® Wall-Mountable Housing (PWH), or equal:
   a. PWH-04P (48 fibers)
   b. PWH-06P (72 fibers)

5. Rack-mountable Connector Housing Splice Trays, or equal:
   a. M67-112 (Type 2S, 24 fusion splices)
   b. M67-068 (Type 2R, 6 fusion splices)
   c. CCH-CS12-59-P000RE
   d. Corning Cable Systems® Single Panel Housing SPH-01P, or equal, to be used in Rebox cabinet, or equal.

6. Fiber optic cable for outside plant and riser/backbone installations shall be terminated on Duplex 568SC type connector panels at the ADF/BDF/LDF:
   a. Corning Cable Systems®, CCH-CP12-59 (Preloaded 6 duplex connectors, Single-mode, Ceramic Insert, Blue, for connecting 12 SC connectors), or equal.
   b. Corning Cable Systems®, CCH-CP12-59-P03RH (Preloaded 12 Strand Closet Connector Housing Pigtail Modules with 6 SC duplex Single-mode adapters, Ceramic Insert, Blue, or equal.
   c. Corning Cable Systems®, CCH-CP12-A9-P03RH (Preloaded 12 Strand Closet Connector Housing Pigtail Modules with 6 LC duplex Single-mode adapters, Ceramic Insert, Blue, or equal.

Fiber distribution cabinets (rack and wall-mounted closet connector housings) shall be labeled in accordance with Division 27 05 53 Identification for Communication Systems.

**Communications Coaxial Specifications**

Reference MASTER ANTENNA TELEVISION (MATV) SYSTEM Section 27 60 00.

**Communications Horizontal Cabling**

Two types of cables may be used for use in the horizontal segment: Unshielded Twisted Pair (UTP) and single-mode (SM) fiber optic cable.

1. UTP cable shall be 4-pair, 23 AWG, solid conductor UL Listed Type CMP (Plenum) or OFNP (Optical Fiber Nonconductive Riser) cabling that meets ANSI/TIA/EIA 568-C.2 Augmented Category 6 (6A) cable, to include all current Addendums and Bulletins and shall meet specified specifications and performance requirements.
2. Fiber optic cable shall be a minimum of 4-strands, single-mode, 8.3/125µm, tight-buffered, indoor cable and meet or exceed OFN-FT6 requirements.

All conductive cable, fiber optic, radio and television, community antenna and network-powered broadband communications systems and associated components shall comply with the most current edition of the following California Electric Code (CEC) articles:
1. Article 770 Optical Fiber Cables and Raceways
2. Article 800 Communications Circuits
3. Article 810 Radio and Television Equipment
4. Article 820 Community Antenna Television and Radio Distribution
5. Article 830 Network Powered Broadband Communications Systems

Horizontal cables shall not be spliced, nor shall these cables contain manufacturer splices.

Cable shall be manufactured, tested, certified and meet the performance requirements listed in Table 11.

The maximum total length of horizontal cable from the IDF to WAO not to exceed 295 feet; 328 feet (100 meters) including patch cords (equipment and workstation).

Cable slack shall be provided at the workstation to accommodate future cabling system changes.
1. The minimum amount of slack shall be 6-inches for UTP cables and 36-inches for fiber optic cables at the WAO.
2. Service loops are not recommended in copper cable installation practices. Service loops placed during the installation of 4-pair horizontal cables were tested and determined to cause Return Loss and NEXT problems on the order of 2-3dB.

Note: These limits apply to all types of horizontal cables. In establishing these limits, a 33-foot allowance was made for the combined length of the manufactured patch cords used to connect equipment at the WAO and IDF locations.

**Data Communications Horizontal Cabling**

**WAO CABLING REQUIREMENTS**

UC Davis has adopted a Universal Wiring Scheme. All Work Area Outlets (WAO) consist of data service. WAO providing data service shall be cabled with a 4-pair, 23AWG, Unshielded Twisted Pair Cable, with a small O.D> of max 0.275-inches. Provide the following:
1. Berk-Tek™ LANMARK-XTP Cat 6A Riser or Plenum, Pink Jacket for Data NAM circuits, or equal.
2. Berk-Tek™ LANMARK-XTP Cat 6A Riser or Plenum, Green Jacket for Internal/Local Network connections, cameras, or equal.
3. Superior™ 10Gain XP Cat 6A Riser or Plenum, Pink Jacket for Data NAM circuits, or equal.
4. Superior™ 10Gain XP Cat 6A Riser or Plenum, Green Jacket for Internal/Local Network connections, cameras, or equal
### Table 18 Copper UTP Cable Specifications

<table>
<thead>
<tr>
<th>Copper UTP Cable</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction</strong></td>
<td>0.57mm (23AWG), bare copper wire insulated with polyethylene (non-plenum) or FEP (plenum). Two insulated conductors, non-bonded, twisted together to form a pair and four such pairs lay up to form the basic unit jacketed with flame-retardant PVC with an isolation wrap that contains discontinuous sections of metallized material, held in place by a polymeric layer</td>
</tr>
<tr>
<td><strong>Physical Data</strong></td>
<td>Conductor diameter: 0.023 inches</td>
</tr>
<tr>
<td></td>
<td>Maximum Cable Diameter: 0.275 (non-plenum) (plenum)</td>
</tr>
<tr>
<td></td>
<td>Nominal cable weight: 31 lb/kft</td>
</tr>
<tr>
<td></td>
<td>Maximum installation tension: 25 lb</td>
</tr>
<tr>
<td></td>
<td>Minimum bend radius: 1.2 inches</td>
</tr>
<tr>
<td></td>
<td>Available in easily identified reel</td>
</tr>
<tr>
<td><strong>Electrical Data (tested at 500MHz) for Non-Plenum</strong></td>
<td>SRL: 15.2 dB/100m</td>
</tr>
<tr>
<td></td>
<td>Return Loss: 17.2 dB</td>
</tr>
<tr>
<td></td>
<td>Attenuation: 43.0 dB</td>
</tr>
<tr>
<td></td>
<td>Power Sum NEXT: 36.8 dB</td>
</tr>
<tr>
<td></td>
<td>NEXT: 37.8 dB</td>
</tr>
<tr>
<td></td>
<td>ACR: -2.3 dB</td>
</tr>
<tr>
<td></td>
<td>Power Sum-ACR: -4.3</td>
</tr>
<tr>
<td></td>
<td>ACR-F (ELFEXT): 19.8 dB</td>
</tr>
<tr>
<td></td>
<td>PS-ACRF (PSELFEXT): 16.8 dB</td>
</tr>
<tr>
<td><strong>Parametric Measurement (tested at 100 meters)</strong></td>
<td>Mutual Capacitance: 5.6 nF/100m max.</td>
</tr>
<tr>
<td></td>
<td>DC resistance: 9.38 ohms/100m max.</td>
</tr>
<tr>
<td></td>
<td>Skew: 45 ns/100m max.</td>
</tr>
<tr>
<td></td>
<td>Pair to Ground Unbalance: 330 pF/100m max.</td>
</tr>
<tr>
<td></td>
<td>Velocity of Propagation: 66% (Non-plenum) 67% (Plenum)</td>
</tr>
<tr>
<td><strong>Manufacturer</strong></td>
<td>Superior® 10Gain XP, or equal.</td>
</tr>
</tbody>
</table>

### Communications Optical Fiber Horizontal Cabling

WAO’s providing fiber to the desktop (FTTD) service shall be cabled using riser or plenum rated single-mode fiber optic cable. Cable shall be Corning Cable System® Infinicor MCI® cable, or equal.

1. 4-fiber, 8.3/125, tight-buffered OFNR or OFNP rated.
2. Plenum part number: 004K88-31131-29, or equal.
3. Riser part number: 004K81-31131-24, or equal.

Single-mode interior cable shall meet the following specifications listed in Table 19.
Table 19 Horizontal Fiber Optic Cable Specifications

<table>
<thead>
<tr>
<th>Horizontal Fiber Optic Cable, Single-mode (SM)</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>900 micron TBII buffered fibers wrapped in an all-dielectric strength member, ripcord and polyvinyl chloride outer jacket. All components of the complete cable product (glass, inner/outer sheath and jacketing material) shall be from the same manufacturer to ensure quality, performance, fit, function and warranty of product.</td>
</tr>
<tr>
<td>Core Diameter</td>
<td>8.3 ( \mu \text{m} )</td>
</tr>
<tr>
<td>Cladding Diameter</td>
<td>125.0 (+/-) 2.0 ( \mu \text{m} )</td>
</tr>
<tr>
<td>Fiber Strand Coating</td>
<td>Coating to be easily mechanically strippable, dual layered, UV-Cured acrylate applied by the fiber manufacturer</td>
</tr>
<tr>
<td>Maximum Attenuation (SM)</td>
<td>1.0dB @ 1310nm, 0.75dB @ 1550nm</td>
</tr>
<tr>
<td>Gigabit Ethernet Distance Guarantee (SM)</td>
<td>5000 meters at 1310nm</td>
</tr>
<tr>
<td>Manufacturer:</td>
<td>Corning Cable Systems® MIC® Cable, or equal.</td>
</tr>
</tbody>
</table>

**Communications Coaxial Horizontal Cabling 27 15 33**

Provide Quad-shield RG6 and RG11 cables, or equal, for use in interbuilding horizontal segment of an MATV system. Type shall be based on use and distance loss values.

Cables installed shall be UL listed type CMP and comply with CEC 800-51(a). The UL listing shall be marked on the cable sheath.

Coaxial cables installed in buildings shall meet the same code requirements as telecommunications cables. All conductive cabling and associated components shall comply with Article 800 of the CEC.

Reference Division 27 60 00 Master Antennae Television (MATV) System for more information.

**Communications Faceplates and Connectors 27 15 43**

The Network Access Module (NAM) is the actual connector or jack installed in a faceplate or surface mounted box upon which the UTP, coax and fiber optic cable is terminated in the work area.

The term Work Area Outlet (WAO) refers to the actual faceplate or surface mounted box installed in the work area.

WORK AREA OUTLET (WAO) FACEPLATES, SURFACE MOUNT BOXES, WIROMOLD®, OR EQUAL, ADAPTER AND MODULES

Faceplates, Surface Mount Interface Boxes and 106-Type Receptacles:
1. WAO’s shall be installed using fog white, flush-mounted, front entry, front removable, individual port faceplates and surface mount interface boxes. Faceplate color is recommend to match the décor of the room area and electrical and switch plates where required. Faceplates shall be Ortronics® TracJack®, or equal. Reference Table 20.

2. All voice, data and coax faceplates shall be a minimum of double gang angled faceplate. Blank modules of the same color and manufacturer shall cover all open ports not utilized by a NAM.

3. FTTD shall be placed in an Ortronics Multimedia Workstation Fib-or-Cop II Outlet, or equal.

4. Stylistic TracJack Frames (no 106 type), or equal, as listed in Table 20, shall be used when installing NAM’s in metallic type surface raceways when a standard type faceplate cannot be used.

5. WAO are not to be installed within Modular furniture. WAO to terminate flush on the wall and extended to the work area with NAM extensions. Coordinate work with furniture installation. When necessary to pass cable through furniture, install extra deep surface mounted boxes on the bottom panel of modular furniture with a rubber grommet installed in the panel opening.

6. Angled faceplates are preferred on campus with Cat 6A Installation and in Dorms.

**Table 20 WAO Faceplates and Surface Mount Boxes**

<table>
<thead>
<tr>
<th>Wiremold® Part Number, or equal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM-SAP</td>
<td>CM Series Single Gang Angled Faceplate, Ivory</td>
</tr>
<tr>
<td>CM2-U2TJ</td>
<td>CM2 Module for TracJack, Ivory</td>
</tr>
<tr>
<td>OR-40300664</td>
<td>Angled Single Gang, Holds 4 TracJack®, Fog White, Front Entry/Removable</td>
</tr>
<tr>
<td>OR-40300159</td>
<td>Dual Gang Series II, Holds 8 TracJack®, Fog White, Front Entry/Removable</td>
</tr>
<tr>
<td>OR-4030656</td>
<td>Series II angled bezel, accepts 2 flat tracJack modules, 1.5 units</td>
</tr>
<tr>
<td>OR-40300023</td>
<td>Series II Blank module, 1.5 units</td>
</tr>
<tr>
<td>OR-40300185</td>
<td>Surface Mount Box, Single Gang, Fog White, Front Entry/Removable</td>
</tr>
<tr>
<td>OR-40400054</td>
<td>Surface Mount Box, 2-Port, TracJack®, Fog White, Front Entry/Removable</td>
</tr>
<tr>
<td>OR-40400072</td>
<td>Surface Mount Box, 4-Port, TracJack®, Fog White, Front Entry/Removable</td>
</tr>
<tr>
<td>OR-41900017</td>
<td>Stylistic TracJack Frames, 3-Port, TracJack®, Fog White, Front Entry/Removable</td>
</tr>
<tr>
<td>OR-41900018</td>
<td>Stylistic TracJack Frames, 4-Port, TracJack®, Fog White, Front Entry/Removable</td>
</tr>
<tr>
<td>OR-854045212</td>
<td>Single Gang, Holds 1 TracJack® for Wall-Mounted Telephone, Stainless Steel</td>
</tr>
</tbody>
</table>

**Termination Hardware Requirements at the NAM WAO**

Each UTP cable shall be terminated at the WAO with a Category 6A, 8P8C, T568A, 180-degree exit, front installable and front removeable modules.

1. Ortronics Clarity6A TracJack, OR-TJ 610-22, Pink for Data NAMs, or equal.
2. Ortronics Clarity6A TracJack, OR- T J 610-45, Green for Internal/Local Network NAMs, cameras, or equal.
Termination Hardware Requirements at the Fiber WAO

Each fiber optic cable shall be terminated at the WAO using a Small Form Factor LC style connector mounted in an LC type faceplate module. Reference Table 21 for module specifications.

The LC connector module shall be from the same manufacturer as the flush mount faceplate to ensure fit, function and appearance and LC-type module shall be Ortronics® TracJack®, or equal.

Termination hardware requirements at the MATV WAO
Terminate each coax cable at the MATV WAO with an F-type connector, 180-degree exit, 75-ohm module. The F-type connector module shall match the color and appearance of the faceplate. Reference Table 21 for recommended part number and minimum performance specifications. Ortronics® TracJack™, or equal.

Install 75Ohm terminator resistors at all unused system terminal points.

<table>
<thead>
<tr>
<th>Ortronics® Part Number, or equal.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR-63700031</td>
<td>TracJack® LC Single-mode, Angled, 45° degree exit, 2 fibers, feed through, Blue, Front Entry/Removable</td>
</tr>
<tr>
<td>OR-63700006</td>
<td>TracJack® F-Connector, 180° degree exit, 75 Ohm, Front Entry/Removable</td>
</tr>
</tbody>
</table>

**Communications Connecting Cords, Devices and Adapters**

Cords and Electronic Devices shall be provided by University.

**Communications Patch Cords, Station Cords and Cross Connect Wire**

Patch cords shall be from the same manufacturer as the termination hardware to ensure proper compatibility, fit, function, appearance and the highest campus wide system performance levels and warranty.

Patch cords shall be manufactured by a TL 9000 and ISO 9001 Certified Manufacturer and be fully compliant with ISO/IEC/DIS-11801 standard and meet FCC specifications where applicable. These products shall also be UL® certified, where applicable. Field fabricated patch cords shall not be used.

Patch cords shall be of the same or higher transmission category as the cable system installed.

**DATA PATCH CORDS**
Provided by the University.
VOICE CROSS-CONNECT WIRE
Proper selection and installation of cross-connect jumper wire used between cross-connect blocks is essential to the overall performance of the network. The twist shall be maintained to within 0.5 inches of the entry into the cross-connect block.

Contractor shall complete the horizontal and riser cross-connections at the IDF location(s). Contractor shall provide sufficient jumper wire (white/blue, 24AWG for voice, white/red, 24AWG for Fire Systems) to complete all identified cross-connects at the IDF locations.

Note: The University's Representative shall provide the contractor a NAM X-Connect assignment spreadsheet.

FIBER OPTIC PATCH CORDS
Provided by the University.

Note to Design Professional: Generally all patch cords are furnished and installed by the University, excluding voice x-connects at the IDF locations. Please contact the University's Representative to determine the need to specify patch cords when designing a project.

Data Communications 27 20 00
All electronics shall be provided by the University.

Data Communications Wireless Access Points 27 21 33
WIReLESS ACCESS COVERAGE
For New Construction projects, it is the responsibility of the consultant to provide wireless and heat maps for the placement of Wireless Access NAM locations. It is mandatory to provide 100% wireless building coverage in 2.4 GHz and 5 GHz spectrums in all designs. Wireless NAM locations shall be cabled using a square cell topology. Provision for a Wireless NAM location every 30-feet (900ft²). Provision for one Wireless Access Point (WAP) in areas of congregation (lecture rooms, classrooms, large conference rooms, auditoriums, etc) for every 20 people (50-60 devices) based on occupancy rate of the area.

WIReLESS ACCESS NAM
Wireless access NAM consists of two Data Network Access Modules (NAM). The wireless NAM is to be terminated with an 8-position, 8 conductor module.

Location of the wireless NAM is based on the room design:
1. Standard ceiling height rooms (offices, classrooms, conference rooms, etc.) with drop tile ceiling: leave the NAMs, placed within a 2-port surface mount box, concealed above the drop tile ceiling with a minimum of 10 feet of slack. Place the NAMs where it shall provide the greatest amount of useable coverage.
2. High ceiling rooms (lecture rooms, auditoriums, etc.): depending on the size of the room, provision for ceiling and wall mounted NAM locations on each side wall at approximately 8-feet-6-inches AFF. Install each NAM location with a 5-inch square by 2-7/8-inch deep
device box (RANDL Ind. ®, or equal) with a single gang mud ring installed flush mounted within the wall.

3. Hard/inaccessible ceilings: Install the NAM with a 5-inch square by 2-7/8-inch deep device box (RANDL Ind. ®, or equal) with a double gang mud ring installed flush mounted within the hard/inaccessible ceiling.

For Major and Minor Renovation projects, consult the University’s Representative for determination of wireless scope.

Wireless network equipment shall be provided by the University.

**VOICE COMMUNICATIONS** 27 30 00

All wall phones (with an ADA compliant handset); emergency call boxes and towers shall be installed in accordance with ADA requirements.

Wall, counter-top and weatherproof telephones, in addition to emergency call boxes and WAO’s, shall meet the requirements of the Americans with Disabilities Act (ADA). This requirement is referenced in ANSI/TIA/EIA 568-C.1. [http://www.access-board.gov](http://www.access-board.gov)

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

Courtesy, Pay, Text, Area of Refuge, Emergency and Wheel Chair Elevator Telephones shall comply with the American Disabilities Act (ADA) Accessibility Guidelines.

Note: Wall telephones shall not be installed above or over Laboratory countertops. A standard desktop telephone may be installed in these unique locations.

**Telephone Sets** 27 32 13

Indoor Wall-Mounted Telephone

1. A 5-inch square by 2-7/8-inch deep device box (RANDL Ind. ®, or equal) with a single gang mud ring installed flush mounted within the wall. A minimum 1-1/4-inch conduit shall be installed to the cable pathway support system. Place the voice NAM into a single port wall phone plate.

2. Provide a 12-inch square clear area around the outlet for the wall phone to be mounted unobstructed.

3. See Figure 30 for examples.
Figure 30 Desktop and Wall-mounted Telephone Sets

**Elevator Telephone**

Each elevator bay, including elevator chair lifts, is required to have a dedicated phone line. A minimum of one Data NAM shall be installed for each elevator bay (incl. wheel chair elevator) in an accessible area outside and near the Elevator Control Room. The NAM is to be placed within a Hoffman 8-inches by 6-inches by 4-inches indoor rated box (Cat. no. AHE8X6X4) with a hinged cover, or equal. A conduit will need to be provided from the box to the elevator room control panel.

**Ring Down Telephones**

Ring Down Emergency Telephones are not to be provided in Campus projects. Ring down phones are only to be provided if the end user requires them for their department and shall pay for repairs and monthly activation cost. Consult the University’s Representative.

**TWO-WAY COMMUNICATIONS SYSTEMS PHONE**

1. Two-way communications system phone required in multi-level buildings at the elevator landing shall be Talk-A-Phone Model ETP-400KS, hands-free, flush mounted phone, or equal (No known equal). Phone shall be screened with the lettering “Elevator Assistance”.
2. Phone mounting shall meet all ADA requirements.
3. Provide Flush mounted using Talk-A-Phone Flush mount sleeve MS-400, or equal (No known equal).
Warranty
Equipment shall be warranted against any defects in material and workmanship, under normal use, for a period of one year from date of installation. In the event the system is found to be defective within the warranty period, manufacturer shall repair and/or replace any defective parts, provided the equipment is returned to manufacturer.

TTY Equipment
Payphones are not provided in Campus projects. Payphones are only to be provided if the end user requires them for their department and shall pay for repairs and monthly activation costs. Consult the University's Representative.

TTY Payphone
The mounting height of the device box for Payphone shall be 40-inches Above the Finished Floor (AFF). TTY phone requires a shelf and power receptacle at 18-inches AFF under the Text Telephone.

Figure 32 ADA Compliant TTY/ TDD Payphone

AUDIO-VISUAL SYSTEMS
The Design Process
Audio-Visual (A/V) systems designed and installed in new Campus facilities shall consist of one or more of the following three basic elements:

1. Sound System – A complete sound system meeting the performance standards specified below to be complimented with an ADA approved assisted listening system.
2. Video System – A complete video system consists of various display devices consistent with the intended use of the room and viewable from at least 80-percent of the room while meeting performance standards listed below.
3. Remote Control Systems – A microprocessor controlled audio-visual system provides for the remote control of the various media systems installed in a room. These systems shall be the Smart Panel or equal, which enables a complete room display without extensive operations training.
The design of an A/V system shall be based upon customer requirements, as well as the intended room function. The electronic equipment and cabling shall be consistent with industry standards. The University’s Representative shall coordinate final approval of all A/V systems with CR.

All A/V systems designed and installed shall meet the most current Americans with Disabilities Act (ADA) requirements, including assisted listening systems, visual access and accommodations. The Design Professional shall ensure all requirements are addressed.

PERFORMANCE STANDARDS
All A/V systems shall meet, as a minimum, the following performance standards.

Audio Signal:
2. Total Harmonic Distortion: 0.1 percent maximum from 20 Hz to 20,000 Hz.
3. Frequency Response: +/- -1.0 dB, 20 Hz to 20,000 Hz.

Audio Reproduction:
2. Total Harmonic Distortion: 1 percent maximum from 30 Hz to 15,000 Hz.
3. Sound Output Capability: Provide program levels of not less than 95 dB in the seating area without objectionable distortion, rattle or buzz. Several different samples, such as recorded music and microphones, shall be employed as test signals.
4. Hum and Noise: Hum and noise shall be inaudible (below the background noise level of the space) under normal operation and as observed in normal seat locations.

Video Signal:
1. Signal-to-noise Ratio (peak to RMS) un-weighted DC to 4.2 MHz: 55 dB minimum.
2. Cross talk: Cross talk (un-weighted DC to 4.2 MHz): 45 dB minimum.
3. Frequency Response: +/- 0.5 dB to 4.2 MHz.
4. Line and Field Tilt: 2 percent minimum.
5. Differential Gain: 3 percent maximum.

Video Timing:
2. Color Timing: Within 2-degrees at 3.58 MHz.

Optical:
1. The light fall-off from the center of the projected image to all four corners, as measured at the projected image plane, shall not exceed 50 percent for video projector images and 35 percent from slide projector images.
2. Fixed projectors, lenses and cameras shall be solidly mounted and braced so there shall be no observable movement in the image induced by motor vibration or other mechanical operations.
Control System:
1. Correct functional operation for all specified controls.
2. Feedback of the active function at operator and wired remote stations.
3. Wireless systems neither shall be the source of, nor be affected by, radio-frequency interference to and from any external signal devices.

Integrated Audio-Video Systems and Equipment
MULTIMEDIA CLASSROOMS AND OTHER LEARNING SPACES STANDARDS
The preferred method for A/V installation is a wall mounted media cabinet with all cabling and conduit being routed through walls and ceilings.

LIGHTING
Classrooms require lighting that can produce enough brightness for note taking and reading while at the same time is controlled to allow audio-visual projection without washing out the images on a screen or TV monitor.

The University utilizes an interior lighting control system that provides addressable network programmable lighting control with building energy management system and central campus lighting integration. Refer to Division 26, Section 26 09 23.

Lighting fixtures and lamps:
1. Provide minimum light intrusion onto projection screens (less than 2 foot candles at the screen).
2. Provide 20-35 foot candles of task lighting at student seats.
3. Provide 20-35 foot candles of light for chalkboard or white board illumination.
4. Provide energy efficiency, low heat generation, and easy maintenance.
5. Light fixtures shall be fluorescent or LED and shall minimize audience glare and light spillage on projection screens.
6. Ballasts shall not operate at frequencies greater than 30 KHz in order to eliminate potential interference with infrared controls.

General guidelines for the selection of light fixtures shall include:
1. The use of recessed lamps in sharp cutoff luminaries to provide controlled lighting with minimal light spill on projection screens and to avoid shining light directly in the audience’s view.
2. No incandescent lamps installed in order to reduce maintenance, conserve energy, and reduce heat generation.
3. Carefully plan any use of pendant lighting fixtures to ensure that ambient light at the screen remains within specifications and the fixtures do not invade the light path of projected images or viewer sight lines.

There shall be a minimum of 3 lighting zones in each classroom:
1. Front presentation/blackboard and front seating area.
2. Center seating area.
3. Rear seating area.
4. Lights at the front of the room shall illuminate the chalkboard areas to improve readability.
5. Large lecture halls shall have a 4th light zone of just the board area separate from the front presentation area.

Lighting controls
1. Each zone shall have a simple on/off switch with a corresponding slider type control for dimming each zone to desired levels.
2. When the front lights are turned off for screen projection, the remaining illuminated light zones shall allow no more than 2 foot candles of ambient room light to fall on the screen.
3. Each light switch control shall be clearly labeled to indicate which switch controls which lights.
4. Light control switches shall be conveniently located at the front of the room and clustered by the media cabinet so the instructor can control lighting levels during the class presentation.
5. An additional light switch shall be located at each door entry to the classroom to control one bank of lights to sufficiently illuminate the room upon entry. This would ideally be the blackboard lights or lighting zone 1. These door light switches shall be the illuminated type so they can be easily found in a darkened room.
6. Large lecture halls shall have 24/7 safety lighting to allow safe entrance into the hall but shall not intrude onto any projection screen surface.
7. Additionally, signs shall be located at all switch locations to remind occupants to turn off lights when vacating the room.

POWER REQUIREMENTS
One and Two-gang outlet boxes:
4-11/16-inches square by 2-1/2-inches deep box with single-gang and double-gang plaster rings respectively.

Three-gang and larger: Ganged or masonry boxes, minimum 3-inches deep.

Outlet Boxes Locations:
1. Duplex 20 amp outlet power box shall be installed at each ceiling mounted projector location. Wherever possible it shall be flush mounted to the ceiling and within 2 feet of the projector location.
2. Quad 20 amp outlet power box shall be installed inside the A/V Smart Panel at the designated wall location placement of the media cabinet and/or instructor workstation/desk.
3. Power junction box shall be located in the ceiling with flex cable to connect to each electric projection screen. Contact the University’s Representative to coordinate the exact location with the Communication Resources.
4. Quad 20 amp outlet power box shall be installed on the back wall of the room to allow for auxiliary A/V equipment to be installed as needed. Contact the University’s Representative for the exact location which shall be designated by CR.

5. Duplex 20 amp outlet power box shall be installed at each wall Assistive Listening Device location which shall be 96-inches AFF.

Power outlets for the projector power and the media cabinet power shall be on the same circuit with a minimum 20 amp load.

No floor mounted outlet boxes shall be located in the teaching area unless the University’s Representative indicate they are needed as part of the A/V installation design.

Provide common ground for all A/V power outlet boxes.

CONDUIT AND BACKBOX REQUIREMENTS
Several conduits shall be installed in the wall from the A/V Smart Panel located behind the wall mounted or roll up A/V Media Cabinet and/or instructor workstation/desk to:

1. Projector location - Minimum of 2-inch conduit. Conduit shall run the entire distance to the projector location. Conduit shall not have more than two 90 degree turns within the entire length of the run.

2. Projection screen - Minimum 1-inch conduit to the projection screen location; the exact location to be designated by the University’s Representative.

3. Wall speaker locations - Minimum of 1-inch conduit to each wall speaker location. Back boxes shall be a standard size to accommodate 1-inch conduit.

4. Ceiling speaker locations - Stub minimum of 1-inch conduit above the accessible ceiling. If it is a plenum rated or hard lid ceiling, then conduit shall run the entire distance to each ceiling speaker location. Ceiling mounted speakers for drop ceilings shall have model specific plates along with tile rails for support.

5. Wall mounted assistive listening device locations - Minimum of 1-inch conduit to each wall location. Back boxes shall be a standard size to accommodate 1-inch conduit.

6. Rear wall auxiliary equipment location - Minimum of 1-inch conduit to rear wall location; the exact location to be designated by the University’s Representative with concurrence with CR. Back boxes shall be a standard size to accommodate 1-inch conduit.

All conduits shall not have more than two 90 degree turns within the entire length of the run and include pull wire.

Accessible pull boxes are required so that no conduit pull is longer than 100 feet.

Install an insulated bushing on each end of all conduits including conduit stubs.

Clearly document the exact location of pull boxes, show exact locations on record drawings and provide documentation to the University’s Representative.
All conduits shall be clear of all debris and have no obstructions to ensure the full inside dimension is available for wire/cables. Bushings required on all conduits.

SPECIAL BACK BOXES
Smart Panel back box is located flush mounted within the wall where the media cabinet is located. Preferred size is 12-inches by 14-inches by 4-inches deep junction box. The media cabinet power and NAM boxes are located within the smart panel.

Figure 33 A/ V Smart Panel

A/V SMART PANEL

Power Requirements
Two-gang outlet boxes:
4-11/16" square by 2-1/2"
depth box with
double-gang plaster
rings respectively.

Quad outlet power box
will be installed inside
the A/V Smart Panel at
the designated wall
location placement of
the media cabinet.

Data NAM’s
Data network NAM’s shall be installed in the following locations:

1. Inside the smart panel
   junction box at the designated wall
   location placement of the media cabinet.

2. At each ceiling mounted
   projector location. Wherever
   possible it will be located within the
drop tile ceiling next to the
   projector power outlet and within 2
   feet of the projector location.

Conduit Requirements
The preferred method for A/V installation is a wall mounted media cabinet with all cabling and conduit being routed thru walls and ceilings.

Several conduits shall be installed from the A/V Smart Panel located behind the A/V Media Cabinet to:

- Projector location – Minimum of 2’
  conduit. Conduit must run the entire distance to
  the projector location.
- Wall speaker locations – Minimum of 1’
  conduit to each wall speaker location.
- Ceiling speaker locations – Minimum of 1’
  conduit. If there is a drop ceiling in the room,
  the conduit may be stubbed out above the ceiling
  allowing cabling to be run above the ceiling.

- Wall mounted assistive listening device
  locations – Minimum of 1’ conduit to each wall
  location.
- Rear wall auxiliary equipment location –
  Minimum of 1’ conduit to rear wall location.

FLOOR BOXES
Floor boxes shall not be installed for A/V cabling unless the University’s Representative indicates it is desirable and falls within the installation plans for the room.

MEDIA CABINET
Multimedia electronics, equipment and teacher input shall be contained within the Media Cabinet. Media cabinet shall be a 22-inches W by 30-inches H by 24-inches D enclosure. Provide special heavy duty rotating slide out shelving systems when installing audio and video equipment in custom cabinetry, entertainment centers and in walls.

Locate media cabinet near light switches and projector screen switch to ease instructor use.
SPEAKERS

Audio reinforcement in large lecture halls shall be via two methods:

1. Speech presentation shall be via ceiling mounted speakers dispersed throughout the room. The number of speakers required shall be determined by the University’s Representative.
2. Presentation materials such as video etc. shall be via front wall mounted speakers. There shall be a minimum of two speakers used for this audio reinforcement. Additional speakers shall be determined by the University’s Representative. Height for installation points to be determined by size and dimensions of the room and sound dispersal pattern to cover all seating areas.

Audio reinforcement in small classrooms shall be via one speaker system.

Speech presentation and presentation materials shall all be routed through the front wall mounted presentation speakers. A minimum of two speakers shall be used for this audio reinforcement.

Wall mounted speakers shall be installed on either side of the projection screen minimally at 84-inches AFF.

PROJECTION SCREENS

Screen placement is critical to ensure proper viewing angles for all seats in a room. The following considerations shall be applied to the placement of projection screens.

1. Most instructors prefer to teach from the center of the room.
2. Most instructors utilize projected images to augment materials written on the board. Therefore, it is advantageous to maximize the amount of usable board space that remains available while projection screen is in use.
3. Avoid positioning a screen to face uncontrolled light sources such as windows, skylights, exit signs, etc.

Screen placements may therefore be centered in the room, offset to the left or right side of the room or angled in a corner of the room. Exact placement shall be determined by the University’s Representative.

Locate projection screen switch near Media Cabinet to ease instructor use.

Screen Specifications:

1. Projection screens shall be electric and shall be tab tensioned unless otherwise determined by the University’s Representative.
2. For low ceiling rooms the projector may be recessed in the ceiling to maximize the viewing surface available for image size.
3. It is preferred that screens be wall mounted if possible in the context that it allows a large viewable image for the room.
4. Screens shall be mounted to clear any installed writing boards when deployed but not to create any obstacle to egress or a gap larger that 3-inches between screen and the outmost edge of an installed board.

5. Electric screens shall have a low voltage control box located at the media cabinet location.

6. Screen surface shall be seamless, solid vinyl with a matte white surface.

PROJECTOR MOUNTS
Projectors shall be mounted in the ceiling of the classroom, utilizing drop ceiling plates when a drop ceiling is present.
1. Drop ceiling plates shall contain knock out plates for power and NAM's to be installed flush to the ceiling.
2. Applicable tile and seismic supports shall be installed for each drop ceiling plate.

Rooms not having drop ceilings such as large lecture halls without a projection booth shall utilize Unistrut, or equal, with extension poles and appropriate projector mount. Extension poles shall be anchored with cables to ensure no movement of the projector for a steady image and provide seismic support.

The University's Representative shall be consulted prior to finalizing any projector mounting systems.

DATA NAM'S
Data network NAM's shall be installed in the following locations:
1. Inside the smart panel junction box at the designated wall location of the media cabinet and/or instructor workstation/desk.
2. At each ceiling mounted projector location, next to the projector power outlet and within 2 feet of the projector location.
3. On the back wall of the classroom to allow for auxiliary A/V equipment to be installed as needed. The exact location to be designated by the University's Representative.

ASSISTIVE LISTENING DEVICES
All classrooms or lecture halls having 50 or more fixed seats shall have assistive listening devices (ALD's) installed to accommodate ADA requirements.

Number of ALD's installed shall be dependent upon the physical size and dimensions of the classroom to ensure complete coverage of all seats.

Each device shall be installed at 96-inches AFF within 1 foot of power outlet.
IDENTIFICATION
Label each conduit at each end with the purpose (e.g. “projector”, “speaker”) and destination (e.g. “media cabinet”, “wall speaker”).

Label each outlet box, back box and pull box with purpose.

Provide labeling which is clear and permanent, such as black permanent ink marker.

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800 MHz IN-BUILDING RADIO SYSTEMS

THE DESIGN PROCESS
This chapter establishes the policies and procedures regarding 800 MHz in-building amplified radio systems required in new campus buildings.

General Radio Communications Coverage
All buildings are required to support radio communications from public safety entities (Campus Fire, Police etc.)

All capital building projects exceeding 5,000 square feet (to include multi-level structures) are required to install, at a minimum, an amplification system on the first floor and basement. Additional performance coverage tests shall be performed before and during the construction phase to determine if additional in-building amplification is required for adequate coverage throughout the entire building.

EVALUATION PROCESS
The evaluation process for determining the need for additional in-building amplification shall be conducted in a minimum of two phases: Pre-construction and construction.

1. Pre-construction Phase: Before the construction of the new building, basic information shall be gathered to begin the process of determining the type and actual implementation of an augmented radio system, including the design and costs estimate of an in-building radio system (IBAS).
2. Construction Phase: As the construction progresses, refinements to the initial multi floor system estimate shall be made to ensure that the proposed IBAS shall provide adequate coverage and to re-evaluate the impact on existing structures. A re-evaluation of the initial specifications shall help to fine-tune the proposed system size.

DESIGN REQUIREMENT:
A 2-inch conduit shall be dedicated from the equipment/telecommunications room (ER/TR), on the highest building level, to a sealed junction box on the roof of the building for use as an antenna access point. This conduit shall be grounded using a path other than the telecommunications ground provided in the ER/TR.
The assessment, design and cost shall be performed by a Communications Resources. Please contact the University’s Representative for more information.

**MASTER ANTENNA TELEVISION (MATV) SYSTEM**

**27 60 00**

**THE DESIGN PROCESS**

The UC Davis MATV system consists of two distinct systems – Baseband and Broadband (RF). In addition, the campus also supports an IPTV system for Student Housing. The Campus Broadband system uses modulation and radio frequencies to distribute signals to campus locations. The two systems co-exist and provide connectivity to many of the campus general assignment classrooms and auditoriums.

Three basic elements:

1. **Headend** – The UC Davis MATV system provides channel operations with a bandwidth up to 1000 MHz.
2. **Distribution System** – A network of distribution media located in the Building Distribution Frame (BDF) and Intermediate Distribution Frame (IDF). Performance of the broadband distribution system shall meet the forward path bandwidth of 49-1000 MHz (passive components) and a flat gain of no less than 32 dB. Cross modulation, composite triple beat and hum modulation shall be 3 dB or better. Active components shall operate to 1000 MHz.
3. **Subscriber Drop** – The coax cable and MATV Work Area Outlets (WAO) where the users connect their TV set.

In addition to the MATV system, the UC Davis campus employs Moving Picture Experts Group (Mpeg), Video over Internet Protocol (IP) and digital distribution to send sound and images throughout the campus.

Provide a MATV Broadband Riser and Functional Drawing as part of the design drawings.

**THE TYPE AND NUMBER OF MATV WAO’S**

The subscriber drop coax cable shall be terminated at the MATV WAO with a standard F type connector inserted in a standard single gang faceplate.

Coordinate with the University’s Representative for the consultation with the building occupant and Communications Resources during the design process to identify the number and location of MATV WAO’s to be installed.

**CABLE TYPES AND LENGTHS**

1. Types of cables for use in interbuilding horizontal segment of an MATV system: CMP Quad-shield RG6 and RG11, or equal.
2. The length of the drop cable shall be no more than 90 m (295 ft).
3. The loss difference between the shortest and longest drop cables from a tap shall be no more than 7 dB. This shall provide the recommended signal level at the outlet of 3 dBmv to 10 dBmv.
4. Coaxial cables installed in buildings must meet the same code requirements as telecommunications cables. All conductive cabling and associated components shall comply with Article 800 of the CEC.

5. Horizontal coax cables shall be installed in one continuous length and shall not be spliced.

6. Coax cable shall be labeled in the same manner as telecommunications cables.

7. Reference Table 22 for coax cable specifications.

### Table 22 Coax Cable Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>RG-6M</th>
<th>RG-11M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>Drop Feeder</td>
<td>Trunk and Riser Feeder</td>
</tr>
<tr>
<td>Loss at 55 MHz (dB)</td>
<td>1.60</td>
<td>4.40</td>
</tr>
<tr>
<td>Loss at 450 MHz (dB)</td>
<td>0.96</td>
<td>2.75</td>
</tr>
<tr>
<td>Manufacturer (Triple Shield)</td>
<td>Belden 1189A or 1189U</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CommScope F6TSWV, F677TSWV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>West Penn/CDT T841 or equal</td>
<td></td>
</tr>
<tr>
<td>Manufacturer (Quad Shield, Flooded Jacket)</td>
<td>Belden 1190A</td>
<td>Belden 1618A</td>
</tr>
<tr>
<td></td>
<td>CommScope F6SS, CommScope F11SS, or equal</td>
<td></td>
</tr>
<tr>
<td>Antenna and Headend Placement</td>
<td>Quad Shield and PVC Jacket</td>
<td>Quad Shield and PVC Jacket</td>
</tr>
<tr>
<td>Metallic Raceway Placement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not in Raceway Placement</td>
<td>Triple or Hardline Shield and CEC 820-15 Jacket</td>
<td>Triple or Hardline Shield and CEC 820-15 Jacket</td>
</tr>
</tbody>
</table>

**TERMINATION HARDWARE REQUIREMENTS AT THE MATV WAO AND BDF/IDF**

1. Each coax cable shall be terminated at the MATV WAO with an F-type connector, 180-degree exit, 75-ohm module and inserted in a single port, fog white single gang faceplate. The F-type connector module shall match the color and appearance of the faceplate or patch panel to be installed. Provide Ortronics® TracJack™, or equal. Reference Table 23 for part number and minimum performance specifications.

2. A 4-11/16 inch by 2 1/8-inch square electrical back box with a single gang plaster ring shall be used at each MATV WAO location. A minimum 1-inch EMT conduit shall be installed to the cable pathway support system.

3. Each coax cable shall be terminated in the BDF/IDF and connected directly to the wall-mounted signal splitter.

4. Install 75Ohm terminator resistors at all unused system terminal points.

5. Cable slack shall be provided at both ends of the cable run to accommodate future cabling system changes. Approximately 6-inches of slack at the WAO location and 6-feet of slack at the equipment end (headend).
Table 23 MATV WAO Termination Hardware

<table>
<thead>
<tr>
<th>Ortronics® Part Number, or equal</th>
<th>Description</th>
<th>Minimum Performance Standard</th>
</tr>
</thead>
</table>
| OR-63700006                      | F-Connector, 180-degree, TracJack®, Fog White or equal | Return Loss: > 25 dB @ 2GHz  
Insertion Loss: < 2 dB @ 2GHz |
| OR-40300549                      | Faceplate, Single Gang, Holds 1 TracJack®, Fog White or equal | 

STRUCTURES TO SUPPORT THE HORIZONTAL CABLING
The space above the ceiling grid shall be used, whenever possible, to route the horizontal cabling.

1. At a minimum, 1-inch EMT conduit shall be used from the MATV WAO electrical backbox to the cable tray, not to exceed the recommended 30 percent fill ratio. Install conduit with a pull string with a minimum test rating of 200 pounds.
2. Conduit ends shall be reamed and bushed to eliminate sharp edges that can damage cables during installation or service.
3. Verify that the distance from each MATV WAO to the IDF does not exceed the manufacturer’s recommended distance for the type of coax cable to be installed.
4. Conduits shall be appropriately firestopped in accordance with TIA/EIA 569-D, Annex A, and any/all local fire codes. All firestop installations shall be labeled in accordance with TIA/EIA 606-B.

BROADBAND DISTRIBUTION EQUIPMENT
1. Blonder Tongue Fiber Splitter: FOC-1XXU-SA, or equal.
4. Blonder Tongue FAF Attenuator, or equal.
5. Blonder Tongue SRT-4A & SRT-8A Directional Couplers, or equal.
6. Blonder Tongue BTF-TP Terminator, or equal.
7. Toner XEQ-900 Equalizer, or equal.
8. Belden 1189A triple shield RG6M, or equal.
9. Thomas & Betts SNS6 RG6 conn, or equal.

ASSIGNING THE MATV NAM NUMBERS
1. A block of MATV NAM numbers shall be provided by Communications Resources. Contact the University’s Representative.
2. The design professional is responsible for the issuing of accurate MATV NAM numbers on the drawings and completing the MATV NAM Matrices.
3. The consultant shall complete the MATV NAM Matrices. MATV NAM Matrices shall be completed at the beginning of Construction Document (CD) preparation. A hardcopy of MATV NAM Matrices in MS-Excel 2000 spreadsheet file format shall be provided to the University’s Representative for coordination with Communications Resources.
The design professional shall ensure that specifications are placed in the Documents that inform the Contractor regarding use and maintenance of the MATV NAM Matrices for the project.

CABLE TESTING PROCEDURES
A properly designed system shall provide a signal level between 3 dBmV and 10 dBmV to every MATV WAO on all channels.

Test and report on each intermediate cabling segment, including BDF/IDF to MATV WAO.

Test each end-to-end cable link.

The tests shall ensure that the system and its components meet the specifications for:
1. Distortion.
2. Signal Uniformity
3. Signal-to-Noise Ratio (SNR)
4. Signal Ingress
5. Hum Modulation

PERFORMANCE REQUIREMENTS
The MATV system shall meet the following performance requirements:
2. Provide interference-free distribution of any of the scheduled UC Davis channels and allow for future distribution of internally generated forward and reverse channels.
3. Provide CATV compatible adjacent channel operation with bandwidth to at least 1000 MHz. Bandwidth of amplifiers shall be from 49 MHz to 1000 MHz in the forward direction, unless otherwise indicated.
4. Passive elements shall permit upstream (reverse channel) transmission of 5 MHz to 36 MHz sub-low band VHF television channels from the Headend to any MATV WAO.
5. Output levels of +6 to +12 dBmV from 54 MHz to 450 MHz nominal. +3 dBmV at output levels above 450 MHz. Tap off output level shall not exceed +15dBmV.
6. Signal level from any channel to any adjacent channel shall not vary more than 2 dB at the tap off location.
7. Long term variations in amplitude shall not exceed 3 dB.
8. Amplitude response within any channel shall not exceed +1.0 dB.
9. Amplitude response for the entire spectrum sector shall not exceed +/- 2 dB.
10. Visual carrier to noise ration shall not be less than 50 dB.
11. Composite triple beat ratio shall not be less than 55 dB.
12. Cross modulation ratio shall not be less than 57 dB.
13. Visual carrier to hum modulation ratio shall not be less than 63 dB.
14. Visual carrier to reflections ratio shall not be less than 46 dB.

End of Division 27