DIVISION 27 – COMMUNICATIONS

27 00 00 – COMMUNICATIONS

Introduction

This document's objective is to provide Architects, Engineers and other designers with a design-requirements and guidelines document that will help them plan the telecommunications facilities for the UCSC campus. The Scope of Work includes the telecommunication inside plant (ISP) and outside plant (OSP) cabling and support facilities required by new buildings or additions and/or upgrading of existing buildings and facilities. The document is a design guide and is not a project specifications document.

Drawings must contain a reference and coding system that uniquely identifies each jack to be protected-in-place, newly installed, or removed as part of the project. The reference system is to include building number, floor number, room number, wall reference, work area outlet reference, jack identifier and Technology Room termination destination. All such jack reference records need to be submitted in an electronic database CSV file format for the entire project to the University no later than the 50% Construction Drawing set. Any changes to the jack's layout need to be electronically updated and submitted in subsequent Construction Drawing revision cycles, As-Builts, and CSV-records files.

Telecommunications Spaces (TS)

1. Telecommunications Spaces (TS): The term TS refers to space allocated to a building to provide a secure and protected operating environment for telecommunications cabling and termination facilities and/or network equipment. TSs shall be designed and provisioned per ANSI/TIA-569 Telecommunications Pathways and Spaces and per the BICSI Telecommunications Distribution Methods Manual (TDMM), most recent edition. Depending on the building size, design, and network requirements, one or more of the functions of a TS may be combined into one space. The primary functions housed in TSs are:
    a. Telecommunications Rooms (TR)
    b. Entrance Facility (EF)
    c. Equipment Room (ER)
    d. Area Distribution Frame (ADF)
    e. Building Distribution Frame (BDF)
    f. Intermediate Distribution Frame (IDF)

Types of ISP TS/TR Facilities

1. Types
    a. **Entrance Facility (EF)**: Is a room that houses the termination and grounding point of OSP network service cables that enter or exit a building. It enables the joining of intra-building and inter-building backbone cabling. The EF is generally co-located in a BDF or ADF rather than being a separate room.
    b. **Equipment Rooms (ER)**: Is a room that houses telecommunications equipment.
    c. **Area Distribution Frame (ADF)**: Is a multiple building serving facility. The ADF is the room within a building for telecommunications equipment that meets the voice, data, video, radio, and wireless needs of its building, and serves other buildings in a designated area (zone) on the UCSC campus. It generally acts as an EF and BDF but can also act as an IDF

serving the floor it occupies. ADFs are generally placed on the lowest floor of a building to allow the entry of OSP cables without transition splicing and for grounding of cables.

An ADF provides a controlled environment to house telecommunications equipment, termination hardware, splice closures, Main Telecommunications Grounding Busbar (TMGB) grounding and bonding facilities, and protection apparatus where applicable. Equipment in the ADF includes the Campus PBX telephone systems (LIMs) or MX1 equipment; local area and core network switches; video distribution equipment; wireless network equipment; Land Mobile Radios (LMR) and Public Safety Networks (PSN) for firefighters, police and first responders including the campus 800 MHz radios and off-campus police and fire frequencies used for in-building radio equipment (also known as Distributed Antenna System or DAS as defined in CBC Article 915 and CFC Article 510); in-building cellular systems; and large uninterruptible power sources that are sized to operate the ADF cooling and electronics for up to 8 hours.

ADFs are distinct from other TRs due to the nature and/or complexity of the equipment they contain. They are distribution points for the campus fiber and copper OSP cable plant.

d. **Building Distribution Frame (BDF)**: Is a building-serving facility. The BDF enables connection of OSP services (telecommunications) to the building and then distributes those services throughout the building to IDFs using riser cables.

e. **Intermediate Distribution Frames (IDF)**: IDFs are considered to be floor servicing facilities as opposed to building service facilities. The IDF provides a connection point between riser cable from the BDF and the end user Work Area Outlet (WAO) horizontal cabling. All new multi-story buildings shall have at least one (1) IDF on each floor of the building. More than one (1) IDF per floor may be required in larger buildings where cable lengths of 295 ft. per ANSI/TIA Standards would otherwise be exceeded. In remodels of existing buildings of or less than 5000 GSF it is permissible for an IDF to service an adjacent floor. This exemption from the rule of one IDF per floor must be approved by the University Representative on a case-by-case basis. Access switches and UPSs are equipment commonly used in IDFs.

2. The TRs described above shall be designated for the exclusive use of the following telecommunication systems:
   a. Voice systems
   b. Data network systems; including uninterruptible Power Supplies (UPS) both rack-mount and stand-alone supporting these systems
   c. Wireless network systems
   d. Cellular telephone and in-building DAS systems
   e. Security systems
   f. Access control systems

TR Use Restrictions

No TR shall be used as a passageway to other equipment rooms, power transformers, custodial equipment, or any other function that would require access for reasons other than service and maintenance of the communication equipment and cabling they house.

TRs shall be designed and provisioned according to the requirements in ANSI/TIA-569.

Design Requirements

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) such as induction devices, transformers, ballasts, power supplies, elevator equipment, generators, motors, X-ray generators, photocopiers, microwave ovens, and similar equipment or sources of mechanical vibration. Take care to design Distributed Antenna System uplink devices so as not to interfere with campus systems.
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. Avoid locations that limit expansion such as structural steel, stairwells and elevator shafts, outside walls or other fixed building walls.
4. No individual cable run shall exceed 295 feet; minimizing the length of the backbone and horizontal distribution cables. Unlisted building entrance cables shall not be longer than 50-feet once they exit the incoming conduit, as required by the California Electrical Code.
5. Easily accessible and accessed directly from public hallways and not through offices or other utility spaces.
6. Have easy access to distribution cable pathways.
7. Vertically aligned (Stacked) within a multistory building. Horizontal pathways shall terminate in the TR located on the same floor as the area being served.
8. Meet Seismic Design Category D requirements.
9. 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.
10. A TR numbering scheme is to be applied for new and existing facilities. The first number will be the last three digits of the CAAN, all TRs located in the basement are to be labeled "0". The first TR will be 0.1 with each successive TR to be number 0.2, 0.3 and so on. All 1st floor TRs are 1.1, 1.2 etc. "0" is not to be applied to any TR room. The actual room number will be at the end. Example: The first TR on the first floor of the Communications Building would appear as "175-1.1-1234".
11. A TR must be a rectangular room with no obstructions or protrusions (beams, columns, etc.) that decrease the usable square footage available in the room.
12. TRs shall not service WAOs on more than one floor except as previously noted in this document with reference to existing buildings.

TR Room Construction Guidelines

1. Enclosing Walls
    a. TR walls shall extend to the structural ceiling above.
    b. Fire rating of TR walls shall meet all requirements of the Authority Having Jurisdiction (AHJ).
    c. Penetration of rated TR walls shall be fire stopped.

2. Ceiling: A suspended, false, lay-in, or hard lid ceiling shall not be installed over any TR floor space. Minimum clear ceiling height shall be 10 feet (10'). In remodels of existing structures where HVAC needs cannot be met without a false ceiling, this rule can be waived with the written approval of the University Representative. This exemption must be approved by the University on a room by room basis.
3. Floor
    a. Do not design raised floor systems for TRs regardless of the set of functions they perform. TR floors should be floor slab, no raised or false floor.
    b. The floor finish shall be smooth, dust-free, and not susceptible to static electricity build-up. Acceptable finishes are low static composition tile, static dissipative tile (SDT), or sealed concrete.
4. Door: Provide 3 ft. 0 in. wide X 7 ft. 0 in. high door, opening outward, with a card reader lock that supports brass key access for emergency use. ADFs require double doors.
5. Windows: TRs shall not have windows.
6. Water Infiltration: Measures must be taken to prevent water intrusion. Water, sewer, chemical, or drain piping of any kind shall not be routed through/within a TR.
7. Sprinkler Systems: If codes require fire protection sprinkler system heads within a TR, the sprinkler heads shall be the high heat type and shall be protected with a wire cage to prevent accidental discharge. Do not install sprinklers directly above the equipment racks.
    a. Note: For TRs that support the ADF or BDF functions consider installing a standalone dry pipe sprinkler system.
8. Wall Plywood Sheeting: Provide sufficient number of 4 ft. X 8 ft., ¾ in. thick Grade A-C, certified/ stamped as fire retardant and painted with two coats of white fire-retardant paint plywood sheets, to cover all four TR walls. Fire retardant stamps shall be visible after painting. Sheets shall be mounted securely to walls with 8-foot length vertical, 4-foot or less width horizontal. Bottom of sheet shall be at six inches (6") A.F.F.

TR Room Sizing Guidelines and Two (2) Typical TR Room Layouts

1. The size of the TR is dependent upon the size of the area that the room will serve, and the variety of equipment installed within the room. The TR shall provide enough space for all planned termination and electronic equipment and cables that will be installed within the TR, including any environmental control equipment, power distribution/conditioners, door access controllers and other security systems, in-building cellular equipment and uninterruptible power supply systems. Special consideration needs to be given to space requirements for Distributed Antenna Systems and back-up batteries required.
2. TR Sizing:
    a. If the Gross Square Footage (GSF) is between 1,000 and 10,000 sq. ft., the IDF shall be 12 ft. long X 9 ft. wide.
    b. If the GSF is between 10,000 and 17,000 sq. ft., the IDF shall be 14 ft. long X 9 ft. wide.
    c. If the GSF exceeds 17,000 sq. ft. the IDF shall be 17 ft. long X 10 ft. wide.
    d. If a second IDF is required to manage the horizontal cable placement run distance limit of 295 ft. (90 meters), size the second IDF per the GSF guidelines explained above.
    e. When a TR supports the BDF and ADF functions, dimension that TR at a minimum of 22 ft. long X 10 ft. wide.

f. When remodeling existing buildings, it is permissible to use cabinets or smaller TR sizing with written approval of the University Representative on a case-by-case basis.

3. The TR sizes listed above are minimum requirements and provide a good starting point for the programming phase of a project. Depending on the services and functions performed by the building's TRs, such as serving as an ADF, or serving a building with high density of WAOs, or installation of DAS equipment additional space and fire ratings may be required. ADFs and BDFs for larger size buildings may require additional rows of equipment racks or cabinets not accounted for in the above sizing guidelines.
4. Typical TR Layouts: It is always preferable to size TRs with enough length so that a single row of racks is sufficient to house all equipment and cabling. The following guidelines reference clearances for equipment and cross-connect fields housed in TRs.
5. Provide the following clearances for equipment and cross-connect fields in TRs.
    a. Allow a minimum of 36 inches (36") of clear working space in front and 42 inches (42") at rear of equipment racks measured from the front and rear wire managers.
    b. Allow a minimum of 36 inches (36") of clear working space in front and at rear of equipment cabinets.
    c. Allow for 8-inch depth off wall for wall-mounted equipment.
    d. If multiple equipment rack rows are required, provide a minimum 36-inch aisle between each row of racks measured from the face of the equipment installed in the racks. In multiple rows, the fronts of each rack shall face each other.
    e. A minimum aisle clearance of 36-inches is required at one end of an equipment rack row. Clearance shall align with TR doorway.
    f. In many cases, equipment and termination hardware may extend beyond racks and backboard mounting surfaces. Clearance is measured from the outermost surface of these devices, rather than from the mounting surface of the rack or backboard.
6. IDF/ADF Racks, Patch Panels, Fiber Panels, Cable Management design considerations.
    a. 19” 7’-tall (racks are 24.75" wide) seismic category D rated seismic relay racks shall be used.
    b. A 7' tall, 6.25" wide, double sided vertical cable manager shall be placed between racks and at the ends of each rack row. Wider vertical wire managers can be utilized if required to accommodate more incoming cabling or patch cord containment and management.
    c. 2RU, 48-port patch panels shall be used for horizontal cabling.
    d. A 2RU horizontal cable manager shall be placed above and below each copper patch panel.
    e. Mount 1RU, 24 port voice cross-connect patch panels below WAO station cable patch panels. The number of voice cross-connect jacks shall be equal to the number of pairs in the voice riser cable pair count.
    f. A 1RU horizontal cable manager shall be placed above each voice cross-connect patch panel.
    g. The fiber connector housings shall be placed in the center rack of the row, in the top-most position of the rack. A fiber connector housing does not require its own horizontal cable managers.
    h. The rack with the fiber connector housing will be loaded with one less 48-port station cabling patch-panel than other racks.
    i. 2 RU fiber panels shall be used for IDFs. 4 RU fiber panels shall be used for BDFs and ADFs.

j. Fiber terminations shall be fusion spliced LC pigtails.

TR Layout (General Notes)

1. Lighting shall not receive power from the same electrical distribution panel breaker as the telecommunications equipment in the TR.
2. 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. TR 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 TR. Coordinate keying and door handle specifications with Division 9, and the University Representative.
3. Coordinate requirements for CCTV and Card Access with Division 28 and the University Representative.
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.
    c. A raised floor system shall comply with the requirements of Article 645 Information Technology Equipment of the most current California Electrical Code version approved by the authority having jurisdiction and with NFPA 75 Standard
    d. In developing Emergency Power Off schemes coordinate with University Representative to assure life safety features such as 911 service, fire alarm and emergency phones (elevators and blue phones), security systems and global lockdown features are not inadvertently shut off in an event, and provide signage as required.
5. Ceilings shall be open to the underside of the floor above and have a minimum clearance of 9-feet.
6. 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. Initial planning should allow for 6,000 BTU's (1/2 Ton) per equipment rack with the heat rejection. Temperature 68-72 degrees Fahrenheit. Humidity between 30-55 percent.
7. 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 Representative shall coordinate CR approvals on submittal, installation and field changes.

TR Environmental Requirements

1. HVAC
    a. Each TR in a building should have its own dedicated HVAC system not served or dependent upon other building HVAC systems. A TR's HVAC must be designed for 24 hours per day, 365 days per year operation. Each TR shall have its own thermostat. This need can typically be fulfilled by a dedicated high efficiency split system air conditioning unit. Coordinate with Division 23.
    b. HVAC systems shall not use the same electrical panel that is used to support the outlets servicing the electronics housed within a TR.

c. The temperature in a TR shall be maintained in the range of 68°F to 78°F.

d. The humidity shall be non-condensing. HVAC should provide for a minimum of 1 air change per hour.

e. For HVAC sizing at the programming state of a project assume the following:

   i. For a TR performing the IDF function only, assume 1.5 tons of HVAC will be required (5,100 watts, 17,000 Btu/hr).

   ii. For a TR performing the BDF/IDF function, assume 2 tons of HVAC will be required (7033 watts, 24,000 Btu/hr).

   iii. For a TR performing the ADF function, assume 3.75 tons of HVAC will be required (13,200 watts, 45,040 Btu/hr).

   iv. As the program evolves coordinate with Division 23, 26 and 28 to refine the HVAC loads. It has been historically found the design too loads identified above result in an oversized system when not evaluated in later stages of design.

f. The filters in the HVAC system should have an ASHRAE dust spot rating of 85% or better.

g. The TR HVAC shall be on standby or emergency power when the TR equipment within has been deemed critical enough to require standby or emergency power. Coordinate with Division 26.

h. Condensate from in room evaporators shall be trapped, routed away from electronic equipment and be connected to the Sanitary Sewer via an indirect waste connection. If on the perimeter of the building it may be acceptable to drain to landscape coordinate with Division 26 and 33 and the University Representative as appropriate.

TR Room Electrical

1. Sub-panels shall be provided for dedicated electrical service for all TRs. The estimated electrical load for the telecommunications space shall not exceed 80% of the panel capacity. No power outlets outside the TR shall be serviced by this panel. For initial planning, provide a 100-amp, 120/208 volt, 3 phase panel.

   a. Individual branch circuits: All power circuits that supply outlets that support electronics shall be individual branch circuits from their breaker in the TR sub-panel to the outlet receptacle supplying the electronics.

   b. Sub-panels: Ideally sub-panels should be located on the inside of the TR near the room entrance door and should be connected to a standby or emergency power source. Sub-panels shall be lockable.

   c. Standby or Emergency power: Standby or emergency power connection is critical in the TRs that house campus telephone systems equipment or Core Routers (ADFs) to ensure voice and emergency systems remain operational during power outages that may extend past the systems battery backup capability, coordinate requirements with Division 26.

   d. Convenience wall outlets:

      i. Convenience wall outlets should be mounted in each room at +18 inches A.F.F. and horizontally spaced not to exceed 6 feet around the perimeter of the room.

      ii. Convenience outlets shall be non-switched, 120VAC 20 Amp, duplex and divided equally on branch circuits, (i.e., all receptacles in the same room shall not all be on the same circuit). A minimum of two (2) circuits shall be provided per room alternating duplexes around the room with no more than four (4) receptacles on the same circuit.

iii. Outlet labeling: Label all TR outlets with breaker and panel designation.

2. Estimating Electronics Power Circuit Count for Equipment Racks:
    a. Provide One (1) quad device box containing two (2) duplex 20 Amp, 120V AC individual branch circuits terminated on NEMA L5-20R-twist-lock receptacles for each equipment rack.
    b. Provide One (1) quad device box on standby or emergency power containing two (2) duplex 20 Amp, 120V AC individual branch circuits terminated on NEMA L5-20R-twist lock receptacles for each equipment rack.
    c. Device boxes should be mounted to the cable tray on the backside of each equipment rack.
    d. The placement of the device box and its conduit shall not block or interfere with the rack's equipment mounting area (rails) on either side of the rack.
    e. For estimating at the programming stage of a project, see the TR sizing guidelines for the number of racks to be installed.
3. Estimating Electronics Power Circuit Count for Enclosed Equipment Cabinets:
    a. Provide two (2) quad device boxes with each device box containing two (2) duplex 20 Amp, 120V AC individual branch circuits terminated on NEMA L5-20R-twist lock receptacles for each equipment cabinet.
    b. Device boxes should be mounted to the cable tray on the backside of each equipment rack.
    c. The placement of the device boxes and their conduit shall not block or interfere with the cabinet's equipment mounting area (rails) on either side of or front and rear of the cabinet.
4. The TR Performing the ADF Function - Special considerations.
    a. Four (4) 30 Amp, 220V L6-30R outlets for ADFs containing voice equipment. Specific number and location of outlets to be confirmed with the University Representative. Dedicated circuits shall be on standby or emergency power.
5. Lighting:
    a. Lighting in the TR shall provide a minimum light level of 50 fc at desktop level on all sides of the rack equipment.
    b. If the building is equipped with a standby or emergency power system, TR lighting should be connected to it, or the TR should be provided with its own standby or emergency lighting in case of power failure.

The Telecommunications Grounding and Bonding System

Telecommunications grounding and bonding systems shall be installed to support the telecommunications infrastructure. The requirements for this system are specified in ANSI/TIA-607: The Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

Fire Safety and Protection Requirements

1. Portable fire extinguishers shall be located within 50 feet of the room. The size of the fire extinguisher shall be a minimum 2-A, 10-B, C rating.

2. Generally, TR rooms will be sprinklered with the rest of the building, drainage troughs shall be placed under the sprinkler pipes to limit leakage from joints onto the electronic equipment. Provide a drain to route the water outside of the TR.
3. Verify with the University Representative if Pre-Action or Clean Agent Systems are to be specified. These systems provide cross-zoned operation. In cases where an under-floor fire suppression system is provided it shall be cross-zoned. Placement of the detector may affect the way cables are routed under a raised floor. Provisions shall be made in the fire suppression system design to reduce the possibility of false alarms and activation of a fire suppression system when ionization detectors are installed.

Telecommunications OSP Pathway

The main UCSC Campus is served from offsite Central Office facilities via underground structures that enter the campus. The campus has a “north core” and a “south core” that make up entrance facilities with redundant backbone cables connecting the two facilities and that extend independently up the east, and west sides of campus to provide a High Availability Backbone Infrastructure.

In designing the OSP infrastructure the concept is to provide strands from the west backbone, and strands from the east backbone, terminating at an Area Distribution Frame (ADF). Single cables serve Telecommunication Rooms (TR) where switches are arranged in a matrix patching to provide redundancy of equipment locally off the single fiber cable from the ADF to the Building Distribution Frame (BDF).

Given the size and age of the campus not all areas have access to the High Availability Backbone Infrastructure. It is necessary to plan major extensions early in the project to capture infrastructure requirements.

Verify points of connection to the existing outside plant cabling system (OSP) with the University Representative.

1. Campus OSP Environments: Construction involving a new or existing building structure shall have an assessment of the OSP pathway connectivity infrastructure. If sufficient duct space is not available additional duct space will need to be made available through cable consolidation, cable-mining, or installation of new ducts. This assessment is of particular importance if demolition of any structure is required as part of the overall project, and/or the new project may impact an existing OSP connectivity infrastructure.
2. ADF Function Connectivity
    a. All buildings must physically connect to an ADF designated to serve the campus area in which a particular building is located.
    b. Coordinate with University Representative as early as possible in the project planning phases how any given project will achieve its required ADF connectivity.
3. Building OSP EF (Entrance Facility)
    a. A minimum of four (4) 4” entrance conduits shall be installed into the EF of any building from the nearest existing telecommunications OSP plant point of connection, usually a telecommunications maintenance hole (MH). If the required OSP point of connection is non-existent or the use of the nearest OSP access point is impractical, the required OSP access point must be designed and built.
    b. Dual OSP entrances from different OSP points of connection are desirable where possible, and are essential for buildings that house emergency services, data core systems, disaster recovery systems, or those buildings designated as essential service buildings on campus. These dual duct paths should be on physically separate routes, if possible.
4. OSP Design Reference Material

5. OSP shall be designed per BICSI, Outside Plan Design Reference Manual (OSPDRM), most recent Edition.
6. Slab on Grade
    a. Shall meet the following minimum requirements:
        i. Supporting conduits shall run beneath the slab and shall be PVC schedule 40 or better.
        ii. At no time shall the conduit run below the membrane barrier or be placed directly in the soil.
        iii. Conduits shall not contain more than two 90-degree sweep bends and exceed more than 100-feet in length between pulling points.

Telecommunications ISP Pathway

1. Pathway design coordination: Clarify as early in the design planning phases as possible what pathway is required and which construction discipline will draw, specify, and construct each portion of the required pathway. Telecommunication pathways detail design and build out requires coordination between the electrical/mechanical and telecommunications drawings and specification documents so that build out supply and construction responsibilities are clearly defined before the start of the Design Development phase of a project.
2. Interior TR Pathway
    a. Cable run management:
        i. All cable tray shall be a minimum 12” wide.
        ii. Cable tray shall meet Zone 4 or higher seismic bracing standards.
        iii. Cable tray layout design shall be reviewed and approved by the University Representative.
3. Riser pathway
    a. Riser pathway interconnects the TRs in a building.
    b. When more than one IDF will be needed in a building, four (4), four-inch (4") conduits will be installed from the BDF to the first IDF. Then each IDF will connect to the one above it with three (3), four-inch (4") sleeves. When the TRs are stacked this requirement is easily accomplished using only conduit riser sleeves floor/ceiling penetrations from one IDF to the next. If the IDFs are not in a stacked configuration, then conduits must be installed between the IDFs.
    c. Two (2), two-inch (2”) conduits shall connect the IDF on the top floor of each building to the roof for use by distributed antenna systems. Note these conduits must be installed in a 2 hours rated shaft, and the TR must then be provided with the appropriate fire rating.
4. Primary horizontal cabling pathways
    a. Primary horizontal cabling pathways are major pathways that transport Work Area Outlet (WAO) cables from the TR to secondary horizontal cabling pathway access points (see below). Conduits can be used when it is necessary for the pathway to cross over a hard-lid ceiling.
    b. At a minimum, primary horizontal pathways will always require pathway fire-wall penetration fire-stop technology (“assemblies”) through the TR walls into the occupied space of the floor the TR serves. Other wall penetrations may be required depending on the wall/ceiling layout of the TR's WAO service area.

c. These primary horizontal cabling pathways should be routed following building lines and major floor access routes such as corridors and hallways. They should never cross over end user work areas such as offices, conference rooms, or work cube areas.

d. Access for cabling personnel and technicians that is sufficient for easy cable placement yet causes minimal disruption to floor occupants is an important design consideration when laying out the routing of primary horizontal cabling pathways.

5. Secondary horizontal cabling pathways: to each WAO (conduits to WAO junction boxes)

   a. Conduits will be installed from within 3 feet of a cable tray to each WAO in-wall junction box.

   b. Junction boxes are mounted in the wall and connect to the conduit. They are used to mount the WAO faceplate that houses the cable termination jacks that are the WAO's network connection points. Generally double-gang boxes with single-gang mud rings are used.

   c. There are two special cases of secondary pathways that must be accounted for in most projects. These secondary pathways require an understanding of the layouts and use of the areas they serve before they can be sized and specified in any detail.

      i. Modular furniture raceway access.

      ii. Wall-mount access - stand alone or raceway.

   d. Conduits to each WAO will be sized depending on the number of cables at the WAO, but unless otherwise noted, most WAO conduits will be 1-1/4” conduits.

   e. All cable to each WAO will be homerun through the pathway systems described. The WAO cable will travel through the secondary pathway (conduit), then the primary pathway (cable tray and possibly conduits), then to the area-serving TR.

6. Pathway Fill

   a. Conduit: See BICSI Telecommunications Distribution Methods Manual (TDMM), most recent edition, for pathway cable fill recommendations and restrictions.

   b. Cable tray and J-hooks: See manufacturer's load tables.

Structured Cabling System

1. The Telecommunications/ITS spaces and pathway requirements stated above support what the Telecommunications Industry calls a Structured Cabling System which includes OSP backbone, riser cable, and WAO horizontal cabling.
2. The Contractor installing the Structured Cabling System shall be documented by the manufacturer/ supplier as a certified and approved installer of the manufacturer's Structured Cabling System.
3. Quantity Estimates

   a. The estimated number of required OSP backbone copper pairs is based on each building’s utilization and Assignable Square Footage (ASF). Coordinate with OSP Engineer to determine the number of required copper pairs for each building.

   b. Estimate number of required OSP backbone fiber strands based on each building's utilization and ASF. Coordinate with OSP Engineer to determine the number of fiber strands required for each building. All OSP fiber shall be OS2 suitable for underground duct installation.

   c. The riser copper and fiber strand count are to be determined on a case-by-case basis. Confirm sizing with the University Representative.

   d. Reference project drawings for specific WAO cable counts.

e. Minimum cable performance certification shall meet the manufacturer's UTP Category specifications.

Network Wireless

1. Existing network wireless is 802.11xx service.
2. Network wireless shall be designed per TIA/TSB 162 and BICSI Wireless Design Reference Manual (WDRM), most recent Edition.
3. Design all wireless coverage to 802.11xx for the entire building.
4. WAP cabling and jacks are for the exclusive use of network services.
5. WAP
    a. Each WAP location shall have 2 horizontal cables.
    b. WAP junction boxes shall be at ceiling level and opening shall face downward. Junction box shall not be higher than 20 ft.
    c. WAP power is Power Over Ethernet (POE).
    d. Location of WAPs:
        i. University representative will review heat maps developed by designer.
        ii. Place in hallways on or near cable trays.
        iii. Place in conference rooms.

Horizontal Cabling Density Design Requirements

The goal of the cabling density standards is to provide guidance to the design teams for the purpose of sizing the ISP structured cabling system and in turn enable the organization of the TRs to provide a level of service that achieves:

1. Data service to Work Area Outlets at standard speeds up to and including 10 Gbps.
2. Voice over IP (VoIP) service capability.
3. Station wiring media types and density to support all communications service for 10+ years.
4. Closet space to allow simultaneous support to two generations of data service and support parallel voice services from existing and new campus VoIP systems.
5. Cabling closets to support all communications services for 25 years.

General Outlet Density Standards

The schedule below describes the quantity of jacks/cables required at Work Area Outlet (WAO) faceplates for specific applications. Faceplate density for the various room types is addressed herein. Examples below are subject to change based on room use case.

Room types not shown on this list will be on a case-by-case basis. Size for one WAO per 100 sf unless otherwise noted. For reference, the space type designation in the table below is based on space types as defined in the UC Facilities Data System (FDX) maintained by the Campus Office of Planning and Budget. In the programming phase of the project coordinate space types with the University Representative.

WAO Definition (Cat 6A Jacks/Cables per faceplate)	
Standard	Jack/Cable Quantity
General UCSC WAO Standard (u.o.n.)	2
Occupancy Specific WAO (Space types map to FDX standard coding)	
Campus Phone, Wall Mount	1
Computer Teaching Lab	As required per narrative
Campus Phone, Wall Mount	1
Elevator Machine Room	1 per cab
Intrusion Detection/ Access Control	1 per panel (Radionics/Bosch/C-Cure iStar)
IP Cameras	1 per camera
Fire alarm panel	2 (where FACP not already connected by fiber)
BMS Devices (Building Controls)	1 (Minimum of 1 per BMS device)
Omnilocks gateway	1
Research Lab Bench	1
Research Lab, Staff Workstation	2
Wireless Access Point (WAP)	2
Wireless Phone Access Point	1

Application Narratives/Tables		
Reference (Space Type)	**Definition**	**Assignment**
Classrooms, Lecture Halls (Conference Rooms, Seminar Rooms, Colloquia over 500 SF)		
CL		See classroom design standards, page 30 Section IX B. in May 2012 draft. Lecture Halls standards: 1. WAO with at least two jacks at each of at least two locations at the front of the classroom. 2. WAO with at least two jacks at each video projector. 3. WAO's with at least one jack at each wireless network access point. Density: 1 WAO for wireless per every 50 stations (seats). 4. WAO with at least four jacks in the projection booth. 5. WAO with at least four jacks at the media equipment rack 6. WAO with at least four jacks at the lectern. 7. WAO with at least two jacks on each wall of the room. 8. One WAO per wall and one campus phone WAO at the doorway.

		Classrooms, Seminar Rooms and Colloquia - as per the above w/o the projection booth.
Circulation Space/ Corridors		
		Wireless Systems: 30-foot on center. Intent is a combination with the specific space WAP WAO allocations herein to develop a wired grid infrastructure to support Wi-Fi at 30-foot on center. Alternate placement of WAO's on adjacent floors to limit crosstalk. Final placement to be determined by wireless survey design.
Fine Arts (Elena Baskin Area)		
		There are no standards established in this area, consult with the University Representative prior to the start of preliminary design for projects in this facility.
Instructional Computing labs larger than 120 SF		
IL	120 asf+	One campus phone at the door. 1 jack per workstation 2 jack WAO per shared printer 2 jack WAO for supervisor (E) Electronic door locks and IP cameras to be rewired 1:1 Media Services std implementation at projection systems where they exist.
	120 asf and below	Provide Office/General WAO density with Instructional Computing Lab WAO.
Interior Interactive Spaces		
IA		Minimum of one WAO per interactive space. 1 WAO for wireless
Library/ Study		
ST		Basic plan - replace existing 1:1. Science Library is a special case with the Active Learning Classroom, consult with the University Representative for this space. Most non-stack areas are covered in other categories herein. At stacks: Wiring to OPAC's, wireless per campus std for student access, 1 WAO per group study room.
Lobbies/Entries/ Exterior		
EN		Two WAO locations, with 2 jacks each. 1 WAO for wireless in large lobbies with seating areas.
		WAP(s) associated with each entry/exterior gathering area. Quantity required is based upon the size and use case of the area to be served. Coordinate with the University Representative to confirm current requirements as designated by ITS.
Mechanical, Electrical and Plumbing Rooms		
MEP		Replace (e), on a 1:1, + 1 jack basis. Typically, only one such room per building needs to be provisioned with a campus IP interface. The remaining MEP spaces will tie to one another using the building controls network, refer to Division 23 and 27. In renovations of existing buildings coordinate with the University Representative to facilitate Physical Plant point of interface to existing systems. WAO is surface mounted to the wall, adjacent to JACE enclosure.

Office, Research Office, Open Office, and General space (Incl Conference Rooms < 500 SF):		
OG	40 to 80 asf	1 WAO
OG	Open Plan/Cubicle	1 WAO
OG0	80 to 135 asf	2 WAO on opposite walls.
OG1	136 to 200 asf	3 WAO.
OG2	201 to 300 asf	4 WAO.
OG3	Larger than 301 asf	4+ WAO - One plate per 100 sf, with a minimum of 4 plates. The sf will include aisles and common space. For conference rooms (CF) add 1 WAO for wireless.
OS	Office Service	Kitchen or Break Rooms: Minimum 1 WAO. Rooms currently used for Storage to be fit out as if an office based on size. Copier/Print rooms= special case as needed. Fit up as Office UON.
Research Labs		
General Narrative	Consult with the University Representative on WAO density in dry labs, in the absence of information follow Office standards. At permanently installed lab benches, place one WAO at each side of each bench. Install at center. Maintain 3' min separation from sinks and permanently installed lab equipment. Lab Phones. Where labs have existing wall phones, the project installs new station cabling to existing locations. Otherwise, no new wall phone cabling is installed in lab spaces. Place cabling and WAO (630A mount style) for courtesy phones in lab corridors at regular intervals. Select locations for line of sight while complying with path-of-travel requirements of CBC.	
RL0	40 to 64 asf	1 WAO
RL1	Small, 65 to 120 asf	2 WAO's
RL2	Medium, 121 to 300 asf	3 WAO's and1 WAO for wireless
RL3	301 asf and greater	1 WAO per 100 ASF rounded up to the nearest whole unit + 1 WAO for wireless (assumes less than 900 SF).
RLS	minimum 2 WAO	If the room is large, design with the flexibility to become a research lab.
Scholarly Activity/ Tutorial/College Study		
SR/CF		Basic plan for renovations is replace existing 1:1 For flexibility of changes in room use, use Office standards. Provide1 WAO for wireless per room.
Small Server Room/ Departmental Computer Room		
DC	< 300SF	For remodel: Use office WAO std, confirm with the University Representative to anticipate if it is intended for service to feed a Firewall or datacenter/server cabinet core switch).
Teaching Labs (Class Labs, Special Class Labs):		
TL	Teaching Labs	Minimum one WAO per wall on four walls (three walls if the window wall can't readily be wired) and one campus phone WAO at the doorway. For wet teaching labs, provide one WAO for every four stations. For most dry

		teaching labs and all teaching labs with computer stations (TLC), provide one WAO to match station count in the room.
TLS	Teaching Labs Service (Class Lab Service, etc.)	One WAO per wall on three walls (assumes window wall can't readily be wired) with minimum 2 WAO for lab prep.
Trailers/ Relocatable Buildings		
RE		1 WAO per 60 sf density.
Housing		
		[Specifiers note: coordinate requirements with other disciplines as appropriate] Provide a minimum of one electrical outlet at each bedroom wall. Provide a double duplex electrical outlet adjacent to the WAO. For single bedrooms provide one WAO. For double bedrooms and lounges provide one dual data WAO. This is applicable to dorm style rooms, consult with the University Representative for apartment and suite style rooms.

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.
2. For office areas, provide maximum flexibility for change within the work area (i.e., on opposing walls).
3. Open office area interior design, telecommunications distribution planning and power system distribution planning shall be coordinated to eliminate placement discrepancies.
4. Building Systems WAO's, coordinate requirements with Division 23, 26, 28 and 33
    a. A minimum of one WAO shall be installed for each elevator bay (incl. wheelchair elevator) in an accessible area outside and near the Elevator Control Room. The WAO is to be placed within an indoor rated box with a hinged cover. A conduit will need to be provided from the box to the elevator room control panel.
    b. For the minimum number of jacks per WAO, reference the general outlet density standards. The WAO shall be installed outside within 3ft of the BMS device.
    c. For the minimum number of jacks per WAO, reference the outlet density standards table. The WAO shall be planned for any Building Access Systems (card readers, cameras) within 3ft of the Security Control Panel (SCP).
5. Note to Design Professional: Provide note on the drawings that the Contractor shall coordinate Building Management WAO final locations with building systems and with the University Representative.

Courtesy, Pay, Text, Emergency and Wheelchair Elevator Telephones

1. Comply with the most current American Disabilities Act (ADA) Accessibility Guidelines.
    a. Wall-mounted telephones shall not be installed above a countertop.
    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.

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 current approved National Electrical Code.
2. Contact the University Representative to survey the existing cable plant. There is a possibility that all or a portion of the existing installed cable may be reused.

END OF SECTION 27 00 00

27 05 00 – COMMON WORK RESULTS FOR COMMUNICATIONS

1. Work shall be designed and installed per the following:
    a. California Electrical Code (CEC)
    b. National Electrical Safety Code (NESC)
    c. California PUC General Orders 95 and 128
    d. ANSI/TIA-758 Customer-Owned Outside Plant Telecommunications Infrastructure Standard.
2. Consult with University Representative to coordinate with the campus ITS department to determine the best cable distribution method along a proposed cable route.

END OF SECTION 27 05 00

27 05 26 – GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

The following standards shall apply:

1. ANSI/TIA-607, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
2. ANSI/TIA-606 Administration Standards for the Telecommunications Infrastructure of Commercial Buildings.
3. BICSI guidelines
4. National Electrical Code (NEC)
5. California Electrical Code Article 250 and references therein.
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 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/TIA-607. Refer to Section 26 06 00 – Schedules for Communications. Product/Material Category, "Bonding".

Telecommunications Main Grounding Busbar (TMGB) & Telecommunications Grounding Busbar (TGB)

1. IG systems are not recommended for voice and data equipment, regardless of intent. It defeats the purpose of an equipotential plane, verify requirements with University Representative.
2. The TMGB & TGB must be a pre-drilled copper busbar with holes for use with standard- 2-hole sized lugs, have minimum dimensions of 6.3 mm (0.25 in) thick by 101 mm (4 in) wide and be minimum 20" of an equipotential plane, verify requirements with University Representative.
3. TMGB to be located in a building's ADF.
4. The TMGB needs to be connected directly to the building's main electrical entrance facility Primary Bonding Busbar (PBB).
5. The TGBs are to be located in the buildings IDFs and sourced from the TMGB.
6. The Telecommunications Bonding Backbone (TBB) must be a continuous conductor, not daisy chained or segmented in any way.

Labeling

All ground attachments shall be properly tagged and labeled in accordance with ANSI/TIA-606.

Testing

1. Test per ANSI/TIA-607 with an Earth Ground Resistance Tester used in the Two Point Test Method.
2. The installer / technician conducting these tests must be certified level VI by UIC ACCC TED.
3. These tests shall be recorded and provided to the University Representative.

END OF SECTION 27 05 26

27 05 29 – HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

Communications J-hooks

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.
2. Main cable bundle shall be made up of 4-inch J-Hooks and supported on a minimum of 3/8-inch rod.
3. Secondary cable bundles shall be made of a minimum of 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 degrees 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.
4. Cables shall not be secured to the J-hook with cable ties or vinyl tape.
5. Contractor to provide drawings indicating Primary and Secondary pathways to University Representative for approval before installing cable.

END OF SECTION 27 05 29

27 05 33 – CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

Interior Conduits

1. Be installed in the most direct and accessible route possible (parallel to building lines and located in and above accessible hallways).
2. Contain no more than two 90-degree sweeps in any dimensional plane or exceed 100-feet in length between pulling points or interior pull boxes.
3. A pull box is not to be used in place of a conduit sweep.
4. Stub up to an accessible ceiling area 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 (California Electrical Code) and ANSI/TIA-607, where applicable.
9. Interior conduits and/or sleeves shall be properly sized in accordance with ANSI/TIA-569.
10. 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.

Structures to Support Vertically Aligned Telecommunications Spaces (TS)

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. 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 shall be coordinated with other work during construction or remodeling.
    a. Each 4-inch metallic conduit shall be installed with a mule tape and contain a ground bushing on each end grounded to the TGB.
    b. 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.
    c. Conduits located in the ceiling or wall shall protrude into the ER/TR 4 inches and a minimum 8 feet above the finished floor. Conduit shall not turn down.
    d. Provide a conduit riser diagram in the Drawings.
    e. Note: A minimum 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 antenna cable. This

conduit shall be grounded using a path other than the telecommunications ground provided in the ER/TR. Coordinate in-building Distributed Antenna System (i-DAS) cabling requirements with the University Representatives.

Work Area Outlet (WAO) Conduit and Backbox Size Requirements

1. All WAOs 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 4-inch square by 2 7/8-inch-deep device box with a single gang mud ring installed flush mounted within the wall.
2. Wall-mounted courtesy telephone device boxes shall be mounted per ADA requirements.
3. 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.
4. The maximum allowable conduit fill requirements shall be adhered to when designing conduit installations for WAO device box and Wiremold®, locations.
5. Typical mounting height shall be +18-inches AFF or match the height of new and existing power receptacles, where appropriate.
6. WAOs 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 faceplate, outlet covers and patch cords.

Communication Floor Poke-through Devices

1. All floor poke-through devices shall be
    a. 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.
    b. Suitable for use in air handling spaces in accordance with Sec 300-22(C) of the National Electrical Code.
2. For the purpose of estimating, provide Wiremold Legrand® Evolution Series Poke-Thru Devices, confirm product features with the University Representative starting at the DD phase of the project. 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.
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 located in restricted and/or highly secured areas, such as X-Ray rooms, Clean rooms, etc.
4. Pull boxes are not to be used in place of sweeps and 90's to round corners.
5. Pull boxes are to be sized per the CEC (California Electrical Code).

END OF SECTION 27 05 33

27 05 36 – CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

Communications Cable Runway and Trays

Cable Runway shall be:

1. Used only in Telecommunications Rooms (TR).
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 12-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 ANSI/TIA-569 and applicable addendums.
7. Grounded and bonded in accordance with ANSI/TIA-607. All splices, T-Sections and bends shall be bonded together. Cable runway and trays shall not be used as an equipment ground nor seismic support or bracing.
8. Meet Seismic Category D 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 12-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, electro zinc plated wire basket tray system is the preferred cable tray system within the corridors. 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 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 seismic design category D seismic bracing standards.
6. Shall be sized to accommodate future installations and building growth. Initial cable fill not to exceed 25% of tray capacity.
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.
8. Cable tray shall transition to a fire rated assembly to penetrate walls. 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.
9. Shall be grounded and bonded in accordance with ANSI/TIA-607 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-606.
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 ANSI/TIA-569 and applicable addendums.

Cable Tray and Runway Clearances

1. Cable trays shall not be placed within 5-inches of any overhead light fixture nor 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 at all times. 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.

END OF SECTION 27 05 36

27 05 39 – SURFACE RACEWAYS FOR COMMUNICATIONS SYSTEM

Raceway shall be:

1. Used only in areas where cabling cannot be placed within walls, ceilings or cable trays.
2. Secured using mechanical fasteners, double sided sticky tape is not acceptable.
3. Comply with the most restrictive requirements of Division 27 for wiring of the applicable class in the applicable location.
4. At a minimum, provide raceway with cross-sectional area equivalent to 1 inch diameter trade size for communication station cabling.
5. Install complete raceway system including track, cover plate, device boxes, radiused inside and outside elbows and manufacturer's category and fiber cabling guideway fittings, splice plates, T's, transitions and extension rings and end caps as required.

END OF SECTION 27 05 39

27 05 41 – FIRE-STOPPING SYSTEMS

Fire stopping is intended to prohibit the spread of fire and smoke from one location within a building to another. This means restoring the integrity of rated walls, floors, and ceilings when these barriers are penetrated. Penetrations include cable tray, ladder racking, cables, sleeves, and conduits. A fire resistance rating uses the time (in hours) that a firestop “Assembly” or an architectural feature show an acceptable resistance to fire. The rating of the firestop Assembly must meet (or be better than) the rating of the architectural feature that is penetrated. It is difficult to standardize an overall firestop system because of the complex interactions of the materials, penetrating items, and construction assemblies. Since many proprietary solutions are available, only engineering considerations are referenced. All systems MUST be a UL listed system/assembly.

END OF SECTION 27 05 41

27 05 43 – UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

Coordinate with Division 26 and 33 for conduit routing.

Underground Conduit Construction

General

1. All designs must be coordinated with and approved by the University Representative.
2. 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.
3. Spacers shall be used in the trench to support the conduits.
4. A solid core #10 AWG copper wire shall be installed externally along any conduit run for the purpose of locating and tracing the conduit route.
5. Fabric multi-cell type of inner duct shall be considered for conduits planned.
6. 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.
7. All conduits shall be provided with mule tape with a minimum of 200 pound pulling tension.
8. 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.
9. 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.
10. All future conduit stubs shall be flagged for easy identification and an electronic ball marker shall be placed.
11. All metallic conduit and sleeves shall be reamed, bushed and capped when placed.
12. 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.
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 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 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, if used within the concrete shall be sized accordingly for the load and stress at each location.
20. Contact the University Representative to inspect and approve all conduits prior to encasement.
21. Conduit shall be encased in concrete or cement slurry when the following conditions exist:
22. Minimum conduit depth cannot be attained.
    a. Conduits pass under sidewalks, roadways, driveways, railroad tracks and at bend points.

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

Directional Boring

1. High-density polyethylene (HDPE) conduit to be used for directional boring.
2. A swivel shall be used at all times 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 as required by the National Electrical Safety Code (NESC) for personnel safety and the protection of telecommunications equipment shall be maintained at all times.

All plastic underground piping shall be kept at a 10-foot distance from steam/condensate lines unless approved by the University 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 Representative for review and approval prior to the beginning of any installation work.

Maintenance Holes (MH) and Pull Boxes (PB)

General Requirements

1. MH/PBs 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/PBs or between two MH/PBs is 600 feet.

3. No more than (2) 90-degree bends in conduit between MH/PBs.
4. MHs and PBs 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/PBs 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 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. Provide (4) L-Cable Racks PB and (8) L-Cable Racks per MH.
11. Where placement location is a roadway, driveway, bike path, fire line, loading dock or trash pickup area, provide only a MH.

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. PBs shall not be placed in a main conduit route between two MHs. MH/PBs 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 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 ANSI/TIA-758 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 gasses from entering the building. MH/PB conduits shall be plugged with duct seal material to prevent the entrance of water and gasses.

END OF SECTION 27 05 43

27 05 53 – IDENTIFICATION AND LABELING FOR COMMUNICATIONS SYSTEMS

Identification and labeling shall meet the requirements in this document and the current ANSI/ TIA-606, "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings", where applicable.

Permanent Links Terminated on a WAO

1. Each Permanent Link consists of 1 Horizontal Cable, 1 WAO jack and 1 Patch Panel port. Each Permanent Link is assigned a unique identification number and every part of the Permanent Link must be labeled with that number.
2. Permanent Link Identification Number and WAO Jack Label Placements: Each WAO jack position shall be labeled with the corresponding Permanent Link identification number. The label shall be placed directly above or below the jack. The Permanent Link Identification number shall be YZZZ where:
    a. Y = the floor number - use zero (0) for basement floors.
    b. ZZZ = the WAO jack number the cable is terminated on - 001 through 999.
3. An alternative labeling method to increase label readability would be to label the jacks with the 4-digit jack number and have a header label on the faceplate in the following format: "Building XXX." This alternative must be approved by the project manager.
4. All labels shall be machine created labels, clearly legible, black letters on white background.

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.
2. Fiber strand numbering shall be consistent with the Consecutive Fiber Numbering (CFN) sequence as identified in ANSI/TIA-568. This fiber stand numbering sequence shall be accomplished at each terminated end of the fiber optic cable. The rolling of fiber optic strands, as identified in ANSI/TIA-568 as Reverse Pair Positioning (RPP) shall not be used on the Campus.

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 as seen when facing the front 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 numbered consecutively left to right, top to bottom.

Fiber Optic Splice Shelf Labeling

1. Fiber optic splice shelves and drawers shall be labeled sequentially from top to bottom using an adhesive backed, self-laminated labeling machine and vinyl glossy label stock affixed to 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.
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 attached with a plastic tie wrap.

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).
2. Labels shall be pre-printed using an electronic label maker such as the Brother P-Touch®, 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 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 the University 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.

END OF SECTION 27 05 53

27 10 00 – STRUCTURED CABLING, BASIC MATERIALS AND METHODS

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

END OF SECTION 27 10 00

27 11 13 – 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 gas state protector modules, which include 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. Cable shall be blocked with an approved manufactured seal to prevent the gel filled compound from escaping.
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.
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.
7. 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/TIA-607.

END OF SECTION 27 11 13

27 11 16 – COMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES

Equipment Racks and Distribution Cabinets

1. 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.
2. Equipment racks shall meet the following requirements:
    a. One piece 10 gauge welded steel. Nominal height is 7 feet (45U). 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.
    b. 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.
    c. NEBS-Telecordia GR-63-CORE Zone 4: Tested with 500 lb of equipment installed. Dynamic shaker table tested and passed. Proof of conformance shall be supplied with submittal prior to work.
    d. Approved and Stamped by a Certified State of California Structural Engineer to OSHPD (Office of Statewide Health Planning and Development), CBC (California Building Code). Proof of conformance shall be supplied with submittal prior to work.
    e. 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).
3. Free standing cabinets shall be used only in locations that are not securable by a lockable door or meet environmental requirements. The University Representative shall approve these areas prior to the design or installation of these cabinets.
4. Cabinets shall meet the same requirements as equipment racks listed above.

Equipment Rack and Cabinet Dimensions

Table 13 Equipment Rack and Cabinet Dimensions

Type of Termination	Equipment Rack Dimensions (H by W)	Distribution Cabinet Dimensions (H by W by D)
ADF	84-inches by 19-inches (3 each)	84-inches by 24-inches by 32-inches (3 each)
BDF	84-inches by 19-inches (5 each)	84-inches by 24-inches by 32-inches (5 each)
IDF	84-inches by 19-inches (4 each)	84-inches by 24-inches by 32-inches (4 each)

Table 14: Wall Mountable Cabinet Dimensions

Type	RU	Height	Depth	Width
R5A	5 + 4	42	10	24
R5B	5 + 4	32	10	24
R12A	24	49	34	24
R12B	35	68	28	24
R13A	40	91	32	24
R13B	46	102	29	24

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.

Equipment Rack and Cabinet Layouts

1. Area Distribution Frame (ADF)
    a. Planning for a new ADF shall be coordinated with the ITS Engineering and Construction Management, contact the University Representative.

END OF SECTION 27 11 16

27 11 19 – COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

Copper Patch Panels

1. UTP cable patch panels that provide data service to WAO's shall meet the following specifications.
    a. Patch panels shall support specified performance requirements as listed in Table below.
    b. 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.
    c. Patch panels shall be empty, utilize Keystone port openings, and capable of accepting the same jacks as used at the WAO with an exact fit.
    d. Patch panels shall be labeled above the port opening using an electronic label. The electronic label shall be 3/8" in width, contain black, Helvetica, Size 1 Font, block letters on a white background as shown in the Figure below. Labels shall be inserted into the magnifying label holder depicted.
2. Provide horizontal wire managers above, below or between each patch panel as appropriate.

UC Santa Cruz has adopted a Universal Wiring Scheme. All Work Area Outlets (WAO) consist of data service. WAO UTP cabling shall be terminated on CAT6A jacks, mounted in a Quickport® patch panel mounted within the patch panel equipment rack located within the Telecom Room. Jacks at the patch panel shall correspond in color and rating to jacks at the WAO.

250 MHz Data Patch Panel Specifications (UL certified testing laboratory)

Data Patch Panel Termination Hardware	Specifications
Construction (48 Port Patch Panels)	16-gauge steel. Accepts Category 6A jacks to match WAO, T568B wiring, 8P8C, high density, 6 port groupings, rear cable management, front magnifier strips, 19-inches (483mm) wide by 3.5-inches (89mm) high (48 port), Low emission IDC contacts, ANSI/TIA-568 compliant and UL Listed
Electrical Data (Jacks at 250MHz)	Return Loss: 16 dB
	Insertion Loss: 0.32 dB (max)
	NEXT: 46 dB
	FEXT: 35.1 dB

Voice Cross Connect System

At the backbone wall field, install a voice 100 pair 110 block. At the rack side, install a dedicated patch panel. In an R15 environment, install a voice patch panel. Terminate two pair per port. Quantity to be determined by building and/or user requirements.

Voice Backbone UTP Cable Termination Blocks

1. Voice backbone UTP cables that provide voice service to Work Area Outlets (WAO's) and cross-connects 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 100 pair size to include 110-type blocks, 110-C type connecting blocks, jumper trough, bottom tray and labels.

   b. Wall-mountable 110-type cross connect field shall facilitate cross connection and intermediate cross connection using 110 wall mount backboard channels 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-568 compliant in both design and performance.
   b. Be UL LISTED 1863, Communications Circuit Accessories, 1995.
   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 Patch Panels

1. Fiber Patch Panels provide termination and inter connectivity of fiber systems. Patch Panels should be manufactured by an ISO 9001 certified manufacturer. All patch panels shall be of steel construction.
   a. Patch panels shall be empty, utilize plug and play systems and capable of accepting duplex LC and SC connectors.
   b. Patch panels shall be installed with easy access splice trays.
   c. Patch panels shall be labeled on the front access door with clear labels and cable identifiers provided by university representative.
   d. Patch panels shall have all exposed pigtails and buffer tubes protected by approved meshing or solid tube insulation.
   e. Patch panels shall be sealed with solid plastic grommets at cable entrance to prevent rodent intrusion.

END OF SECTION 27 11 19

27 11 23 – COMMUNICATIONS CABLE MANAGEMENT

The goal of a pathway component is to accommodate all standards-compliant cabling and the potential need for change during the life cycle of the cabling system. Furthermore, the design should minimize the unit change time and cost for cabling system renovations.

Inner Ducts, Conduits, Cable Trays, Raceways

Horizontal cabling supported by continuous cable pathways shall not be bundled (to minimize the risk of alien crosstalk).

Cable Hangers

The distance between cable hangers is not to exceed 4’

Racks, Cabinets, Enclosures, Patch Panels (PPs)

TR Rack Elevations

1. Top RU is typically populated with a Fiber Patch Panel (FPP).
2. Next leave 2 RU empty for future expansion.
3. Next a group of Voice Copper Patch Panels (V-CPPs) and Wire Manager Panels (WMPs) (see below for V-CPP/ WMP arrangements).
4. Next a group of Data Copper Patch Panels (D-CPPs) and WMPs (see below for D-CPP/ WMP arrangements).
5. Next a group of Network switches and WMPs.
6. Then lastly a power supply group, with a Power Distribution Unit (PDU) on top, the UPS in the middle and battery packs at the bottom.
7. The Network Switch and Power Supply Group is typically supplied, wired and dressed by the University Representative. All other groups are wired and dressed by the contractor.

Horizontal and vertical WMPs:

WMs shall be properly sized with a maximum fill-ratio of 80% at system design. Horizontal and vertical WMPs front surfaces shall be flush.

FPPs and WMPs

No fiber WMPs are required for the FPPs.

D-CPPs and WMPs

1 x 2RU WMP above and 1 x 2RU WMP below each 48 port CPP.

1 x 2RU WMP above or 1 x 2RU WMP below each 24 port CPP.

V-CPPs and WMPs

1 x 2RU WMP above or 1 x 2RU WMP below each 24 port CPP

Network Switches and WMPs

1 x 2RU WMP followed by 1 network switch, followed by an empty 1RU space, followed by 1 network switch and lastly followed by 1 x 2RU WMP.

END OF SECTION 27 11 23

27 13 00 – COMMUNICATIONS BACKBONE CABLING

Consult with the university representative for specific design specifications. Reference 27 13 13 and 27 13 23.

END OF SECTION 27 13 00

27 13 13 – COMMUNICATIONS COPPER BACKBONE CABLING

Building Backbone Inside Plant UTP Copper Cable

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).

Copper Riser Cable Specifications

Riser cables shall meet the following requirements:

1. UL 444 and 1666, ANSI/TIA-568, FCC Part 68, Telecordia GR-111, Category 3, listed as CMR or CMP. Conform to CEC (California Electrical Code) Article 770 and comply with the State of California fire codes and the Campus Fire Marshal's office.
2. 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.
3. The riser cable is labeled based on a cable number assigned by the University Representative. The cable pair count shall also be included in the label.
4. 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 WAO = 2 pairs, three (3) or more voice WAOs = 1.5 pairs per WAO.
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 20-foot service loop prior to terminations at the ADF/BDF/IDF location. The University 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.

END OF SECTION 27 13 13

27 13 13.13 – 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 for underground, direct-buried, aerial and building terminal splices. 710-type connectors shall be 3M.
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.
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 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.

END OF SECTION 27 13 13.13

27 13 23 – COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

Fiber Optic Riser Cable

Riser cables shall meet the following requirements:

1. Conform to CEC (California Electrical Code) 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.
4. Reference Division 27 for labeling requirements.
5. Reference Division 27 11 19 Communications Termination Blocks and Patch Panels for termination hardware.

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. Equipment shall be installed in accordance with the manufacturer's instructions.
2. Note: Indoor/ outdoor rated cable shall be installed in locations where the termination or splice location exceeds 50-feet.
3. Minimum bend radius shall be maintained during and after the installation phase. The minimum bend radius during installation is 20 times the outside diameter of the cable and 10 times the outside diameter after installation.
4. Buffer tube fan out kits shall be used per manufacturer's requirements.
5. Fiber optic cable shall have a 30-foot service loop prior to terminations at the ADF/ BDF/ IDF location. The University 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.

END OF SECTION 27 13 23

27 13 23.13 – COMMUNICATIONS OPTICAL FIBER SPLICING AND TERMINATIONS

Fiber Optic Cable Splice Methods

1. Coordinate with the University Representative to confer with ITS Engineering and Construction Management 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 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, reusable/ resealable type of fiber optic cable closure.
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 LC Ultra PC Polish (UPC) type pigtails at the ADF/BDF/IDF.

Closet Connector and Splice Housings

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

END OF SECTION 27 13 23.13

27 15 00 – COMMUNICATIONS HORIZONTAL CABLING

1. Two types of cables may be used for use in the horizontal segment: Unshielded Twisted Pair (UTP) and single-mode (SM) fiber optic cable.
    a. UTP cable shall be 4-pair, 23 AWG, solid conductor UL Listed OFNP (Optical Fiber Nonconductive Riser) cabling that meets ANSI/TIA-568 Category 6A cable, to include all current Addendums and Bulletins and shall meet specified specifications and performance requirements. See Product Section 27 06 00 in Division 27 Specifications.
2. 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:
    a. Article 770 Optical Fiber Cables and Raceways
    b. Article 800 Communications Circuits
    c. Article 810 Radio and Television Equipment
    d. Article 820 Community Antenna Television and Radio Distribution
    e. Article 830 Network Powered Broadband Communications Systems
3. Horizontal cables shall not be spliced, nor shall these cables contain manufacturer splices.
4. Cable shall be manufactured, tested, certified and meet the performance requirements specified in Section 27 06 00 - Communications Product Schedule.
5. 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).
6. Cable slack shall be provided at the workstation to accommodate future cabling system changes.
    a. The minimum amount of slack shall be 6-inches for UTP cables and 36-inches for fiber optic cables at the WAO.
    b. 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.
7. 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.

END OF SECTION 27 15 00

27 15 43 – COMMUNICATIONS FACEPLATES AND CONNECTORS

The term Work Area Outlet (WAO) refers to the actual faceplate or surface mounted box installed in the work area. WAO shall be permanently labeled per spec in section 27 05 53 "faceplate labeling."

Work Area Outlet (WAO) Faceplates, Surface Mount Boxes, Raceway, Adapters and Modules

Faceplates, Surface Mount Interface Boxes and 106-Type Receptacles:

1. WAO's shall be flush-mounted, front entry, front removable, multiple port faceplates and surface mount interface boxes.
2. All voice, data and coax faceplates shall be a minimum of double gang faceplate. Blank modules of the same color and manufacturer shall cover all open ports not utilized.
3. Device frames as listed in 27 06 00 - Communications Product Schedule, shall be used when installing WAO's in metallic type surface raceways when a standard type faceplate cannot be used.
4. For modular furniture WAO installation, coordinate work with University Representative.

END OF SECTION 27 15 43

27 15 53 AND 27 15 54 – COMMUNICATIONS FIBER AND COPPER CABLE PLANT TESTING

Testing Requirements for Copper and Fiber Optic Horizontal Cables

1. General
    a. Test and document each horizontal cable segment separately.
    b. Test each end-to-end cable link.
    c. Design Professional shall develop testing specifications and requirements.
2. The Contractor shall perform testing on all installed cabling systems. All documented test results shall be provided to the University Representative for review and approval by CR.
3. Prior to testing, all cables shall be installed, terminated, labeled and inspected. The Contractor shall notify the University Representative 48 hours in advance and provide a testing schedule. The University Representative has the right to verify the setup and procedures of testing instruments and be present during cable certification. The Contractor shall provide calibration certificates 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

Permanent Link test all UTP horizontal station cables with a Level IIIe or later tester for full compliance with ANSI/TIA-568, CAT6A specifications. Test using or CAT6A test cords, by the 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 or exceed the guaranteed parameters as specified in Division 27 Specifications.

Horizontal and Riser/ Backbone Fiber Cable Testing

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

Fiber optic testing procedures include the following.

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 ANSI/TIA-568, 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 meter/light source capable of recording and plotting data.
3. ANSI/TIA 568 and ANSI/TIA-526 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 wavelengths for dB loss and end-to-end total installed distance with an OTDR.

Table 12 Maximum Loss Measurements

Maximum Loss Measurements for Installed Fiber Optic Cables	
Mated Connector Loss:	0.5 dB per mated pair
Connector Loss:	0.5 dB per connector
Fusion Single-mode Mechanical	0.06 dB 0.3 dB
Fiber loss: Single-mode	0.4 dB/km @ 1310 nm (Outside Plant Cable) 0.3 dB/km @ 1550 nm (Outside Plant Cable) 0.7 dB/km @ 1310 nm (Inside Plant Cable) 0.7 dB/km @ 1550 nm (Inside Plant Cable)

Test Result Documentation

1. Power meter fiber optic test results shall be submitted electronically and according to Division 1 requirements. Provide in manufacturer software format.
2. OTDR fiber optic traces shall be submitted electronically and according to Division 1 requirements. Provide in manufacturer software format.
3. Test results shall be organized by technology room in an orderly fashion.
4. 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.).
5. CD shall have a computer-generated label with:
    a. Contractor’s Name
    b. Date
    c. UC Santa Cruz Bldg. name, CAAN and project number
    d. Contents (Fiber/copper Test Results, etc.)

END OF SECTIONS 27 15 53 & 27 15 54

27 20 00 – DATA COMMUNICATIONS

All electronics shall be provided by the University.

END OF SECTION 27 20 00

27 21 33 – DATA COMMUNICATIONS WIRELESS ACCESS POINTS

Wireless Access Coverage

All new construction projects involving wireless technology shall be coordinated with a University Representative. It is the responsibility of the consultant to provide wireless map and heat map for the placement of a Wireless Access Point (WAP). The University Representative will review and approve the wireless design.

Wireless Access Point (WAP)

1. Current Campus wireless network supports 2.4GHz and 5 GHz wireless technologies. Wireless spectrum subject to change. Coordinated with a University Representative.
2. Network wireless design shall conform with TIA/TSB 162 specifications and BICSI Wireless Design Reference Manual (WDRM), most recent Edition.
3. Wireless Access Point (WAP) power is Power-Over-Ethernet (PoE).
4. All Wireless Access Point (WAP) cable and jack are for the exclusive use of Campus Network Services.
5. The Network junction box shall be at ceiling level with the opening facing downward. The Network junction box shall not be higher than 20ft.
6. Location of the wireless device is based on the room design:
    a. Standard ceiling height rooms (offices, classrooms, conference rooms, etc.) with drop tile ceiling: leave the wireless device, placed within a 2-port surface mount box, concealed above the drop tile ceiling on an SMB hanger, suspended by dedicated ceiling wire or pencil rod as previously described. Utilize a varying length patch cord to optimize signal coverage. Place the surface-mount block and hanger where it may initially provide the greatest amount of usable coverage.
    b. High ceiling rooms (lecture rooms, auditoriums, etc.): depending on the size of the room, provision for ceiling and wall mounted WAO locations on each side wall at approximately 8-feet-6-inches AFF. Install each WAO location with a 4-inch square by 2 7/8-inch-deep device box with a single- or dual-gang mud ring installed flush mounted within the wall. Secure jacks if WAP is to be mounted directly to the backbox.
7. Hard cap ceilings: Install the WAO with a 4-inch square by 2 7/8-inch-deep device box with a single- or dual-gang mud ring installed flush mounted within the wall. Secure jacks if WAP is to be mounted directly to the backbox.
8. For Major and Minor Renovation projects, consult the University Representative to determine wireless scope of work.
9. Wireless network equipment shall be provided by the University.

END OF SECTION 27 21 33

27 32 23 – ELEVATOR TELEPHONE

1. Each elevator bay, including elevator chair lifts, is required to have a dedicated phone line.
2. ITS will provide a dedicated analogue circuit for each elevator telephone.
3. No dial telephones should be used.
4. See Division 14 24 23 for specifications.

END OF SECTION 27 32 23