



Districtwide Technology Infrastructure Standard

Revision 02.60

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Document Revision History

Revision	Revision Description	Revision Date
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Standards Document Changes from 2.5 to 2.6

- 1) Significant formatting changes to correct structural problems with file. Formatting changes to make document branding consistent. Change attachments to appendices to be consistent.
- 2) Updated references to Industry Standards and codes throughout.
- 3) Removed Krone as an option for LMC. Formerly 1.3
- 4) Includes language for ERRC and 2-way communications systems – Added in several places as appropriate
- 5) Clarified clearances around racks in TR design – 5.3
- 6) Clarified required lighting in TRs – 5.5
- 7) Coordinate the receptacles for 220 twist-lock at time of installation – 5.6
- 8) Clarification in 5.7
- 9) Clarification in 5.11 for fire protection
- 10) Clarification in 5.12 for Environmental control
- 11) Changed descriptions of WAO count to table to improve readability – 11.8
- 12) Removed references to pay phones – 12.5
- 13) Added section 13 for Wireless Access Point Design
- 14) Added section 18 for Emergency Responders Radio Coverage
- 15) Added section 19 for Two-way Communications Systems
- 16) Updated Fiber standards in 271300
- 17) Updated Jack colors per site in Appendix III
- 18) Removed Contact for Los Medanos College
- 19) Appendix V – Noted which items are OFCI, OFOI, CFCI
- 20) Added Classroom Notification Speakers to Appendix V

List of Appendices

Appendix I	Glossary of Terms
Appendix II	Division 27 Specification Section Highlights
Appendix III	Site Specific Specifications (in progress)
Appendix IV	AutoCAD Symbols
Appendix V	District Specified Equipment List

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1. General

1.1 This document is intended to guide the engineering, design, and installation of structured cabling (voice and data) infrastructure throughout the Contra Costa Community College District (CCCCD). The document should be used to guide the installation of cable and infrastructure additions/remodels as well as the engineering and design of new construction.

1.2 Key Points For Architects, Facility Planners And Engineer

1. Initial building modeling shall accommodate space planning for telecommunication space footprints, power requirements, riser pathway and media systems and adequate heat dissipation.
2. Facilities shall be designed to support standards-based infrastructure solutions providing long-term flexibility.
3. Designs in support of a specific technology shall be avoided.
4. Telecommunication Rooms (TR) shall be dedicated to the support of telecommunications systems only.
5. Any telecommunications space housing or expected to house electronic equipment shall be designed with 24 hour a day/365 days a year environmental conditioning services configured for the specific campus conditions.
6. Each project shall have a specific telecommunications pathway prepared from the point of network origination on campus into and throughout the facility. Outside Plant (OSP) pathways planning is critical to the project. Fill ratios of conduits shall not exceed 40% fill or exceed minimum bend radius.
7. All instructional areas shall be designed to support the distribution of technology for faculty, staff, and students and the use of multi-media systems.
8. High technology spaces should be designed with flexible access flooring and/or telecommunications pathways built in to support flexibility in use.
9. When updating the infrastructure in renovation projects, the designer shall be aware of the limitations imposed by older electrical and HVAC systems, outdated ceiling systems, existing wiring methods, and hazardous materials.

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10. Telecommunications pathways shall be designed as a specific part of an overall telecommunications infrastructure plan, not as a system or technology-specific component.
11. All telecommunications related infrastructure issues shall be based upon published industry standards such as the ANSI/TIA series and RUS bulletins. Vendor-specific requirements shall be analyzed and approved by designated IT representative in light of an overall “standards based” approach.
12. The District has selected Category 6A as our cable standard for new construction and where complete building remodels make it possible to scale up the conduit and ladder racking. Where Category 5 or 5E is being replaced Category 6A should be utilized with the existing conduits and ladder racking. If ladder racking and/or conduits are missing those should be addressed per the standards document.
13. Provide all services, labor, materials, tools, testing, and equipment required for the complete and proper installation and termination of new horizontal "station" cabling as called for in the specifications and related drawings. Perform all horizontal cable installation in conformance with manufacturer's installation guidelines for warranties.
14. Security camera, audio/video or other systems that may use the network or terminate in a TR must adhere to the Standards for Cat 6A. Where there is a conflict District IT will resolve.
15. Prerequisites for network equipment installation:
 - a. Final, permanent power is installed in TR
 - b. Permanent cooling is provided in the room when the doors are closed per specifications.
 - c. Sufficient lighting to work safely
 - d. Lockable doors with at least one key provided to District/Campus IT with the understanding that the doors to the TR's must be locked at end of day and District/Campus IT will be accessing them off construction hours at times and therefore need their own access.
16. The wireless network is for convenience only. No systems shall be designed to operate over the wireless network.
17. Any device or system that transmits or receives using wireless technology

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must be reviewed by DO IT to minimize conflicts with existing wireless networks. Specifically any devices that broadcast using frequencies in the 2.4 or 5 GHz spectrums or are defined as “Wi-Fi”, are not allowed without approval.

2. Contact

- 2.1 As the engineering and design progresses, there may be questions regarding specific or unique infrastructure applications. No deviation from the guidelines listed in this document are allowed unless such deviation approval is documented by the contact designated for that site in Appendix III.
- 2.2 The term “CCCCD” is intended to include all facilities owned, rented or leased that comprise the Contra Costa Community College District, its District Office (DO), Main campuses (Contra Costa College, Diablo Valley College, and Los Medanos College), Satellite campuses (Brentwood and San Ramon), and their environs.
- 2.3 The terms “CCCCD Representative”, “CCCCD Designee”, “Site Representative” and “Site Designee” are intended to identify the CCCCCD employee that is to be contacted for approval or clarification of items relating to the completion or acceptance of any contract work.

3. Code, Standards and Methodologies to Follow

- 3.1 California Administrative Code. Determine and conform to the Code of Record as applies to the Project, including but not limited to the applicable portions of the following California Administrative Code, Title 24 documents:
 1. Part 1 - California Building Standards Administrative Code
 2. Part 2 - California Building Code - Vol. I & II
 3. Part 3 - California Electrical Code – including safe working areas around equipment.
 4. Part 4 - California Mechanical Code
 5. Part 5 - California Plumbing Code
 6. Part 6 - California Energy Code
 7. Part 8 - California Historical Building Code
 8. Part 9 - California Fire Code

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9. Part 10 - California Existing Building Code

10. Part 11 - California Green Building Standards Code

11. Part 12 - California Reference Standards Code

as applies to the structured cable infrastructure design of the Project.

3.2 Cal-OSHA. Designs to provide workspaces for District staff, students and service contractors that conform with the applicable requirements of the State of California Department of Industrial Relations, Division of Occupational Safety and Health (DOSH), also known as Cal/OSHA and Federal OSHA.

3.3 CPUC. In addition, to the extent applicable to the work of the Project, conform with the requirements of State of California Public Utilities Commission

1. General Order 95 - Rules for Overhead Electric Line Construction

2. General Order 128 - Rules for Construction Of Underground Electric Supply and Communication Systems

with respect to interface to the serving public communications utilities.

3.4 Standards. The following standards must be incorporated into the engineering, design, and installation of all District infrastructure systems.

1. ANSI (American National Standards Institute)

a. ANSI/EIA-310-D (1992) Cabinets, Racks, Panels, and Associated Equipment (ANSI/EIA/310-D)

b. ANSI/TIA-568-C.1, C.2 and C.3 Commercial Building Telecommunications Cabling Standard, 2009

c. ANSI/TIA-569-D (2015) Telecommunications Pathways and Spaces

d. ANSI/TIA-606-B-2012, Administration Standard Telecommunications Infrastructure.

e. ANSI-J-STD-607-C, (2015) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.

f. ANSI/TIA-758-A, Customer-Owned Outside Plant Telecommunications Infrastructure Standard.

2. ASTM (American Society for Testing and Materials)

3. BICSI

a. Telecommunications Distribution Methods Manual (TDMM) - 12th edition.

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- b. BICSI - Outside Plant Design Reference Manual (OSPDRM) - 4th edition.
 - c. BICSI - Wireless Design Reference Manual (WDRM) - 3rd edition.
 4. ICEA (Insulated Cable Engineers Association)
 5. IEEE (Institute of Electrical and Electronic Engineers)
 - a. IEEE 100: The Authoritative Dictionary of IEEE Standards.
 6. ISO
 - a. ISO/IEC 11801 Information Technology — Generic Cabling For Customer Premises
2. National Electrical Manufacturers Association (NEMA)

4. AutoCAD Symbols

See Appendix IV for AutoCAD symbols.

5. Telecommunication Room (TR) Design

5.1 Location

1. To minimize the horizontal cable lengths within a maximum of 85 M (279 feet), locate the TR on each floor as close as possible to the center of the area it is to serve.¹
2. Ensure that the TRs are directly accessible from the hallway or other on area. TRs should have only one door and not be used as a passage way to other rooms.
3. It is recommended that all TRs be vertically aligned (stacked) above each other in multistory buildings.
4. TRs shall not be co-located with custodial, mechanical or other shared spaces unless the TR is a self contained, locking enclosure. Self contained, locking enclosures shall not be located in closets with running water.

5.2 Entry

1. Personnel entry to TRs shall be through a locked door at least 36 inches wide, 80 inches high. The door should open outward if this is acceptable

¹ For further information, see Attachment II, Division 27 section 271500 Horizontal Cabling.

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to local building codes. If the door opens inward it must completely clear all racks or other obstacles.

2. TR doors shall utilize card reader controlled electronic locking systems compliant with District standards and fully integrated with the campus ESS.
3. Doorways shall be properly sealed to avoid dust and pest from entering the room.
4. Where TR's are used as riser for ERRC and/or 2-way communications systems, provide 2 hour construction as required by Code, including at entries.

5.3 Telecommunication Room Sizing

1. The recommended minimum floor dimension for a TR shall be 100 square feet (i.e., 10' x 10'). The minimum sizes shall be increased as building size, floor square footage served, or usage increases. The design professional shall consult with the designated contact (see Appendix III) if any questions arise concerning the proper sizing. The room must be at least 8' clear in each dimension.
2. The TR should be square or rectangle to maximize the useable square footage. The MDF room will contain a four post cabinet as well as at least one 19 inch two post relay rack with cable management systems. This equipment list will be provided as Appendix V. This specification does not alleviate the design engineer's responsibility to ensure compatibility of components.
3. Clearance around the racks within each TR is to meet the requirements of the California Electric Code and Cal-OSHA, including 36 inch clear from front face of rack and, and for two-post relay type racks, 36 inch rear clearance behind the deepest District furnished equipment anticipated, which can be assumed to be 26 inch deep as measured from the front face of the rack. For four post cabinets, the point of measurement is to be taken as the deepest point of the cabinet, its doors or door handles. Measurements should be to the nearest wall and/or grounded plane including all required panels, blocks and conduit riser sleeves, tray and/or pullboxes. Where access control panels, door lock power supplies and similar devices require line voltage electrical service, arrange the TR layout to maintain at least 36 inch clear from the face of panel to be equipment racks and cabinets, protruding equipment and other obstructions within the TR.

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4. Any devices installed on the walls of TR's to be located to ensure that they do not interfere with the installation/clearance/maintenance of equipment installed in cabinets/racks nor should they be within 12" of a 90% corner.
5. Special Exception: Smaller single story buildings - Less TR space is needed in smaller single story buildings with less than 8,000 square feet of assignable floor space. In most cases, there will be only one TR. The minimum TR sizing recommended for these applications is a shallow TR (3' x 8.5') or self-contained wall cabinet or enclosure.

5.4 Wall Finishes

1. All walls should be finished, i.e., sheet-rock/painted, and covered with 3/4- inch thick Plywood backboard, 8 foot high by 4 foot wide and affixed in such a manner that it will support the weight of the cable, terminals, and other equipment. The plywood should extend around the entire room, corner to corner on every wall except for a one foot section on either side of the entrance door. Smooth side shall be installed out. The plywood backboard shall be void free. The plywood shall be fire retardant treated and painted with white paint, masking the plywood's fire rated symbol from the paint such that the symbol is still visible after painting OR the plywood shall be treated with two coats of fire retardant paint materials.

5.5 Lighting

1. A light intensity level of 80 footcandles minimum should be provided measured at 3.3 feet from the finished floor on the front and rear faces of equipment racks and cabinets and across the face of the equipment backboards. Lighting should extend uniformly from the top to the bottom of each of the two rack/cabinet faces. Conform with the applicable portions of CalGreen with respect to controls of lighting. Review standards with the AHJ with respect to the requirement to provide functional lighting suitable for precision termination and inspection.
2. Where Code limits the maximum lighting that can be provided in the room, design to ensure that it is focused on the rack/cabinet faces and backboard enumerated above and not wasted on the tops of racks and cabinets, on ductwork, or similar.

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5.6 Power ²

1. Provide at least two dedicated 120 VAC, 20 amp (non-switched) duplex receptacles on each wall a minimum of four feet apart. These must be fed with separate circuits on each wall.
2. Provide one dedicated 120 VAC, 20 amp (non-switched) quad receptacle box and dedicated circuit above each two post relay rack plus a minimum of two 220 VAC, 30 amp twist lock receptacles and circuits at the top of each 4 post relay rack in each TR. The 220 receptacles shall be coordinated with District IT for receptacle type at time of installation. These receptacles should be mounted above rear of the racks. Should multiple UPSes be planned for that TR then two 220 VAC, 30 twist lock receptacles per UPS must be installed.
3. If the building is provided with an emergency generator system the electrical power, HVAC and lights in the TR shall be supplied from that power source.

5.7 Relay Racks ³

1. Racks are typically installed in TRs for the termination of horizontal data cabling, fiber optics and LAN, and other equipment. TR relay racks to be 7 foot tall (at least 43 RU) and to provide vertical rails with threaded holes at ANSI 310-D on center spacing to support use of 19 inch equipment, patch panels and similar. Racks to have a seismic (dynamic) load rating of at least 1000 pounds supported by NEBS GR-63-Core dynamic testing or equivalent means provided by the manufacturer or provide equivalent means of demonstrating conformance with ASCE -7-10 as referenced by the California Building Code.
2. The quantity of racks provided is to be sufficient such the ratio of station cabling per floor per rack does not exceed 200 cables to permit ready support for future adds moves and changes and/or simultaneous operation of current and future network equipment during periods of transition.
3. The size of a typical 19 inch Relay Rack is 7 feet high and 40 inch deep footprint inclusive of vertical wire managers protruding from the front and Contractor and District furnished equipment inserted in the body of the

2 For further information, see Attachment II, Division 27 section 270526 Grounding and Bonding.

3 For further information, see Attachment II, Division 27 section 271100 Equipment Room Fittings

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rack and protruding to the rear. Ensure the required clearance around the racks provides for the equipment installed as required by this standard and outlined herein above.

4. All racks must be attached to the floor using floor mounting anchors and the rack must have seismic bracing by the edition of the CBC that applies to the work of the Project.
5. Racks shall be bonded to each other and grounding shall meet the California Electrical Code requirements and ANSI-J-STD-607-C (2015) Generic Telecommunications Bonding and Ground (Earthing) for Customer Premises.⁴
6. Between each rack and at the end of each row of racks provide vertical wire managers at least 10 inch wide and 19 inches deep, with hinged cover doors that swings in either direction and with continuous fingers permitting cabling to enter the sidewalls of the manager. Racks shall have vertical wire management for the left/right on front/back. Horizontal wire management will be mounted on the front.
7. Patch panels or fiber termination panels should only be installed in two post racks. Four post racks are reserved exclusively for items such as servers or UPSes that require four posts for installation.
8. Racks shall be placed side by side with no spaces between and no racks standing alone.

5.8 Cable Tray⁵

1. Each TR shall have a Cable Tray for the routing of cable inside the rooms that is a minimum of 12 inches wide installed from corner to corner on every wall mounted 8 feet above finished floor. All trays must be bonded and grounded to the telecom ground bus bar for the room. Ladder racking shall be installed to carry cable from cable tray to racks.
2. Alternately if room is designed with cable sleeves in line with the sides of the relay racks, ladder rack over the top of the racks extending the length of the room can substitute for cable tray surrounding the room.

5.9 Ceilings

1. To permit maximum flexibility and accessibility and to maintain dust

4 For further information, see Attachment II, Division 27 section 271116 Communications Cabinet & Racks.

5 For further information, see Attachment II, Division 27 section 270528-29 Hangers and Supports.

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control, suspended ceilings (ACT, T-Bar or drop ceilings) are not permitted in TRs.

2. Over-head clearances shall be at least 8 feet (i.e., Cable tray mounted at 8 feet and HVAC duct work, sprinkler heads, etc. mounted above 9 feet).

5.10 Dust Elimination

1. The floor shall be tiled with VCT or concrete that has been sealed with sealant.
2. Door seals will be installed to ensure dust and debris stays out of the room while keeping the cold air in. Refer elsewhere herein for the requirement to provide opening protection of 2 hours where TR supports Code required ERRC and/or 2-way communications.

5.11 Fire Protection:

1. At standard District TR's, provide wet sprinkler protection using high temp heads. Protect from impact damage and leakage as permitted by Code. Provide sufficient quantity of heads such that heads are not located directly over equipment racks in the event of leakage, including during testing.
2. For special function information technology spaces, including large server rooms and data centers, design to provide clean agent protection as first line of defense, with pre-action wet sprinkler system provided as backup.

5.12 Environmental Control

1. Provide heating, ventilation, and air conditioning that will maintain continuous and dedicated environmental control 24 hours per day, 365 days per year. Since the TRs house equipment, the normal temperature range should be 70 degrees to 80 degrees with 30% to 55% relative humidity. In particular, conform with the applicable requirements of ANSI/TIA-569-D (2015) which incorporates ASHRAE TC9.9, including maximum air temperature at the inlet to each piece of networking electronics.
2. Switches, thermostats, or other devices shall be installed beside the door and not in/on walls containing telecommunications backboards. An environmental condition monitoring system will be provided.
3. Where cooling systems utilize condensate drains, drain(s) to be positioned away from space allocated to current and future electronics systems both in equipment racks and on TR room backboards.

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6. Outside Plant Pathway Design

6.1 General

1. The outside plant (OSP) pathway system is the route by which telecommunication copper and fiber optic cabling travel between and enter into campus buildings.
2. OSP cabling shall terminate at the main telecommunications room / terminal room location of the building; usually on the ground floor or basement. The designated contact and appointed layout engineers shall be contacted to determine the best cable distribution method along the proposed cable route. Follow local codes and BICSI methodology for conduit placement.⁶

6.2 Underground Entrances

1. The recommended size for conduit used in an underground entrance is 4 inches in diameter. A spare conduit of equal size is required, thus giving a total of two 4-inch conduits as a minimum into any building under 10,000 square ft usable floor space. Conduit duct banks entering buildings of more than 10,000 square feet shall be sized with the assistance of the Designated contact (see Appendix III). Fill ratios shall not exceed 40% fill or exceed minimum bend radius.
2. Entrance conduit must not include more than two 90-degree bends without a pull box, hand-hole, or manhole. Bends must be sweeping bends with a radius not less than 10 times the inside diameter of the 4-inch conduit.
3. Conduits shall have a pull cord having a metallic member (tone tape) with a minimum test rating of 200 lbs pulling strength in each conduit.

6.3 Maintenance Holes

1. Any new maintenance hole number assignment shall be coordinated through the CCCCDC.
2. New maintenance holes shall be 5'x6'x4' deep with round lids with a diameter of 32-1/2 inches. Hand holes (small maintenance holes) are not acceptable unless approved by the CCCCDC facilities dept and college IT

6 For further information, see Attachment II, Division 27 section 271113 Entrance Protection.

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designee (Appendix III). No square lids are permitted. Lids should have pull-slots for easy removal, traffic rated, and labeled “TELECOMMUNICATIONS” OR “TELEPHONE”. Grounding rods should be included in the design of all maintenance holes. The distance between maintenance holes shall be no more than 300 feet if a direct path is possible and no 90-degree bends are used. Refer to the referenced BISC design standard for acceptable design approach.

3. All outside plant backbone cables shall be labeled at each end and in each hand hole/maintenance hole that they pass through. Labels shall be metal tags and waterproof so they do not decay when exposed to the elements. All labels shall be visible at point of access. All labels shall be according to ANSI/TIA-606-B-2012 standards and pre-approved by the IT designee (Appendix III).

7. Intrabuilding Backbone (Riser) Pathway Design

7.1 A vertical telecommunications conduit riser system shall be provided to bring telecommunication cables from the main TR (BDF) to the various floors of the building.

7.2 As a design guideline, the vertical cable riser system should use a series of vertically aligned 4-inch sleeves in each floor beginning in the ceiling of the TR of the lowest floor and ending in the floor of the TR of the uppermost floor.

7.3 Riser Conduit Design Recommendations

1. The vertically aligned 4-inch sleeves should be located in the vertically aligned (stacked) TRs on each floor. Riser conduits or sleeves entering through the floor shall extend 3 inches above finished floor at the wall. Riser conduits or sleeves extending down from the ceiling shall extend to 9 feet above finished floor.
2. Sleeves should not be placed in the middle of the TR floor, but placed next to the wall that has plywood attached, preferably starting in the opposite left corner as seen when entering the door.
3. After the riser cable has been installed, all sleeves shall be fire stopped.⁷
4. Where structured cabling pathway is to be used for 2-way communications and/or ERRC radio systems cable distribution, maintain 2-hour protection in the riser pathway.

7 For further information, see Attachment II, Division 27 section 270528-41 Firestopping.

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8. Telecommunications Workstation Pathway Design

8.1 Horizontal Pathway Design Recommendations

1. Preferred Design Method - Conduit System

- a. Each workstation voice/data outlet box shall be installed using a minimum of a 1-1/4" inch conduit. All conduits shall be home run or routed directly to the main telecommunication room (TR) of the same floor. Conduit shall be EMT with screw or compression fittings. Flex conduit shall not be used in buildings for telecommunications cabling. Horizontal conduits designated for outlets shall not feed floor to floor or be daisy chained from outlet to outlet. Standard office and classroom wall boxes are to be mounted at the same height at the electrical outlets in the room unless specified differently on the design plans.
- b. The total individual conduit length including pull boxes used for telecommunications systems should not be longer than 85 M (279 feet).
- c. Conduit runs should take the most direct path possible, following parallel lines of the building.
- d. There should be no more than two 90-degree bends between pull boxes.
- e. Provide a pull cord with a minimum test rating of 200 lbs pulling strength in each conduit. This cord is to remain once all work is completed.
- f. Outlet boxes for standing kiosks, payphones or standing equipment shall be 4"W x 4"H x at least 2-1/4"D. These outlets shall conform to current ADA requirements.
- g. Wireless Access Point and special application locations shall be 4"W x 4"H at least 2 1/4"D and mounted between 12" below a structural ceiling with a maximum height of 12' from the finished floor. These locations would be determined based upon a spectrum/needs analysis. These boxes may be installed above a false ceiling.
- h. All cables must be terminated in patch panels and face plates (jacks) on both ends.

2. Second Choice - Concealed Cable Trays - This choice is campus specific, the

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designer must obtain permission from the designated campus contact, see Appendix III.

- a. Concealed cable tray systems may be used, but are not recommended due to the potential for long term maintenance issues, increased costs of plenum rated materials, increased installation labor costs, wire damage and fire code violations. If cable trays are located in a ceiling that is a return air plenum, the wire and cable used shall be specified as plenum wiring, listed for use in an environmental air space by its manufacturer.
- b. Supports shall be installed no more than 5 feet apart and within 2 feet of any fitting.
- c. Cable tray shall be installed with 4-inch cable fence on both sides of the tray placed in main corridors throughout the floor allowing the shortest cabling distance from the tray to the WAO conduit. Basket type cable tray is an acceptable option.
- d. Cable tray shall be readily accessible and placed in ceilings that utilize removable tile. If transition over gyp or similar inaccessible ceiling is required, access hatches of a minimum of 24" x 24" should be installed every 15 feet or continuous 4 inch conduits should be used to span the inaccessible ceiling area.
- e. Cable trays shall be installed in ceilings of hallways and shall avoid passing over office spaces, offices, classrooms, and other occupied spaces.
- f. Cable trays shall be used in conjunction with 1-1/4" conduits from the outlet box and run to the ceiling raceway. Conduits should extend all of the way to the tray. Conduits should be properly cleaned, a bushing installed, and bonded to the cable tray.
- g. J hooks may be permitted for limited applications where permitted by designated IT representative.

8.2 Special Use Considerations

1. Special use considerations - Some specific types of areas and uses differ from "office/conference room" type space. Therefore, these areas should be addressed in the list below:
 - a. Classrooms - The design professional should consult with the department and the CCCCD on a case by case basis to assure that

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any special needs are met.

- b. Modular Office/Open Areas - These areas are unique and at times may require special modular telecommunications hardware. Special conduit and termination boxes may also be required. Therefore, the design professional should consult with the department and the CCCCDC on a case by case basis to assure that needs are met.
- c. Fire/Intrusion Alarm Panels A dedicated 1" homerun conduit shall be run from each fire and intrusion alarm panel to the TR horizontal cross connect.
- d. Elevators A dedicated 1" homerun conduit shall be run from the TR to the elevator equipment room and connected to a 2"W x 3"H x 2-1/2"D single gang box adjacent to the elevator equipment. Elevator instruments are normally provided by the CCCCDC. The design professional should consult with the CCCCDC concerning the district instrument of choice.
- e. Floor Outlets - Floor outlets shall be multi service recessed floor boxes. Any box shall be approved in advance by the designated contact (see Appendix III).
- f. ADA Requirements Outlets in public locations that will require access by the handicapped (i.e., payphones, public phones, etc.) have special height and reach requirements for their installation in terms of the "Highest Operable Mechanism."
- g. Emergency Notification Speakers with Push To Talk buttons will be installed in all large classrooms or other large areas where people gather. The push to talk button must be located within 15 feet of the speaker and must be ADA accessible. Push to talk buttons shall not be placed next to a doorway unless other criteria force that location.
- h. 8.2.8 All cables must be terminated in patch panels and face plates (jacks) on both ends.

9. Outside Plant Cabling

9.1 Outside Plant (OSP) Copper Cable

- 1. Cable used for outside plant copper applications (between campus buildings) shall be rated for underground duct and direct buried

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applications or aerial and duct applications and shall meet REA (PE rated) or Bell specifications. Either filled OSP rated cable or air core pressurized OSP rated cable shall be used. Underground cable placed in the duct system is the OSP installation of choice.⁸

2. Place outside plant copper cabling to allow for service loops in the cable as follows:
 - a. one loop in each maintenance hole and 15 feet at each TR end.

9.2 Fiber Optic Cables

1. Fiber Optic cable used in OSP applications shall be loose buffer tube with jell fill or dry blocking. The minimum fiber cable configuration for backbone fiber cable is a Corning Loose buffered Hybrid 24 fiber optic cable with 18 single mode and 18 - 50/125 micron multimode fibers. Installed fiber shall meet all requirements of the ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, published 2008, plus errata issued in October, 2008. Review design with the designated contact (see Appendix III) for strand count approval. At the LMC College Complex any fiber traveling from Sector to Sector must be considered OSP.
2. The use of Direct Buried or Aerial Cable must have prior approval of the designated contact (see Appendix III).
3. Place outside plant fiber cabling to allow for service loops in the cable as follows:
 - a. one loop in each maintenance hole and 10 feet at each TR end.

10. Intrabuilding Backbone (Riser) Distribution Cabling

10.1 Copper Backbone Riser for Telephones

1. The copper riser shall be a Category 3 Unshielded Twisted Pair (UTP) Multi-pair, 24 AWG, solid copper cable formed into 25-pair binder groups.
2. The designated contact (see Appendix III) will work with design professionals to determine the riser quantity based on specific building needs.

10.2 Optic Fiber Backbone Riser

1. 10.2.2. Optic Fiber Riser will be used for data networking and other high

8 For further information, see Attachment II, Division 27 section 271113 Entrance Protection.

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speed applications and shall consist of a minimum of six multimode (50/125um) and minimum six Single-mode (8.3/125nm) optic fibers and be terminated on each floor as design requires. The minimum standard Optic Fiber is a Corning riser or plenum rated tight buffer, 12 fiber cable per destination TR.

2. 10.2.3. The designated contact (see Appendix III) will work with design professionals to determine the riser quantity based on specific building needs if it exceeds the minimum of 12 strands.

10.3 Documentation

1. All cables shall be marked. Both ends of the cable should be marked. Information will be physically marked by attaching a permanent cable label on both ends. See appendix III for campus standard.
2. As-built drawings shall be provided to the CCCCDC Facilities dept as well as designated contact (see Appendix III).

11. Horizontal Distribution Cabling

- 11.1 All cables must be terminated in patch panels and face plates. No "home run" or male to female cables will be accepted ever.
- 11.2 The horizontal cabling is to be installed in a star topology with a dedicated cable to each jack. It extends from the work area outlet (WAO) to the telecommunications room (TR). Horizontal Cabling Systems shall meet requirements as specified in ANSI/TIA 568-C.
- 11.3 No telecommunications cable shall be run adjacent and parallel to power cabling. A minimum of 5" distance is required from any fluorescent lighting fixture or power line up to 2 kVA and 24" from any power line over 5 kVA. Similarly, cable should be routed and terminated as far as possible from sources of EMF, such as ballasts, generators, fans, motor control units, motors, etc.
- 11.4 All wiring shall be run concealed, inside wall cavities and in ceiling plenum. Any deviation from this needs to be discussed with college IT designee.
- 11.5 Horizontal cabling shall terminate in the TR on the same floor as the WAO.
- 11.6 The placement of all WAOs is largely dependent upon the type and location of furniture (see college IT designee).
- 11.7 As part of the construction process for renovation, project plans shall include the removal of any abandoned cable(s) that shall be in the space. The California Electrical Code requires removal of accessible abandoned

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cable. All cabling reserved for future use, shall be identified as such and tagged.

- 11.8 Cabling shall be provided to support a minimum of those described as the types of WAO's below. The horizontal cable extends from the station outlet (jack) to the horizontal termination block or patch panel in the TR and is part of a structured cabling system that must be warranted by the manufacturers to meet guaranteed performance while working with the selected horizontal cable height of WAO station jacks is campus specific, see appendix III. ⁹

Room Usage	Minimum WAO #	# of Jacks per WAO	Notes
Standard Lecture Classrooms			
Teaching Oriented Wall	1	3	Coordinate with multimedia plan
Non teaching wall	1	3	
Projector	1	2	
Classroom Notification Speaker	1	2	<p>Speaker shall be installed 12" below the ceiling and viewable from all locations in the room.</p> <ul style="list-style-type: none"> Install a 20AWG wire from the speaker to the location of the button, this 20 AWG wire must be securely routed to the speaker through conduit or Panduit securely mounted to the walls with screws (use of double-sided tape is not acceptable). The wire shall be connected to the speaker as well as the button as directed

⁹ For further information, see Attachment II, Division 27 section 271500 Communications Horizontal Cabling.

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			<p>in the manufacturer installation directions</p> <ul style="list-style-type: none"> • All Buttons must be installed at ADA height (between 36" and 48" off the floor). • All buttons must be within 15 feet of the speaker. • Contractor to provide wall box for the button.
Instructor's Podium	1	3	Coordinate with multimedia plan
Instructional Lab *see #2 below			Typically sized for 40 student computers plus 1 instructor computer and several printers/scanners
Instructor	1	3	
Students	1	1	Plus 1 spare drop per grouping of student workstations.
Printer/scanner	1	2	
Self-Study Lab *see #2 and #3			
Students	1	1	Power must be provided at each location
Printer/scanner	1	2	
Student Carrels			
Student	1	2	Power must be provided at each location
Printer/scanner	1	2	
Office Space			
Single Person Office with meeting space	3	3	On opposing, non-door walls. A WAO shall be installed, normally at +18" A.F.F. for the meeting table/space.
Single Person Office	2	3	On opposing, non-door walls.
Single Person Modular Furniture	1	3	

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not in single person room			
Two Person Office Space			
Network Multi-function printer	1	2	For office/cubicle areas determine where a networked, centralized, multifunction printer/scanner will be placed. Ensure WAO and appropriate power for placement.
Conference Rooms			
Presentation wall	1	3	Coordinate with multimedia plan for room.
Projector	1	2	
Mounted TV/Display	1	2	Flush mounted biscuit and appropriate power. Coordinate media connections with multimedia plan for the room
Under table	1	3	One floor mounted communication outlet box as well as an electrical outlet to allow access under the conference table per 6 ft of table.
Walls	1 per 10 ft	3	
Work Rooms			
			Along counter tops where devices and printers shall be placed, communications outlets, with appropriate electrical outlets, will be distributed every six feet. Depending upon the size and configuration of the room, IT and the project's need will define the number of wired

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			connections required. These will be placed at +6" above counter height. For self-standing copier machines, a communication outlet will be provided with appropriate dedicated electrical outlets.
Mounted TV/Display	1	2	Flush mounted biscuit and appropriate power. Coordinate media connections with multimedia plan
Wireless Access Point	1	2	<p>Shall be installed 12" below the ceiling but not to exceed 12' above the finished floor. This shall take the form of a flush-mount outlet. This outlet can be located above a false ceiling. Variance needs to be requested below 8' on a wall. The location of the access point will be discreetly marked on the ceiling to enable technicians to find the access point without lifting tiles.</p> <p>Placement of Access Points is entirely dictated by the Wireless heatmap based Design.</p>
Security Camera	1	2	Pathway and routing to these security devices will be designed on an individual basis. Cables shall be terminated in suitable biscuit boxes.
Access Control	1	2	Pathway and routing to these security devices will be designed on an individual basis. Cables shall be terminated in suitable biscuit boxes.
Large Indoor Gathering spaces			Cafeterias, student union lounges, etc
Classroom Notification	1	2	Speaker shall be installed 12" below the ceiling and viewable from all

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Speaker			<p>locations in the room.</p> <ul style="list-style-type: none"> • Install a 20AWG wire from the speaker to the location of the button, this 20 AWG wire must be securely routed to the speaker through conduit or Panduit securely mounted to the walls with screws (use of double-sided tape is not acceptable). The wire shall be connected to the speaker as well as the button as directed in the manufacturer installation directions • All Button must be installed at ADA height (between 36” and 48” off the floor). • All buttons must be within 15 feet of the speaker. • Contractor to provide wall box for the button. <p>All cable terminations in the TR’s (BDF’s) must be grouped together on existing patch panels or additional patch panels must be provided where there is no room in the existing patch panels.</p>
Mounted TV/Display	1	2	Flush mounted biscuit and appropriate power. Coordinate media connections with multimedia plan
Moderator/Podium	1	3	To be coordinated with multimedia plan for space
Maintenance Spaces			electrical rooms, security rooms, mechanical rooms, control rooms, boiler rooms, garages
Building	1	2	This shall take the form of a surface-

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Management System			mount outlet coordinated with layout of equipment on wall.
Security Systems	1	2	This shall take the form of a flush-mount outlet coordinated with layout of equipment on wall.
Other devices/panels	1	2	The definition of which devices/panels need cabling will be done in conjunction with engineering specialists for each device type. These can include HVAC monitors, elevators, facility panels, electronic locks, irrigation controllers, etc. This shall take the form of a surface mounted outlet coordinated with layout of equipment on wall.
Workspace	1	3	
Storage Spaces	1	3	If storage space is large enough to be repurposed as office it needs to be designed with Office standards above.

1. Where WAO heights differ from +18" A.F.F., electrical outlets should be provided at same height within 12".
 - a. Wireless Access Points and Classroom Notification Speakers do not require power outlets.
 - b. Coordinate power for all other devices including Access Control and Security Cameras.
2. Raised Floor Computer Labs - In new buildings with rooms that are designed for permanent computer labs, the computer lab design shall include a raised floor environment. For ground floor implementations, a depressed slab is preferred to allow for the raised floor environment without losing rooms space due to ramps or stairs. The raised floor environment will provide an accessible cabling system. The raised floor will provide a depth of 12 inches, with removable floor tiles to grant unhindered access to the floor space.

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- a. Within the raised floor, there will be a matrix of power and communication outlets that provides sufficient density to computer tables. Typically, this will be communication outlets each equipped with four data jacks, spaced every four feet, and equivalent power plugs and circuits to power computers and network devices plugged in to every network jack and powered on concurrently. The number and location of communication and power outlets will vary with room size and orientation. Each matrix will be custom designed with the designated contact.
 - b. Other low profile raised floor systems are permitted on a case-by-case basis.
 - c. Cables routing to the data outlets will be fully enclosed in a metallic raceway system that provides sufficient space so that the enclosed cabling does not exceed a 40% fill. The raceway system shall consolidate to suitable junction boxes that route conduits back to the serving Intermediate Distribution Facility. Sufficient conduits shall be provide as not to exceed a 40% fill.
 - d. Raceway system will be suspended from the floor and mounted so that the communication and power outlets face horizontally. This will minimize the possibility of dust, particulate matter, and liquid falling into the network jacks. The removable floor tiles will be provided with notched access so that patch and power cords can be routed from the raised floor to the computer tables. Floor tiles will be re-locatable so that as room configurations change, cable notches can be positioned underneath tables and avoiding circulation paths.
3. Computer Lab for Student Self - Study - In a computer lab where students come to work on assignments, there is typically no formal instruction. As such, the lab layout is oriented to provide the highest number of student stations, with little or no space reserved for an instructor's workstation or whiteboard. The layout of this type of computer lab will vary with room dimensions and shape. In an arrangement of long tables, typically one computer workstation is provided for every 3.5 feet of tabletop. Outlets for these computer labs shall follow the general design guidelines. All data and power outlets on walls in self-study labs shall be at a height of +6 " above the table top, typically +36" A.F.F. Outlets will be provisioned at intervals corresponding to the table spacing. All rooms, which support islands of tables or kiosks, will be configured with flush-mount floor boxes.

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Dual-purpose floor boxes (communication and power) are acceptable providing that there is adequate separation maintained so that all power outlets and all communication jacks can be used simultaneously without the cords interfering with each other's access. The preferred design is a flush mount brass floor box with brass covers that can be accessed when an outlet is used. All floor outlets will be provisioned in the floor slab. No cabling will extend across the floor. Floor mounted raceway (pancake raceway) is not acceptable. Sufficient floor boxes will be provided to support the required number of computers, plus supplemental printers, scanners and other network devices.

4. Rooftops - Control equipment that is located on building rooftops frequently requires special provisioning of communications connectivity. This equipment can include HVAC monitors, cellular/wireless antennas, broadcasting equipment, telescopes, communication relays, photovoltaics, etc. Some of these systems shall be added after the building is built. It is more important to provide a clear pathway through which connections can be added later. Any control systems that require network connectivity need to be located within 275 feet of a technology space (TR).
5. Specialty Locations - The campus will have specialty locations that will require custom configuration at the time of building design. These locations include but are not limited to theatres, lecture halls (seating capacity > 200), auditoriums, athletic broadcasting venues and control rooms, scoreboards, electronic advertising boards, and others that cannot be envisioned at this time. At the time of design, the requirements for each of these locations will be individually determined with designated contact.
6. Floor duct systems (Walker-type) are permissible when routing horizontal cable to otherwise inaccessible locations in the center of slab floors. The sizing of these ducts is to be based upon 100% spare capacity allocated within the duct fill allowance (space for future additions). Floor duct and conduit system shall provide sufficient space so that the enclosed cabling does not exceed a 40% fill.

11.9 Each jack (whether for voice or data) shall be supported by a four-pair Category 6A cable.¹⁰

11.10 WAO faceplates should be single gang with four jack openings (holes). Electrical

10 For further information, see Attachment II, Division 27 section 270000 General.

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white color. (Confirm WAO color with the campus). Each telecommunications outlet shall have a 1 1/4-inch conduit that extends from the back box to the TR or to the nearest cable tray.

- 11.11 Plenum rated cable must be used where required.
- 11.12 All four pairs must be terminated on both ends.
- 11.13 The maximum pull force for a four-pair horizontal UTP cable is 25 lbs.
- 11.14 Limit spans to 1.5 M (5 feet) or less in suspended cable runs.
- 11.15 Do not cinch cable bundles tightly. Velcro straps should be used on all data cable bundles and not cable ties to avoid over-tightening and deformation of the cable jacket. Avoid deforming the jacket.
- 11.16 Do not twist the cable during installation.
- 11.17 Ensure all horizontal cables meet bend radii of at least 4 times the outside diameter.
- 11.18 Remove only as much jacket as is needed for termination and trimming. Minimize the amount of untwisting of pairs when terminating the cable to devices. Untwisting of Category 6 cable shall not exceed 1/2 inch.
- 11.19 When cable runs are being installed, provide adequate service loops at ends to accommodate future cabling system changes. The recommended minimum amount of slack is 6 inches for UTP cables and 3 feet for fiber optic cables.
- 11.20 In the TR, install 6 feet of slack for all UTP and fiber optic cable. The slack loop is to be placed in the overhead ladder rack within the TR.
- 11.21 Include the slack in all length calculations to ensure that the total horizontal cable does not exceed 85 M (279ft).
- 11.22 Any surface mounted raceway must be mounted with hardware. Adhesive mounting is not acceptable.
- 11.23 Telecommunications outlet locations shall be coordinated with the furniture layout. In administrative WAO the typical outlet placement is +18" above the finished floor (AFF) and within three feet of a general-purpose, single-gang electrical outlet. Desks with modesty panels must accommodate data and electrical outlets at 18" above the finished floor. Panels should be 20" above finished floor at minimum.
- 11.24 In rooms with built-in counters, work surfaces or cupboards the outlets shall still be located at +18" AFF but the Architect will arrange for the drilling of

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routing holes in the work surface, installed with grommets, to facilitate the clean routing of cables. The grommet will be a minimum of two inches in diameter, made of plastic or rubber, oval or circular in shape, fitted to the hole drilled in the work surface with a replaceable cover that can hold the cabling after routing. Outlets will not be placed in cupboards or cabinets unless this specific purpose is desired. Check with designated contact.

12. Termination

12.1 OSP Copper Cable Termination for telephone

1. OSP copper cables will be terminated in the relay racks on 110 style blocks or patch panels depending on the campus.

12.2 OSP Fiber Optic Termination

1. Backbone fiber optic cables will be terminated in the TRs of the building. Fiber cables will be terminated with LC connectors. All connections will be fusion spliced.

12.3 Copper Riser Cable Termination for telephone

1. Copper riser cables will be terminated in the relay rack on 110 style blocks or patch panels depending on the campus. These terminal blocks shall be mounted on the plywood backboard, patch panels will be mounted in 2 post racks.

12.4 Fiber Optic Riser Cable Termination

1. Fiber Optic cables for data networks and other applications will be routed to the equipment relay racks. Fibers will be terminated with LC (single mode) connectors. Cabinets for fiber will be installed in the top most slots of the relay rack. Fiber patch panels will have integrated cable management in the front and cable guides in the rear. Sizing of these cabinets will be done on a case by case basis.

12.5 Work Area Outlet (WAO) Terminations

1. WAO Faceplate Selection - A standard flush, wall mounted telecommunications single gang outlet faceplate with cutouts for jack inserts is the outlet style of choice. Outlets may be mounted in a surface mounted box with associated wire mold if wall construction precludes internal wiring.
2. WAO Configuration - The outlet count shall match the numbers specified for data cables in section 11.8 for snap in modular jack inserts. All unused

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ports shall be filled with blank inserts. All cables pulled must be terminated.

3. Jack Insert Termination - The jack insert shall be an 8-position, RJ45 jack insert rated for Category 6A. The 4-pair, 100 ohm UTP station cable for data shall be used to terminate only one jack and all four pairs shall be terminated. Remove only as much jacket as is required for termination and trimming and minimize untwisting of the pairs to less than 1/2 inch. The manufacturer's guidelines for termination shall be followed at all times. The data jack shall be terminated following T568 pin / pair assignments. (See Appendix III to determine if the 568A or 568B wiring termination is used.)
4. The Category 6A jack is part of a structured cabling system that must be warranted by the manufacturers to meet guaranteed performance while working with the selected horizontal cable and patch cords.
5. Wall phones terminations - Instruments requiring mounting on walls will use a RJ45 wall jack capable of supporting the instrument.
6. ADA Requirements - Outlets in public locations that will require access by the handicapped (i.e., payphones, public phones, etc.) have special height requirements for their installation. Follow local code requirements for those installations to confirm ADA compliance.

13. Wireless Access Point Design

- 13.1 Design to provide for ubiquitous IEEE 802.11 AC networking throughout new and renovated spaces and at selected areas of the exterior designated by the site representative. Contractor's design to utilize a three dimensional enterprise wireless prediction methodology equivalent to the planning manager in Ekahau Enterprise Site Survey to locate access points (AP's). Contractor's WiFi design shall be prepared by an individual trained and holding current certification equivalent to that of an Ekahau Certified Survey Engineer (ECSE) for the planning tool used by the Contractor. Contractor's design to incorporate AP characteristics of the type identified as design basis. AP's will be District furnished and Contractor installed.
- 13.2 The District has standardized on Ruckus Wireless AP's and controllers.
- 13.3 Design for occupied areas of the building interior to assume the following parameters, based on the Ruckus Best Design Practices as presented in Ekahau and District design standards:



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1. Noise Floor: -85 dBm
 2. 1 user/15 square feet min. Increase assumed density at occupied spaces to match actual seat count as shown on the fire exiting plans.
 3. 2 devices per user.
 4. Design basis is 802.11AC devices operating at 5 GHz. Design for 2.4 GHz to assume network will push capable devices to 5 GHz.
 5. Assumed distribution of devices by spatial stream (SS) per device
 - a. 1SS 25.00%
 - b. 2SS 60.00%
 - c. 3SS 15.00%
 6. Design for -65 dBm signal strength minimum.
 7. Signal to noise ratio of 25 dB min.
 8. Max channel overlap: 2 at -85 dB
 9. Max packet loss: 2%
 10. Round trip time: 300 ms max
 11. Design capacity analysis should provide density as required to achieve 10 MBps minimum per device simultaneously.
- 13.4 Design Professional to present complete planning report of the completed analysis to the District for review.
14. Cross-connections ¹¹
- 14.1 Voice Circuit Cross Connection
1. Cross connection between terminals for voice circuits will use one pair, twisted, 24 AWG jumper wire.
 2. The color of this wire will be White/Blue. No more than one wire shall be punched down (terminated) on a single terminal.
 3. Jumpers shall utilize wire management (“D” Rings) and shall not be run diagonally.
- 14.2 Data Circuits Cross-Connects

11 For further information, see Attachment II, Division 27 section 271600 Communications Cords and Devices.

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1. Patch Cords for patch panels - Data circuits are terminated in the data patch panels in the TR racks.¹²
2. A Category 6A pre-connectorized RG45 patch cable shall be used to connect the horizontal cross- connect jack to the data switch or other equipment. Refer to appendix III for type of patch cable needed.
3. The data patch cable shall be limited to the needed length for the cross-connect.
4. Cable Management devices shall be used for routing of patch cables.
5. Patch Cables in the horizontal cross-connect shall be minimized and shall not exceed 6 meters (20 feet). The horizontal cross length shall be included in the maximum combined horizontal patch cable and equipment cable length in the telecommunications room of 7 meter (23 feet).
6. Cross connection of horizontal cabling shall meet all recommendations of the ANSI/TIA-568-C standards. Refer to Appendix III for which pair order is used at the campus.
7. Data patch cords are part of a structured cabling system that must be warranted by the manufacturers to meet guaranteed performance while working with the selected horizontal cable and termination hardware.
8. For new installations, patch cords must be provided in various lengths and quantities sufficient to patch at least 75% of all cables terminated in each TR.

14.3 Fiber Optic Jumpers

1. All fiber optic cross-connect jumpers shall be single fiber Corning fiber Jumpers.
2. Fiber Jumpers shall meet ANSI/TIA-568-C standards.
3. All jumpers shall be pre-connectorized.
4. Multimode fiber riser jumpers shall be 50/125mm, with campus specified connectors and shall be sized in length for the application. Multimode jumpers shall be orange in color.
5. Single mode 8.3/125mm should be with campus specified connectors and sized in length for the application. Single mode jumpers shall be yellow in color.

12 For further information, see Attachment II, Division 27 section 271119 Blocks and Patch Panels.

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15. Labeling

15.1 All telecommunications infrastructure and equipment components shall be labeled according to ANSI/TIA-606-B-2012 standards.

15.2 Backbone Copper Riser Terminal Labeling

1. Backbone copper riser terminal blocks shall be labeled with the cable number and the pair counts indicated on the designation strip.

15.3 Fiber Optic Labeling

1. Each strand of fiber optic cabling will be labeled on the patch panels at both ends with the local termination point and the destination termination point.
2. Each fiber cable, before breakout, shall be labeled at both ends with the local termination point and the destination termination point.

15.4 Horizontal Cable Termination

1. Room number of the destination work area, Station number, Jack Number (Prefixed with type "V" for voice, "D" for data). Voice and data jacks terminate in different patch panels; all voice together and all data together.

15.5 Horizontal Outlet Labeling

1. Labeling must be done in ascending campus room number, not drawing or architect room numbers. No tables or translations will be accepted.
2. TR Room number (where cable terminates), Room number of the work area, Station Number, Jack Number (Prefixed with type "V" for voice, "D" for data) (Example: 109 122-1-V1 109 is the TR, 122 is the room where the jack is located, 1 is the station location, V1 is the 1st voice jack in that particular wall plate)
3. All labeling shall be done with typed inserts, typed on adhesive labels, or pre-stamped jack usage indicators for patch panels. For cabling the labeling shall be printed heat shrink labels or typed adhesive labels specifically designed for cabling. Handwritten labels are not allowed.
4. Post one full size plot (42x30) of as-built drawings, specifically the floor plans, and (as applicable) reflected ceiling plans, within TRs such that show the TR's serving area. Coordinate location of posting with Owner.
5. Submit a "cable ID-to-Office number key" as an electronic file in an MS-Excel spreadsheet file format containing a list of every cable identifier

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associated with the final office number. This should be the Jack Table referenced in 11.7.

16. Telecommunications Grounding and Bonding
 - 16.1 Statement: The information provided in this document for the design of the Telecommunications grounding and bonding system does not replace national, state, local, or other applicable codes, laws, or regulations.¹³
 - 16.2 All cable trays and conduits shall be bonded.
 - 16.3 Telecommunications equipment shall be bonded per the manufacture's guidelines.
 - 16.4 TR racks shall be bonded.
17. Inspections, Testing, and Acceptance
 - 17.1 Frequent inspections should be conducted during the installation of the new services and wiring. These inspections should be conducted jointly by the contractor and representatives from the CCCCDC IT & Facilities Departments.
 - 17.2 Test the structured cabling system to the manufacturer's standards so that a complete structured cabling system warranty will be delivered to CCCCDC.
 - 1.
 - 17.3 Acceptance testing of all installed and terminated structured cabling systems, including UTP and fiber Optic cable, shall be completed and both a hard copy and electronic copy.
 - 17.4 Horizontal data structured cabling permanent links shall be tested for acceptance.
 - 17.5 All required test results shall be delivered to the CCCCDC Facilities and designated IT representative. Failure to do so will place the project in an incomplete status and shall stop final payment due installer.
 - 17.6 At the completion of each installation "As Built" prints and other supporting documentation shall be provided by those performing work specified according to ANSI/TIA-606B standards. A complete set of 100% prints and documentation shall be provided to the CCCCDC Facilities for review and will be maintained on file.

13 For further information, see Attachment II, Division 27 section 270526 Grounding and Bonding.

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18. Emergency Responders Radio Coverage
 - 18.1 Emergency Responders Radio Coverage systems are required by the California Fire Code to extend public safety radio into new and altered building space.
 - 18.2 Designs of new ERRC are ordinarily provided as part of the Fire Alarm System design. Design for new District facilities to provide an Emergency Responders Radio Coverage system in the building where required by and constructed in conformance with the requirements of Code, the District's requirements as a provider of Public Safety services, and the Authority Having Jurisdiction.
 - 18.3 Where ERRC systems route through Information Technology spaces, coordinate the design to maintain clearances and minimum pathway requirements of Information Technology Systems, and NFPA 72 as interpreted by the AHJ for required fire protection of the pathways and Telecommunications Rooms used for this function.
19. Two-way Communications Systems
 - 19.1 Two-way Communications Systems are required by the California Building Code for multi-story new and altered building space where elevators are used to reach the level of discharge.
 - 19.2 Provide design of new two-way communications systems for new and altered District facilities where required by and constructed in conformance with the requirements of Code, the District, and the Authority Having Jurisdiction. Review the answering point options available at each site to meet the Code requirements. District standards for supported two-way communications systems manufacturers are under review – design teams to request clarification at the 50% CD stage to ensure the Project incorporates current standards.
 - 19.3 Where two-way communications systems route through Information Technology spaces, coordinate the design to maintain clearances and minimum pathway requirements of Information Technology Systems as defined elsewhere in this standard, and NFPA 72 Article 12.4.4. as interpreted by the AHJ for required fire protection of the pathways and Telecommunications Rooms used for this function.



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Appendix I

Glossary of Terms

ADA	Americans with Disabilities Act
Aerial Service	Telecommunications Cable installed on supporting structures such as poles, sides or buildings, and other structures.
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
Backboard	Plywood covered wall in telecommunications room or in terminal boxes used to mount termination devices, hardware and equipment.
Backbone	Cabling and pathway used to connect the telecommunications rooms, cross-connects, entrance facilities and equipment rooms.
BDF	Building Distribution Frame: The term that designates a TR within a building as the primary TR for the building. The BDF would be fed with outside plant cabling.
BICSI	The internationally recognized organization that developed methodology manuals describing how telecommunications infrastructure should be designed and installed. Building Industry Consulting Service International
Bridge Tap	The connection of two circuits in parallel to each other or a cable pair continued beyond the point at which the pair is connected to an instrument.
Buried Service	A cable installed under the surface of the ground (not in conduit) in such a manner that it cannot be removed without disturbing the soil. Also called direct buried cable, trenched, or bored.
Busbar	A copper bar used as a common point for connection of the building electrical service ground to all telecommunications hardware and equipment in a room or terminal box.
Cable Bend Radius	The radius that a cable can bend before risk of damage or decrease in transmission performance.
CATV	Community Antenna Television (Cable TV)
Coax	Coaxial Cable. A central conductor surrounded by dielectric and a tubular outer



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	conductor.
Conduit Ductbank	An arrangement of conduit ducts in tiers, encased in concrete used for installing telecommunications cables between buildings.
Cross Connection	A connection made between cables, subsystems and equipment by the use of patch cables, or jumper wires run between the terminating devices.
D Ring	Cable Management Device attached to the backboard.
dB	Decibel
Demarcation point	A point of interface where two services are connected. An example at CCCCDD would be the point at which the local dial tone provider terminates their cables in the Main Telecommunications Room for cross-connection to the Intra-building cabling.
EIA	Electronics Industries Association.
EMI	Electromagnetic Interference. An unacceptable or undesired response, malfunction, degradation, or interruption to the intended operation of electronic equipment caused by the coupling of electrical or magnetic fields.
EMT	Electrical Metallic Tubing
Encased Conduit	Conduit contained inside poured concrete.
Exposed Cable	Any cable that is located so that it is subject to lightning, power induction, or differences in ground potentials.
Outlet Faceplate	A Work Area Outlet (WAO), a plate or cover which holds multiple communications jacks, mounted on a surface, and covering the electrical box and communications cables in the wall.
FCC	Federal Communications Commission
FDDI	Fiber Distribution Data Interface
Foot-Candle	A unit of luminance on a surface that is everywhere one foot from a uniform point source of light of one candle and equal to one lumen per square foot
Gas Tube Protector	An over voltage protector with metallic electrodes in a gas atmosphere contained in a glass or ceramic envelope.
Horizontal Channel	The horizontal cabling which includes all elements of the horizontal cabling Link, plus the equipment cords in the telecommunications room and the work area. Contains all elements needed to support telecommunications applications over the horizontal cabling.



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Horizontal Link	The horizontal cabling which includes all horizontal components except for equipment cords in the telecommunications room and at the work station.
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IDF	Intermediate Distribution Frame: The term that designates a TR within a building as a secondary TR , not the primary TR (BDF) for the building. The IDF would be fed with riser cable from the BDF, never outside plant cabling.
Jack	The horizontal cable end point connection terminated inside a Work Area Outlet.
LAN	Local Area Network. A geographically limited data network used for the local transport of voice, data, and video.
Loose Buffer	In a fiber optic communication cable, one type of component used to encapsulate one or more optical fibers for the purpose of providing such functions as mechanical isolation, protection from physical damage and fiber identification. The buffer may take the form of a miniature conduit, contained within the cable and called a loose buffer, or loose buffer tube, in which one or more fibers may be enclosed, often with a lubricating gel.
Maintenance Loop	An additional length of cable on the end of a installed cable that allows for later use if any of the cable must be shortened or the termination devices moved.
Maintenance hole (MH)	A hole through which a person may gain access into a underground vault or structure.
Marker tape	A plastic tape placed in the ground to identify buried cable location if dug up.
Media	The physical path for telecommunications services. (i.e., copper cable, fiber optic cable, coaxial cable, radio, etc.)
MHz Megahertz.	One million hertz or one million cycles per second.
Modular Jack insert	The modular communications jack that snaps into a faceplate.
Multimode Fiber	An optical fiber that supports the propagation of more than one bound mode. A multimode optical fiber may be either a graded-index (GI) fiber or a step-index (SI) fiber.
NEC	National Electrical Code.
NESC	National Electrical Safety Code.
NFPA	National Fire Protection Association.



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OFNP	Optic Fiber Non-conductive Plenum.
OSHA	Occupational Safety and Health Administration.
OSP	Outside Plant: Telecommunications facilities located outside of the building. Either underground, direct buried or aerial.
CCCCD	Contra Costa Community College District
Outlet	A faceplate with modular jacks located at the workstation (see Work Area Outlet).
Pathway	Structures that conceal, protect, and support telecommunications cables. (i.e. Conduit, cable rack, trays, J-hooks, underfloor ducts, cellular ducts, trench ducts, Raised access floor, etc.)
PE Cable	Filled Cable for use in OSP applications. Designated by the Rural Utilities Service.
Plenum rated	Cable used in a designated area, closed or open, used for the transport of environmental air.
Pull Box	A device to access a raceway, used for access to allow for pulling cable.
PVC	Polyvinyl Chloride
Raceway	An enclosed channel or pathway designed to hold cables.
Rack	A vertical frame upon which one or more units of equipment and patch panels are mounted.
RFI	Radio Frequency Interference. Any Radio Frequency disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics/electrical equipment.
Riser Cable	Intrabuilding Backbone Cable that runs vertically to the TR in a Telecommunications Room (TR).
Single Mode Fiber	A optical fiber in which the signal travels in one mode. The fiber has a small core diameter, typically 8.3 um.
Sleeve	A Conduit placed through a wall or floor to allow the passage of telecommunications cables.
Terminal Block	An insulating base with binding posts used to terminate telecommunications cables and cross connect between cables.
Terminal Box	A metal box with a hinged lockable door used for installing terminal blocks,



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terminating cables and cross connecting. The box provides protection against dust, mechanical damage, weather and vandalism.

TIA	Telecommunications Industry Association
Tight Buffer	A tight buffer consists of a polymer coating in intimate contact with the primary coating applied to the fiber during manufacture. The protective thermoplastic coating is normally a diameter of 900 microns.
TR	Telecommunications Room: The room (or space) that houses voice, data, and video cross-connects and/or equipment. Usually located within 90 meters (270 feet) from the Work Area Outlet (WAO) so that horizontal cable can be pulled from the TR to the WAO.
Underground Cable	A telecommunications cable installed in a underground duct system which separates the cable from direct contact with the soil.
UPS	Uninterruptible Power Supply
UTP	Unshielded Twisted Pair. A transmission line composed of a twisted 2-wire metallic transmission line surrounded by a sheath of non-conductive material.
Wire mold	A surface mounted enclosed channel designed to hold cables.
WAO	Work Area Outlet, the faceplate that houses the horizontal cable and jacks at the terminating end of a horizontal cable.
Work Area Outlet	See WAO
Workstation	An individual user interface where the desk, computer, communications, and other equipment is located and connected to the telecommunications outlet.



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Appendix II

Division 27 Specification Section Highlights

270000 General

- Contractor shall furnish and install a Structured Cabling System including, but not necessarily limited to, copper, fiber optic, and coaxial cabling for the voice, data, and wireless systems.
- Contractor shall provide and install all materials and hardware necessary for complete build-out and provisioning of the telecommunication rooms referenced in the drawing set accompanying these specifications.
- Provide a certified Structured Cabling System with a 25-year CAT 6 channel performance compliance warranty.
- The Contractor shall be a Certified Installation Company of the Structured Cabling System manufacturer.

270526 Grounding and Bonding

- Provide all services, labor, materials, tools, and equipment required for the complete and proper installation of telecommunications grounding and bonding for the Structured Cabling System.
- Each telecommunication room (TR), whether a BDF or IDF in a building, shall have a Telecommunications Grounding Buss Bar (TGB) properly connected per ANSI-J-STD-607-C, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
- Each TR in a building designated as a building entrance point (BDF) shall be the location of the Telecommunication Main Grounding Buss Bar (TMGB) properly connected per ANSI/TIA-607-C.
- All bonding conductors shall be insulated copper. The exception is use of flat, braided, aluminum ground straps utilized for bonding sections of aluminum cable tray.
- Unless otherwise specified, size the conductors as required by CEC.
- Ground communications systems and equipment as required by manufacturer, code, utility, local ordinances, and requirements.
- Label all telecommunications bonding conductors as close as possible to their termination point.
- Confirm that the Electrical Contractor bonded the TMGB to the service equipment (power) ground, typically located in the electrical entrance facility, utilizing the most direct route possible to minimize conductor length.

270528-29 Hangers and Supports

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- Provide all services, labor, materials, tools, and equipment required for the complete and proper installation of equipment supports, cable supports, and fastening hardware as called for in these specifications and related drawings.
- Provide all required of the following
 - 1 J-bolt kits
 - 2 Manufacturer's recommended support devices
 - 3 Clamps
 - 4 Mounting straps
 - 5 Clips
 - 6 Couplings
 - 7 Hangers
 - 8 Other miscellaneous hardware assemblies
- All hardware shall be corrosion resistant.
- For technology pathway systems such as ladder rack and cable tray, provide all associated components from a single manufacturer.
- Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchors on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.
- Do not fasten supports to piping, ductwork, mechanical equipment, lay-in ceiling support wires, or conduits.
- Do not drill structural steel and concrete members.
- In areas where cable tray or conduit is not provided, support the cable with cable hangers. Cable hanger-to-cable hanger center-to-center separation shall be a minimum of five feet. Cable bundles shall be at all times at least six inches above any lay-in ceiling tiles. Cable support hangers shall be placed in a straight line as much as is possible.

270528-41 Firestopping

- Provide all services, labor, materials, tools, and equipment required for the complete and proper installation of firestopping for communications systems as called for in the specifications and related drawings.
- Provide penetrations through fire-rated walls and partitions and firestopping of the penetrating items.
- A through-penetration is created when a cable, conduit, or sleeve passes through an opening in a fire-rated wall or floor. The opening offers a path for fire and smoke to spread. A firestop is a special seal designed and tested to restore the fire integrity of the barrier.
- Design requirements: Provide firestopping systems that are produced and installed to resist the spread of

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fire and the passage of smoke and other gases.

- Deliver firestopping products to the project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying project and manufacturer; date of manufacture; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to the project; curing time; and mixing instructions for multi-component materials.
- When the firestop system has been installed, place a label next to the system.

271100 Equipment Room Fittings

- Provide all services, labor, materials, tools, and equipment required for the complete and proper installation of communication equipment room fittings as called for in the specifications and related drawings.
- Design Requirements: Provide cable management and ladder rack cabling support in each telecommunication room location to transport all communication cabling within the room to the termination racks.
- Manufacturers: Chatsworth Products, Inc. (CPI), or approved equal.
- Provide all ladder rack and associated components from a single manufacturer.
- Bond all ladder rack within an equipment room or telecommunication room to the telecommunications grounding buss bar.

271113 Entrance Protection

- Provide all services, labor, materials, tools, and equipment required for the complete and proper installation of outside plant cable (OSP) entrance protection and termination for copper cabling as called for in the specifications and related drawings.
- Design Requirements: All pairs of both ends of new OSP cable shall be protected and shields shall be grounded at both ends.
- Specify protectors with 300V nominal clamping voltage and with 350 mA sneak current protection.
- All pairs of the OSP multi-pair copper cable entering a building shall be spliced or otherwise connected to a fusible-link cable at least two gauges finer than the entrance cable.
- Install a Building Entrance Terminal protector unit for every 100 pairs of OSP entrance cable or entrance tie cable as specified in the drawings.
- Bond all protectors in each BET together using 1/0 AWG (6 AWG allowed) ground wire, in daisy chain style. Connect a segment of ground wire from the top unit to the Telecommunication Grounding Buss Bar in the telecommunications room. Install 100 5-pin protector units for each protector terminal.



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- Splice entrance cable or entrance tie cable to 26 AWG protector terminal fuse cable pigtails. Secure the splice case vertically on the TR wall as shown on the contract drawings.
- Label Building Entrance Terminals according standards.

271116 Communications Cabinets & Racks

- Provide all services, labor, materials, tools, and equipment required for the complete and proper installation of communications cabinets, racks, frames and enclosures as called for in the specifications and related drawings.
- Design Requirements: Provide communication racks in BDF or IDF locations to terminate all communication cabling and house networking electronics.
- Manufacturers: Chatsworth Products, Inc. (CPI), Universal Self-Support Rack or approved equal.
- All racks must be attached to the floor using floor mounting anchors recommended by manufacturer's installation instructions as appropriate for floor type. The rack must have seismic bracing as required by local building codes.
- Racks shall be bonded to each other and the TGB using hardware approved and/or provided by the equipment rack manufacturer. The bonding will meet local code requirements.
- Ladder rack may be attached to the top of the rack to deliver cables to the rack. Use appropriate hardware from the ladder rack manufacturer.

271119 Blocks and Patch Panels

- Provide all services, labor, materials, tools, and equipment required for the complete and proper installation of communication blocks and patch panels as called for in the specifications and related drawings.
- Building Entrance Terminals: Provide all required 110 style protection building entrance terminals (BET) with 5-pin protectors included.
- Multipair Copper Cable Termination Blocks: Provide all required 110 style field assembly kits with 5-pair terminations and labeling strips.
- Provide all required CAT 6 patch panels. Patch panels are to be 48-port panels unless otherwise specified in the drawings.
- Provide all required cable system optical fiber connectors. (Corning preferred)
- Horizontal Cable Terminations: Install one (1) CAT 6 / 48-port patch panel for every 48 horizontal cables.
- Fiber Cable Termination: Terminate fiber strands of riser links or OSP links per ANSI/TIA-568-C.3. This means the Contractor shall implement a termination system such as 568SC A-B : B-A orientation or



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accomplish the same polarity crossing by using reverse pair positioning.

271300 Communications Backbone Cabling

- Provide all services labor, materials, tools, and equipment required for the complete and proper installation, splicing, and termination of new backbone cabling as called for in the specifications and related drawings.
- Inside Copper Backbone Cabling: Riser Rated Non-Plenum (CMR) Category 3 UTP, 24 AWG. Riser Rated Plenum (CMP) Category 3 UTP, 24 AWG.
- Outside Plant (OSP) Copper Backbone Cabling: Filled or pressurized Air Core, 24 AWG.
- Inside Fiber Optic Backbone Cabling: Single-mode 8.3/125 Fiber Optic Cable Riser-Rated (OFNR) meeting OS1 as defined by ITU-T G.652C and ITU-T G.652D. Multimode Laser Optimized 50/125 Fiber Optic Cable Riser-Rated (OFNR) meeting OM4 as defined by TIA-492-AAAD.
- Outside Plant Fiber Optic Cable: Single-mode 8.3/125 Outside Plant Fiber Optic Cable meeting OS2 as defined by ITU-T G.652C and ITU-T G.652D. Multimode Laser Optimized 50/125 Outside Plant Fiber Optic Cable meeting OM4 as defined by TIA-492-AAAD.
- Fiber Connectors: Single-mode LC connector. Laser optimized multimode LC connector.
- Ensure that maximum pulling tensions of specified cables are not exceeded and cable bends maintain the proper radius during placement.
- Neatly and permanently label all backbone cables with the cable number at both ends and at all splice locations.
- Firestop all sleeves and conduit openings after the cable installation is complete.
- Test and document the final backbone cable installation, including cable footages, on the as-built drawings.

271500 Communications Horizontal Cabling

- Provide all services, labor, materials, tools, and equipment required for the complete and proper installation and termination of new horizontal "station" cabling as called for in the specifications and related drawings.
- The horizontal portion of the telecommunications cabling system extends from the work area outlet (WAO) to the termination in the Telecommunications Room (TR) IDF or BDF.
- Work Area Faceplates: Double gang with four jack openings (holes). Electrical white color. (Confirm WAO color with the campus)
- Copper Modular Jacks: Category 6, 8-position, 8-conductor jack. Campus Specific Pair Order See Appendix III



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- Perform all horizontal cable installation in conformance with manufacturer's installation guidelines.
- Horizontal telecommunications cabling shall be placed in dedicated pathways separate from backbone and other cabling.
- The total length of any horizontal station cable from the jack location to the termination block shall not exceed 85 meters.
- Neatly and permanently label all horizontal cables with the cable number at both ends.
- Firestop all sleeves and conduit openings after the cable installation is complete.
- Test and document final horizontal cable installations including outlet numbering on as-built drawings.

271600 Communications Cords and Devices

- Provide all cords, cross-connect wire, devices, and adapters required to connect the new OSP, riser, and horizontal "station" cabling as called for in the specifications and related drawings.
- Contractor is to provide all necessary communications jumper cabling, copper patch cords, and fiber optic patch cords to connect the communications system end-to-end.
- Supply enough patch cords to connect 75% of the available copper patch panel ports for each and every telecommunication room.
- Supply enough patch cords to connect 75% of the available fiber optic patch panel ports for each and every telecommunication room.



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Appendix III Site Specific Specifications

The purpose of this appendix is to outline the requirements of each site for those specific areas of the standard where campuses must vary from each other.

The District has selected Category 6A as our cable standard for new construction and where complete building remodels make it possible to scale up the conduit and ladder racking. Where Category 5 or 5E is being replaced Category 6A should be utilized with the existing conduits and ladder racking. If ladder racking and/or conduits are missing those should be addressed per the standards document.

Contra Costa College

Contact : Technology Systems Manager
James Eyestone
Jeyestone@contracosta.edu
(510)215-3866

Cable Standard - Category 6A preferably Belkin

Pair Order specification: 568A

Color Coding standard for patch cables and jacks:

- Voice - white cable and jacks
- Data in Administrative Areas and Offices - blue cable and jacks
- Data in Instructional Areas - yellow cable and jacks
- Emergency Speakers – orange cable and jacks
- Wireless Access Points - green cable and jacks
- Security – black cable and jacks

Los Medanos College and Brentwood Center

Contact : Technology Systems Manager

Cable Standard - Category 6A for all new construction.

Pair Order specification: 568A



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Color Coding standard for patch cables and jacks:

- Voice - white cable and jacks
- Data in Administrative Areas and Offices - blue cable and jacks
- Emergency Speakers – orange cable and jacks
- Wireless Access Points - green cable and jacks
- Security – black cable and jacks

Diablo Valley College and San Ramon Valley Center

Contact : Technology Systems Manager
Percy Roper
proper@dvc.edu
(925)969-2270

Cable Standard - Category 6A

Pair Order specification: 568B

Color Coding standard for patch cables and jacks:

- Voice - white cable and jacks
- Data in Administrative Areas and Offices - blue cable and jacks
- Data in Instructional Areas - yellow cable and jacks
- Emergency Speakers – orange cable and jacks
- Wireless Access Points - green cable and jacks
- Security – black cable and jacks

District Office

Contact : Network Technology Manager
Katherine Ogden
kogden@4cd.edu
(925)229-6890

Cable Standard - Category 6A

Pair Order specification: 568A

Color Coding standard for patch cables and jacks:

- Voice - white cable and jacks
- Data in Administrative Areas and Offices - blue cable and jacks










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Data in Instructional Areas - yellow cable and jacks
Emergency Speakers – orange cable and jacks
Wireless Access Points - green cable and jacks
Security – black cable and jacks

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Appendix IV AutoCAD Symbols

Typical Symbols:

-  Double-gang plate with 2 UTP cables.
-  Double-gang plate with 3 UTP cables.
-  Double-gang plate with 4 UTP cables.
-  Wall phone height single-gang plate with one UTP cable and plate
configured with telephone instrument mounting posts.
-  Single-gang plate with 1 CATV coaxial cable connector.
-  Single-gang plate with 2 UTP cables mounted high on wall to facilitate
the placement of a POE device such as wireless access point, camera, or projector.
-  Suggested pathway route for a 12" cable tray



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Appendix V District Specified Equipment List

Network Switches – Owner Furnished, Owner Installed

Exclusively HP ProCurve 5412, 5406 or 3500 switches sized appropriately for the TR or replacement model

Wireless Access Points – Owner Furnished, Contactor Installed

Ruckus 730 Access points sized appropriately for the space or replacement model or 301 for outdoors

Uninterruptible Power Supplies – Owner Furnished, Owner Installed

APC UPS sized appropriately for expected load or replacement model

Classroom Notification System – Owner Furnished, Contractor Installed

Advanced Network Devices IP Speaker with Display and Flashers with Push to Talk Button

Four Post Cabinets – Contractor Furnished, Contractor Installed

Chatsworth

Two Post Racks – Contractor Furnished, Contractor Installed

Chatsworth