

1. General Telecommunications Design Considerations

1.1. Entrance Point and Main Telecommunications Room Design

- 1.1.1. Conduit entrances typically consist of three 4" conduits. Conduit quantities are determined by the square footage of the building and the facilities to be installed. The conduits should be routed to the nearest manhole with telecommunication service.
- 1.1.2. The location of the main telecommunications room must be based on detailed information about the building and the site. The location of the main telecommunications room has a significant impact on all other aspects of telecommunications distribution design. The three main considerations of telecommunications room location are: 1) OSP conduit access into the building; 2) access to cable pathways; 3) horizontal data cabling distance limitations 90 meters (295 feet).
- 1.1.3. The main telecommunications room should be located on an outside wall at or near the location of the conduit penetration into the building. The best location for horizontal cabling is mid-building. A compromise between these two will locate the main telecom room.
- 1.1.4. If the main telecommunications room is not located at the conduit entrance point, EMT or rigid metal conduit shall be extended from that point into the main telecommunications room with appropriate sized pull boxes, not exceeding 150 feet and no more than two 90° bends. Conduit must be grounded at both ends with a #6 stranded conductor, not attached to the closest point in the service grounding electrode system.
- 1.1.5. Do not locate sensitive electronic equipment next to equipment that can cause electromagnetic interference (EMI). Keep electrical feeder circuits away from all telecommunications equipment spaces. Minimum separation of four (4) feet.
- 1.1.6. Equipment not related to the support of the entrance facility (e.g. piping, ductwork, pneumatic tubing, etc.) should not be installed in, pass through, or enter the main telecommunications room.
- 1.1.7. Telecommunications rooms designed to house telecommunications and data equipment shall be sized to meet the known requirements of the building with a minimum size of 10'(l) x 8'(w) x 9'(h).
 - 1.1.7.1. Equipment, entrance, and main telecommunications rooms should be combined in the main telecommunications room if space allows. This combined room needs to have proper HVAC, electrical, and sized according to BICSI standards outlined in other sections of this document.
 - 1.1.7.2. Access door shall be 3 feet wide x 7 feet high and should open outward. For rooms where the door opens inward, the room shall be sized larger in order to provide for lost useable square footage.
 - 1.1.7.3. Painted fire retardant ¾ inch AC grade plywood shall be securely fastened to the supporting wall(s). Size and quantities of plywood to be determined by building size. The color should be light gray.
 - 1.1.7.4. Suspended ceilings are not permitted.
 - 1.1.7.5. Lighting shall be a minimum of 500 lx (50 foot-candles) measured 1 m (3 ft) above the finished floor, mounted 8.5ft above finished floor (or higher).
 - 1.1.7.6. Floors, walls, and ceilings shall be treated to eliminate dust. Finishes shall be light in color to enhance room lighting.

1.1.7.7. All equipment rooms shall meet the following environmental specifications:

Environmental Factor	Requirement
Temperature Range	18°C to 24°C 64°F to 80°F
Humidity Range	30 percent to 70 percent relative
Air Quantity	Filtration systems may be required to minimize particle levels in air

1.1.7.8. A minimum of two dedicated, 3-wire, NEMA 5-20R, 120 VAC, 20 AMP, non-switched, duplex electrical receptacles with generator backup, equipped with surge protection, shall be provided for equipment power.

1.1.8. Access shall be made available for telecommunications grounding system specified by EIA-607.

2. Service Entrance Construction

2.1. General Information

- 2.1.1. Conduit is the preferred method for servicing new building construction.
- 2.1.2. The Contractor will be responsible for all telecommunications related construction work. This includes installation of manholes, hand-holes, conduit runs, etc. The project manager must review any exceptions.
- 2.1.3. S&T IT Networking will work with Project Management and/or their assigned architectural firm to design service entrances in accordance with the design of the cabling to be installed.

2.2. Conduit Quantity, Type, and Size

- 2.2.1. All buried conduit shall be PVC, schedule 40 with the exception of streets, driveways, and parking lots which will be schedule 80.
- 2.2.2. All buried conduit shall have #12 AWG tracer wire taped to exterior of conduit for locating purposes.
- 2.2.3. All conduit exposed to sunlight shall be UV rated.
- 2.2.4. Specific conduit sizes and quantities shall be determined on a building-by-building basis. Items for consideration are: type and use of building, growth, difficulty of adding pathways in the future, alternate entrances, and type and size of cables likely to be installed. As a guide, conduit should be minimally sized based on the following chart:

Fiber Entrance Pairs	Requirement
1-100	One 4-inch plus one 4-inch spare

- 2.2.5. The exact number of one inch innerducts shall be determined on a case-by-case basis depending on the type of services to be installed but should not exceed a fill ratio of > .50.
- 2.2.6. All conduits and innerducts shall be equipped with a minimum 1,500 lb. Strength mule-tape pull line with sequential numbering.

2.3. Conduit Installation Methods

- 2.3.1. Telecommunications facilities shall not be located in the same vertical plane as other utilities.
- 2.3.2. Metal conduit shall be installed through the building penetration, outside of the building, to be connected to PVC conduit for the rest of the run. Metal conduit shall be extended 5 feet away from the building foundation.
- 2.3.3. Metal conduits entering the building through the floor slab shall be extended a minimum of 4 inches above the finished floor. Conduits entering the building through a sidewall shall be extended a minimum of 3 inches beyond the inside wall.
- 2.3.4. The ends of metallic conduit shall be reamed, bushed, and grounded according to the NEC and NESC.
- 2.3.5. Top of conduit must be buried at least 36 inches below the ground surface. When minimum depth cannot be obtained, conduits must be encased in concrete.
- 2.3.6. The conduit shall slope down and away from the building to accommodate drainage.
- 2.3.7. After installation of cables, IT Networking or its authorized vendor shall be responsible for sealing all conduits. All conduits shall be plugged to restrict infiltration of gas, water, and vermin.
- 2.3.8. When joint-trenches are used to install other utilities along with telecommunications facilities, the following separation distances should be used:

<u>Adjacent Structure</u>	<u>Minimum Separation</u>
Power or other foreign conduit	3 inches of concrete
	OR
	4 inches of masonry
	OR
	12 inches of well-tamped earth
Pipes (gas, oil, water, etc.)	6 inches when crossing
	12 inches when parallel

- 2.3.9. The total number of bends in a conduit section run shall not exceed two 90° bends or equivalent sweeps and radius bends. Each bend shall have a radius not less than:

<u>Conduit Size</u>	<u>Radius</u>
2" or Smaller	Six (6) times the internal diameter
Larger than 2"	Ten (10) times the internal diameter

- 2.3.10. Conduit installation methods shall follow industry standards. Reference EIA-569-A and BICSI TDMM Manuals.

2.4. Manholes

- 2.4.1. Manholes will be placed to connect conduit runs together and/or to provide a cable pulling and splicing location as necessary. In addition, conduit runs shall not extend beyond 500 feet without installation of a manhole.
- 2.4.2. Manhole size will be 6'x12'x7' inside diameter.

- 2.4.3. Manhole(s) with a minimum concrete strength of 3,500 psi shall be placed where specified.
- 2.4.4. The interior of each manhole shall have galvanized steel pulling eyes and nylon wall racks manufactured by Underground Devices Incorporated or a compatible product anchored with stainless hardware.
- 2.4.5. Each manhole shall have a sump hole of at least 8 inches in diameter in the floor and bonding inserts in the sidewalls.
- 2.4.6. Each manhole shall have cover(s) that are permanently identified as required (e.g. "Telephone or T" for telecommunications). Manhole covers shall be 32" diameter with 2 pick holes on the edge.

2.5. Hand-holes

- 2.5.1. Hand-holes can be placed when the cable design dictates an in-ground pull or splice box but does not warrant a manhole. Hand-hole specifications and installation locations will be specified on a case-by-case basis.

3. Service Cabling

3.1. General information.

- 3.1.1. All new construction will specify the following utilities to be installed to the building:
 - 3.1.1.1. Twelve strand single-mode fiber
- 3.1.2. IT Networking or its authorized vendor will provide all service (fiber optic) cable; Contractor will install all service cabling.
- 3.1.3. Costs for such facilities will be paid for as follows:
 - 3.1.3.1. IT Networking will provide service cabling up to the nearest existing manhole feeding a particular building. The construction project funds will pay for construction from the nearest existing manhole into the building.

4. Building Wiring System Design

4.1. General Information

- 4.1.1. Construction projects for new buildings and major renovations shall include costs for wiring/re-wiring per the standards indicated.
- 4.1.2. IT Networking will work with consultants on the following issues:
 - 4.1.2.1. Telecommunications room sizes, locations, and quantities;
 - 4.1.2.2. Vertical risers, spaces, and cabling;
 - 4.1.2.3. Horizontal pathway and spaces;
 - 4.1.2.4. Horizontal cable and connecting hardware.
- 4.1.3. IT Networking will provide all electronic equipment; the construction project funds will pay for such equipment. The contractor will provide voice/data outlets and faceplates, equipment racks, patch panels, and all miscellaneous hardware.

4.1.4. The Contractor will provide and install all branch data cable from each data drop to patch panel.

4.2. Telecommunications Rooms

4.2.1. Telecommunications rooms are special purpose rooms designed and dedicated to house electronic and other voice, data, and video equipment and wiring. These rooms have specific requirements due to the nature of the equipment housed therein.

4.2.1.1. There shall be a “main” telecommunications room in which the telecommunications service entrance facilities are housed and where the data backbone connects to the electronic equipment in the building.

4.2.1.2. When referring to the nearest telecommunications room in the building, it shall be defined as the nearest telecommunications room on the same floor as the location being discussed.

4.2.1.3. Telecommunications rooms that contain active equipment need special HVAC and electrical requirements.

4.2.2. Telecommunications Room Size and Location

4.2.2.1. In order to better utilize electronic equipment, the number of telecommunications rooms should be minimized. This is limited by the maximum length of 90 meters (295’) for horizontal cable runs.

4.2.2.2. Telecommunications rooms shall be accessible from common areas and not from occupied space.

4.2.2.3. Telecommunications rooms should be vertically stacked (in multi-floor buildings) and must be sized according to the services provided from each telecommunications room based in the following guidelines. Please note that square feet requirements as well as room configuration should be decided taking rack clearances into consideration.

4.2.2.4. Please note that square footage specifications take into account the space needed for voice, data while rack clearances listed in the following (rack clearance) chart cover clearances needed for data services:

Number of data drops	Number of Racks	Space Required
1-96	1	8’ x 8’
97-192	2	8’ x 10’
193-384	2	8’ x 10’
385-576	3	8’ x 12’
577-768	4	8’ x 14’

Rack Clearances:

Item	Clearance
Rack foot print	32” x 32”
Front	36”
Rear	36”
Sides (between racks)	6”
Exterior Sides	24”

4.2.3. There should be one telecommunications room on each floor unless the total number of outlets in the building is less than 150. For buildings with less than 150 total data drops, all outlets may be consolidated into one room as long as the distance limitation of 90 meters is not exceeded.

5. Horizontal and Vertical Riser Pathways and Spaces

5.1. General Information

- 5.1.1. To avoid electromagnetic interference (EMI), all pathways shall provide clearances of at least 4 feet from motors or transformers, 1 foot from conduit and cables used for electrical power distribution, 5 inches from fluorescent lighting.

5.2. Vertical Risers

- 5.2.1. Project design shall call for adequate backbone conduits between telecommunications rooms. Only a sleeve between floors is required where telecommunications rooms are stacked. Where telecommunications rooms are not stacked, conduit is required. Conduit size and quantity shall be dictated by the size, type and quantities of the cables to be installed but preferred not to be less than four (4) inches in diameter.

5.3. Horizontal Pathways

- 5.3.1. Pathways must support cables and provide protection. Pathways should be planned to facilitate original installation as well as ongoing maintenance, additions, and relocations.
- 5.3.2. Conduit, trays, or other pathway hardware are to be used above the ceilings. Appropriate design of horizontal pathways should accommodate the hanging of cables loosely above suspended ceilings requires appropriate hardware (J-hooks, rings, etc.). Support hardware must not have sharp edges.
- 5.3.2.1. Cable routing, support, and sealing of penetrations must meet applicable NEC codes.
- 5.3.3. Hanging cable supports must be no more than 5 feet apart as the installed cable must exhibit some sag in hanging. This provides visual evidence that cable tension is within 25 pounds as required in EIA-568-A.
- 5.3.4. Bundles of cables supported by typical J-hooks should not be larger than 50 cables, unless additional support is provided.
- 5.3.5. Horizontal pathway design should take into consideration the horizontal cabling distance limitations of 90 meters (295 feet) from the telecommunications room to the outlet.
- 5.3.6. When conduit is used, sections of conduit shall be no longer than 150 ft and must not have more than or the equivalent of two (2) 90° bends between pull points or pull boxes.
- 5.3.7. Conduit inside bend radius must be:

Conduit Size	Bend Radius
2" or Less	Six times the inside diameter
More than 2"	Ten times the inside diameter

- 5.3.8. Pull boxes should be placed directly after a bend or sized accordingly if the pull box is located at the bend.
- 5.3.9. Conduit fill limits must be followed to avoid over-packing cables:

Conduit Size	# of Cables (20% fill)
3/4"	4 cables max

1"	5 cables max
1-1/4"	7 cables max
1-1/2"	11 cables max
2"	19 cables max
3"	42 cables max

- 5.3.10. At a minimum, 3/4" conduit shall be extended from the outlet location box into the ceiling for entrance into the building cable distribution system.
- 5.3.11. Outlet boxes shall be 4" x 4" x 2 1/2" and shall have plaster rings to accommodate a 2" x 4" faceplate.
- 5.3.12. Outlet boxes must be specified for all openings including walls, systems furniture, wiremold, etc. When using wiremold, a WIREMOLD brand model 5744S outlet box (or approved equal) must be provided.
- 5.3.13. Dual channel raceway such as Wiremold 4000 shall use a V/G4007C-1 device plate.
- 5.3.14. When possible, outlet locations should be placed above the work surfaces for easy access. Outlet boxes built into the floor are not recommended.

6. Systems Furniture

6.1. General Requirements

- 6.1.1. Systems furniture should be designed/ordered with electrical and telecommunications wiring requirements in mind.
- 6.1.2. Separate power poles should be provided to separate voice/data wiring from electrical wiring, or physical separators must be provided within the pole.
- 6.1.3. Voice/data wiring should be accommodated within the "top-cap" of the furniture. If the top-cap cannot be used, physical separation of voice/data and electrical cables in the base of the panels is required.
- 6.1.4. The outlet box should be integrated within the furniture above desktop level.
- 6.1.5. It is not recommended to have cabling enter systems furniture panels through floor access boxes.

7. Vertical Riser and Horizontal Cable Design

7.1. Backbone Cable Design

- 7.1.1. Twisted pair copper cable, fiber, and coaxial backbone cabling and connecting hardware shall be installed in accordance with the requirements of the building.
- 7.1.2. A 12 strand single-mode fiber will be installed in conduit or subduct between the main telecommunications entrance location and the main equipment room (if not one in the same).
- 7.1.3. A hybrid 12 strand multi-mode and 12 strand single-mode fiber will be installed in conduit or subduct between the main telecommunications room and all other main telecommunications rooms.

8. Horizontal Cable and Connecting Hardware

8.1. General Requirements

- 8.1.1. Current standards call for installation of four CAT6 cable for data at each outlet location. Ethernet is the supported protocol for data applications.
- 8.1.2. On a case-by-case basis, IT Networking will work with the owner to design/install multi-mode fiber to the desk-top.
- 8.1.3. Building areas not designed as office space shall be designed according to the occupant's requirements. This includes areas such as labs, conference rooms, lobbies, etc.
- 8.1.4. End-user voice/data outlets should be located within 3 meters (10 feet) of the work area or possible work areas.
- 8.1.5. Electrical outlets should be placed at or near voice/data outlet locations.
- 8.1.6. Copper coaxial cable for use in classrooms, labs, office space, etc. will be installed only upon request of the owner.
- 8.1.7. Each 4-port faceplate shall be serviced by 1 white, 1 green, 1 blue, and 1 yellow UTP cable.

9. Office Space

- 9.1.1. All office space shall be designed with two (2) data outlets (4-port faceplate) for every 150 sq. ft. Cubicles or enclosed office areas with less than 150 sq. ft. shall have at a minimum two (2) data outlets.

10. Classrooms

10.1. General Requirements

- 10.1.1. All classrooms shall be designed with a minimum of two (2) 4-port data outlets. If projection is to be specified, two (2) data drops shall be located above finish ceiling directly above projector location.
- 10.1.2. Voice outlets in classrooms shall be installed as required by the owner.

11. Auditoriums

11.1. General Requirements

- 11.1.1. All auditoriums shall be designed with a minimum of one (1) data outlet at the front stage area and the same in the rear "control room" if such a room exists.

12. Cabling Installation and Distribution

12.1. Cable Type, Source of Materials, and Assignment of Tasks.

- 12.1.1. All vertical and horizontal in-building cable shall be plenum rated.
- 12.1.2. The contractor will install provided backbone cable and IT Networking shall perform terminating and testing of such cabling.
- 12.1.3. For contracted projects, the contractor shall provide and install UTP cabling and label such cabling as specified for the project. The contractor will terminate and test all contractor-installed cabling.
- 12.1.4. The contractor/installer shall take into account the following critical installation practices when installing telecommunications cabling.
 - 12.1.4.1. Physical separation from all sources of EMI is critical. Sources of EMI include but are not limited to: motors, transformers, copiers, construction equipment, and branch circuit power cables. Cabling that leaves physical pathways and extends into office areas must not lay on fluorescent lighting.
 - 12.1.4.2. Conduit or other raceway pulling tensions should be minimized using suitable equipment and practices.
 - 12.1.4.3. Cables must not lie on or be suspended from suspended ceiling support wires or frames.
 - 12.1.4.4. Eliminate cable stress caused by tension in suspended cable runs. Cables must exhibit some sag in hanging between supports. Hanging supports, such as J-hooks, must be within 5 feet of each other.
 - 12.1.4.5. Cables bundles should not be larger than 50 cables and shall not be tightly cinched together. Tie wraps must be hand tightened without tools. Cables must never be twisted.
 - 12.1.4.6. Installations of CAT6 and/or CAT3 cables should have no more than two (2) 90° bends. Bend radii must be no less than six (6) times the cable diameter. For fiber optic cable, the minimum recommended bend radius is ten (10) times the cable diameter, twenty (20) times the cable diameter if loaded.
 - 12.1.4.7. Cables shall not be spliced under any circumstances. Damaged or broken cables must be completely replaced or decommissioned with a label attached at both ends.
 - 12.1.4.8. Provide adequate slack at both ends to accommodate terminations. If termination is made inside box, slack shall remain in box after termination for future repairs:

Location	Stack Length
Outlet	12 inches
Closet	10 feet past termination point

13. Data Networking Equipment

13.1. Minimum Standard Equipment

- 13.1.1. IT Networking will design network equipment to support a 100Mb switched port for all data ports proposed to be “active” by the owner’s representative.

- 13.1.2. This design will provide all necessary data network equipment up to, but not including, the desktop.

13.2. Power

- 13.2.1. Power requirements provided previously in this document are a minimum and must be adjusted based on the electronic equipment requirements specified during building design.

14. Warranty

14.1. Warranty

- 14.1.1. The systems products shall be warranted free of defects in material and workmanship.
- 14.1.2. The systems products shall be warranted to perform the intended function within the design limits.
- 14.1.3. This system shall be in compliance with the manufacturer's performance warranty status at completion of the project and receive verification of the warranty in writing from the manufacturer. This shall be included in the O&M manuals for the Owners records.

15. Products

15.1. Equipment Racks

- 15.1.1. Freestanding Equipment Racks
 - 15.1.1.1. Racks shall be UL listed and of aluminum construction with a black polyurethane or mil finish.
 - 15.1.1.2. Rack base shall be pre-drilled and securely mounted to the floor.
 - 15.1.1.3. Racks shall have 12/24 mounting screws included in the package.
 - 15.1.1.4. Rack rails shall be spaced for 19" mounting rail-to-rail and shall be of a U shaped construction with 12/24 pre-tapped holes in the EIA-310-D universal hole pattern on both the front and rear.
 - 15.1.1.5. Racks shall be completely bonded and grounded.
- 15.1.2. CPI Catalog Number:
 - 15.1.2.1. 55053-503 (rack relay 84H"x19W" double sided aluminum clear, with 10595-118 mounting plate runway to rack, gray)
 - 15.1.2.2. 231119 (horizontal cable management)
 - 15.1.2.3. 10250-118 (18" wide gray runway, above racks in telecom rooms)
 - 15.1.2.4. 12100-118 (runway drop-out, provide two at each rack)

15.2. Category 6 Patch Panels

- 15.2.1. Physical Characteristics

- 15.2.1.1. Panels shall be made of black anodized aluminum in 24-, 48 and 96-port configurations as indicated on the drawings.
 - 15.2.1.2. Panels shall accommodate 24 ports for each rack mount space (1rms = 44.5 mm [1.75 in.]).
 - 15.2.1.3. Panels shall be manufactured with a rolled-edge at the top and bottom for stiffness.
 - 15.2.1.4. Panels shall be made of 8-port adapters modules removable by detaching two screws.
 - 15.2.1.5. Panels shall have modular jacks employing staggered array contacts with a flat “hairpin” design made of Beryllium copper with a minimum 50-micro-inch gold plating on contact surfaces over 50-100 micro-inch of nickel compliant with FCC part 68.
 - 15.2.1.6. Panels shall be available in a T568A or T588B wiring schemes (coordinate with Owner).
 - 15.2.1.7. Panels shall be equipped with 110-style termination made of fire retardant UL 94V0 rated thermoplastic and tin lead solder plated IDC contacts.
 - 15.2.1.8. Panel circuit boards shall be fully enclosed front and rear for physical protection.
 - 15.2.1.9. Panels shall have port identification numbers on both the front and rear of the panel.
 - 15.2.1.10. Panels shall have optional rear cable support bar for strain relief.
 - 15.2.1.11. Panels shall have self-adhesive, clear label holders and white designation labels provided with the panel for each row of 24 ports.
 - 15.2.1.12. Panels shall provide wiring identification & color code and maintain a paired punch down sequence that does not require the overlapping of cable pairs.
 - 15.2.1.13. Panels shall terminate 22-26AWG solid conductors, maximum insulated conductor outside diameter 0.05”.
- 15.2.2. BELDEN Catalog Number
- 15.2.2.1. AX103115 (KeyConnect Patch Panel, 48-port, 2U, Black empty)

15.3. Patch Panels – Optical Fiber

- 15.3.1. Rack Mount Panels
 - 15.3.1.1. The Owner is providing and installing the fiber optic patch panels. Coordinate rack layouts with the Owner to ensure open space is located where owner desires

15.4. Category 6 Channel Compliant Jacks – UTP

- 15.4.1. Physical Characteristics
 - 15.4.1.1. Jacks shall be 8 position un-keyed
 - 15.4.1.2. Each jack shall be an individually constructed unit and shall snap mount in an industry standard keystone opening (.760” x 580”)
 - 15.4.1.3. Jack housings shall be high impact 94 V0 rated thermoplastic.
 - 15.4.1.4. Jacks shall have a temperature rating of -10 °C (14°F) to 60°C (140 °F) in conformance with ANSI/TIA/EIA-568-A
 - 15.4.1.5. Jacks shall utilize a 6 layer printed circuit board to control NEXT
 - 15.4.1.6. Jack housings shall fully encase and protect printed circuit boards and IDC fields.

- 15.4.1.7. Contacts will maintain a minimum vertical deflection force of 100 grams.
 - 15.4.1.8. Modular jack contacts shall be formed flat for increased surface contact with mated plugs. These contacts shall be arranged on the PC board to provide a tri-plane contact array to maximize contact spacing and minimize crosstalk.
 - 15.4.1.9. Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.
 - 15.4.1.10. Contact Plating shall be a minimum of 50 micro inches of gold in the contact area over 50 micro-inch of nickel, compliant with FCC part 68.5.
 - 15.4.1.11. Jack termination shall be industry standard 110 insulation displacement contact, integral to the jack housing, laid out in 2 parallel arrays of 4 contacts.
 - 15.4.1.12. Jacks shall utilize a paired punch down sequence. Cable pairs shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.
 - 15.4.1.13. Jacks shall utilize tin lead plated (60% tin/40% lead) phosphor bronze 110 insulation displacement contacts.
 - 15.4.1.14. Jacks shall terminate 22-26 AWG stranded or solid conductors.
 - 15.4.1.15. Jacks shall terminate insulated conductors with outside diameters up to 0.05".
 - 15.4.1.16. Jacks shall be compatible with single conductor 110 impact termination tools.
 - 15.4.1.17. Jacks shall be compatible with EIA/TIA 606 color code labeling and accept snap on icons for identification or designation of applications.
 - 15.4.1.18. Jacks shall be available in 10 colors for identification or designation of applications at the workstation or closet.
 - 15.4.1.19. Jacks shall be marked as T568A or T568B wiring (coordinate with Owner)
 - 15.4.1.20. Jacks shall have an attached color coded wiring instruction label.
 - 15.4.1.21. Jacks shall be supplied with installed dust covers to protect the jack opening and internal elements during installation until the jack is in use.
- 15.4.2. Performance Characteristics
- 15.4.2.1. Jacks shall be designed for 100 Ohm UTP cable termination
 - 15.4.2.2. Jacks shall be UL LISTED 1863 and CSA certified.
 - 15.4.2.3. Jacks shall exceed IEEE 802.3af DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
 - 15.4.2.4. Jacks shall meet or exceed Category 6 transmission requirements for connection hardware, as specified in ANSI/TIA/EIA-568-B.2-1, Transmission Performance Specifications for 4-Pair 100 ohm Category 5E cabling.
 - 15.4.2.5. Jacks shall be made by an ISO 9002 Certified Manufacturer.
- 15.4.3. BELDEN Catalog Number
- 15.4.3.1. AX101320 (Electrical white cat 6+ modular jack)
 - 15.4.3.2. AX101325 (Green, TIA 606 cat 6+ modular jack)

15.5. UTP Cable: Cable shall be category 6 cable

15.5.1. BELDEN Catalog Number

- 15.5.1.1. 3613 009A1000 (White Plenum Rated Cat 6 Cable, Datatwist 3600, Nonbonded-Pair, 4-pair, 23 AWG, CMP, Category 6)
- 15.5.1.2. 3613 D15A1000 (Blue Plenum Rated Cat 6 Cable, Datatwist 3600, Nonbonded-Pair, 4-pair, 23 AWG, CMP, Category 6)
- 15.5.1.3. 3613 005A1000 (Green Plenum Rated Cat 6 Cable, Datatwist 3600, Nonbonded-Pair, 4-pair, 23 AWG, CMP, Category 6)
- 15.5.1.4. 3613 004A1000 (Yellow Plenum Rated Cat 6 Cable, Datatwist 3600, Nonbonded-Pair, 4-pair, 23 AWG, CMP, Category 6)

15.6. Faceplates

15.6.1. BELDEN Catalog Number:

- 15.6.1.1. AX102655 (2-port white)
- 15.6.1.2. AX102249 (4-port white)
- 15.6.1.3. AX102251 (6-port white)

16. Execution

16.1. Equipment Installation

- 16.1.1. All Contractor work shall be performed and supervised by managers and technicians qualified and certified by the manufacturer to install and test the specified system AND shall have a minimum of 2 years' experience installing products specified.
- 16.1.2. All equipment shall be installed in accordance with the manufacturer's instructions
- 16.1.3. The Contractor will terminate, label and test all cabling; IT Networking will install all electronic equipment.

16.2. Labeling

- 16.2.1. The Owner has a specific labeling scheme that shall be followed. This labeling scheme shall be discussed with the owner to ensure acceptability prior to any work beginning. The owner will provide the contractor with all work-area faceplate labels.
- 16.2.2. The contractor will only use adhesive computer generated labels for labeling cables, racks, patch panels, 110 blocks, and fiber optic enclosures.
- 16.2.3. Labeling shall appear on the cable on both ends 5 to 10 inches from its termination point.
- 16.2.4. All labels shall be easy to read so the owner can easily locate cables, cross connect equipment and move wallplate locations in the future.
- 16.2.5. When job is complete, all test results will be checked back to the CAD drawings to make sure all labels are correct.

16.3. Grounding & Bonding

- 16.3.1. The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways and other associated hardware that has potential to act as a current carrying conductor. The TBB shall be installed in accordance with the recommendations contained in the ANSI/TIA/EIA-607 Telecommunications Bonding and Grounding Standard. Coordinate all work with the electrical contractor to ensure the grounding and bonding is installed in accordance.
- 16.3.2. The main entrance facility/equipment room in the building shall be equipped with a Telecommunications Main Grounding Bus Bar (TMGB). Each telecommunications room shall be provided with a telecommunications ground bus bar (TGB). The TMGB shall be connected to the building electrical entrance grounding facility. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between telecommunications equipment and the electrical system to which it is attached. Coordinate all work with the electrical contractor to ensure the grounding and bonding is installed in accordance.
- 16.3.3. All racks, metallic backboards, cable sheaths, splice cases, cable trays, etc. entering or residing in the TR or ER shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors. Coordinate all work with the electrical contractor to ensure the grounding and bonding is installed in accordance.
- 16.3.4. Coordinate locations of all grounding bus bars with all other trades and the owner.

16.4. Testing

- 16.4.1. Patch Panels – UTP
 - 16.4.1.1. Patch Panels shall be tested after horizontal cabling has been installed and terminated to both the panel and the work area outlet.
 - 16.4.1.2. Panels shall be tested as part of the link or channel for Length, DC continuity, NEXT, PSNEXT, Attenuation, Return Loss, ELFEXT, and PSELFEXT using a level IIe tester for enhanced category 5e, and a level III tester for category 6 channels.
 - 16.4.1.3. Testers shall be correctly set to test the type and manufacturer of the horizontal cable used in the link or channel being tested, including the correct NVP.
 - 16.4.1.4. A “PASS” indication shall be obtained for all link or channel tests when tested using the appropriate level tester for the appropriate category.
- 16.4.2. Category 6 Channel Compliant Jacks – UTP
 - 16.4.2.1. Jacks shall be tested as part of horizontal cabling system.
 - 16.4.2.2. Jacks shall be tested as part of the channel for Length, DC continuity, NEXT, PSNEXT, Attenuation, Return Loss, ELFEXT, and PSELFEXT using the specified hardware manufacturer's test heads and an industry standard level III tester.
 - 16.4.2.3. Testers shall be correctly set to test the type and manufacturer of the horizontal cable used in the channel being tested, including the correct NVP. A “PASS” indication shall be obtained for all channel tests when tested using the appropriate level tester for the appropriate category.
- 16.4.3. Backbone Fiber

- 16.4.3.1. Fiber horizontal cables shall be 100% tested for insertion loss and length.
- 16.4.3.2. Insertion loss shall be tested at 850nm and 1300nm for 50/125um and 62.5/125um multimode cabling in at least one direction using the method B (1-jumper) test procedure as specified in ANSI/TIA/EIT-526-14A.
- 16.4.3.3. Insertion loss shall be tested at 1300 and 1550 for singlemode cabling in at least one direction using the method A.1 (1-jumper) test procedure as specified in ANSI/TIA/EIT-526-7.
- 16.4.3.4. Length shall be tested using an OTDR, optical length test measurement device or sequential cable measurement markings.