WEST VALLEY-MISSION COMMUNITY COLLEGE DISTRICT

NETWORK INFRASTRUCTURE CABLING STANDARD

Guidelines for the Design of Telecommunication Network Cabling Infrastructure at WVMCCD Campuses and Facilities

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1 Executive Summary

The Information Systems Department at the West Valley-Mission Community College District (hereafter referred to as **WVMCCD-IS**) is responsible for cabling and network equipment infrastructure for all TCP/IP systems and the telephone voice/voicemail systems at all WVMCCD sites. This Cabling Infrastructure Standard provides a detailed review of standards, guidelines, and choices of implementation methods for providing and installing the telecommunication cabling infrastructure. This Standard is modular and scalable to allow implementation of various portions of the cabling infrastructure as needed. ALL EDITS TO THIS DOCUMENT WILL BE ISSUED BY WVMCCD-IS. WVMCCD-IS will provide the point of coordination and approval among the various engineers, contractors, and employees to maintain a uniform method of design and implementation as specified in this Standard.

WVMCCD-IS has developed this document to provide engineers, contractors, and employees with clear guidance on performing reliable cabling related work in any WVMCCD location. The intent is to maintain consistency at each location and not to introduce a component or component color into an installation that would disrupt the functionality, warranty, or appearance of the cabling infrastructure.

This Standard specifies components and installation methods for a generic telecommunications cabling system that will support a multi-product, multi-vendor environment. It also provides detailed information from which the design of new systems that adhere to WVMCCD standards can be created.

This Standard provides a uniform approach that is independent of applications, which may change several times throughout the life of the telecommunications infrastructure. The following devices and applications are known to connect via wired or wireless and communicate across TCP/IP networks:

- Building Management Systems (BMS), HVAC controls
- Security panels, including IP cameras, access control panels, etc.
- Audio-Visual Systems: projectors, switchers, controllers, LCD displays, TVs.
- Electrical panels for power monitoring
- Kitchen stoves, hoods and discrete appliances
- Paper towel dispensers
- Irrigation systems: distributed controllers and servers
- Clock systems: servers and devices
- Solar panel and monitoring control panels
- Lighting control systems
- Health monitoring devices, PE equipment
- Computer controlled machining tools
- Swimming Pool controls

This list is expected to increase as manufacturers continue to enhance their products for remote communication.

Use of this Standard will increase the value of WVMCCD's investment in infrastructure by reducing the labor expense of maintaining the system, by extending the useful economic life of the system, and by providing effective service to the users. The significant investment made by WVMCCD-IS will require a high level of compatibility and integration with the installed base of switching/routing equipment, network management platforms and related devices. Thus, WVMCCD-IS has standardized on a single manufacturer for campus cabling. This is complementary to the existing practice of using a single manufacturer for campus based switching and routing.

The WVMCCD-IS standard for cabling infrastructure is Commscope SYSTIMAX Category 6A UTP cabling for copper station cabling and Commscope TERASPEED single mode fiber cabling for fiber backbones. This is established as a DISTRICT STANDARD and shall be specified as such with no substitutions allowed.

As warranted by technology changes, the manufacturer and their product line will be re-evaluated before the beginning of any large deployment. If new standards are established, this document will be updated in a timely manner.

The criteria contained in this Standard are subject to revisions and updating as warranted by advances in building construction techniques and telecommunications technology.

1.1 Standards, Regulations and Code Compliance

All work and materials shall conform to and be installed, inspected and tested in accordance with the governing rules and regulations of federal, state, and local governmental agencies. Refer to specific standards in Section 9.

The installation shall be compliant with the most current revision of these standards and related documents, as listed in Section 8 of this document. Any engineer or contractor performing work for WVMCCD is responsible for acquiring and abiding by the content of these standards, and their most recent versions, as applicable to any installation at a WVMCCD site.

1.2 WVMCCD-IS Authority

These standards have been created with the joint expertise of the voice and data network staff in the WVMCCD-IS department, manufacturer technical resources, and Telecommunication Consultants engaged by the WVMCCD-IS. These resources are available as needed for clarification and updating of the content in this document.

In creating and publishing this document, WVMCCD-IS does **not** relinquish responsibility or authority for design, inspection or acceptance to any individual or company who may be contracted for the design and construction of new or replacement cabling infrastructure. WVMCCD-IS will always maintain absolute ownership for the content of this Standard, and the inspection and acceptance that all drawings, documents, and construction projects meet the Standards outlined herein.

WVMCCD-IS shall have an active role during all phases of the building design and implementation. This includes attending all architect and engineering meetings and design sessions for the building/backbone design development, construction document checkpoint reviews, review/approval of construction submittals, supplying RFI responses/clarifications, performing site walkthroughs, participating in acceptance testing, reviewing as-built documentation and providing verbal and written approvals for construction acceptance.

2 Introduction

2.1 RESPONSIBILITIES OF WVMCCD-IS

WVMCCD-IS owns the responsibility for the voice/data cabling infrastructure standards. In the current environment, all TCP/IP network systems include desktops, printers, servers, and network equipment in the "data" world. WVMCCD-IS also owns the responsibility for voice and voicemail systems, both analog/digital and VoIP implementations. In addition to the traditional voice/data systems, the network cabling infrastructure currently supports the connectivity needs of intelligent building controllers, IP-based security systems, audio-visual and other systems whose inter-communication between components is based on TCP/IP transmission protocols. Configuration and operations of those individual subsystems will continue to remain the responsibility of the departments assigned to the maintenance of those areas. WVMCCD-IS will be solely responsible for the establishment of the standards that will provide a robust cabling infrastructure, the TCP/IP network and network equipment environment.

WVMCCD-IS staff, or its designated representative, will actively participate in the design process for any new or modernized building. This includes attending any architectural and engineering meetings during the course of the project that may impact the network infrastructure.

WVMCCD-IS retains the right to review, approve, and reject all design and construction documents pertaining to, or affecting Information Technology Infrastructure. WVMCCD-IS also retains the right to be the final reviewer and approval authority for all construction submittals and project acceptance of Information Technology Infrastructure systems. This includes pathways, cabling, the quality of workmanship and acceptance testing of any or all cable plant installed, and any other aspect of the construction/renovation project that could affect the Information Technology

Infrastructure. It is the expectation of WVMCCD-IS that the information provided in this document shall be used for the basis of the design of the cabling infrastructure and included in the drawings and specifications for the project.

2.2 NETWORK CABLING INFRASTRUCTURE DESIGN ELEMENTS

The design process is streamlined and efficient when the Architect engages WVMCCD-IS in design meetings and coordination sessions beginning with the Basis of Design phase. WVMCCD-IS staff is available to assist in providing a detailed list of requirements that will aid in programming the required connectivity to rooms and telecommunication IDF spaces.

In any construction project, the following Information Technology Infrastructure elements shall be included in the construction design and budget:

Within Building:

- ❒ Telecommunication BDF/IDF Room components, including room size, centralized location, construction (walls, floors, lighting, ceiling, doors, security), cable runway, racks, cabinets, cable management, backboards, grounding, electrical service, UPS, HVAC, access control, etc.
- ❒ Voice and Data Station cabling to outlets in all types of rooms, and as needed in support of Building Automation systems and network equipment installation.
- ❒ Termination components including patch panels, jacks, faceplates, patch cords, etc.
- ❒ Pathway components, including pullboxes, conduits, chases, sleeves, J-hooks/slings, basket/cable tray, etc.
- ❒ Riser cables such as multi-pair copper (voice) and single mode fiber backbones.
- ❒ Access infrastructure, such as hatches, panels, doors, device mounts, etc.

Between Buildings

- ❒ Pathways including conduits, maintenance holes, pull boxes, grounding, drainage, pull ropes, innerduct, sleeves, etc. Typically, this pathway infrastructure is provided to the closest point of interconnection to the site outside plant.
- ❒ Backbone cables such as multi-pair copper (voice) and single mode fiber backbones.
- ❒ Termination hardware such as Building Entrance protection blocks (BET), fiber and copper patch panels, slack loop storage, suspension and routing apparatus, grounding.

The Architect shall assume a complete installation of new infrastructure, without salvage or reuse of the current infrastructure.

Note that active equipment components such as computers, network switches, access points, telephones, voice and voicemail systems, etc. are NOT part of the construction package, but shall be budgeted for inclusion related to the overall cost of the construction project.

WVMCCD-IS shall participate in the design phases to ensure that the following elements are addressed:

Design Phase	**Information Technology Infrastructure Design Considerations**
Basis of Design or Programming – This includes the discussion of building and spare purpose and function.	Definition of sufficient quantity and space for cabling infrastructure and centralized Telecommunication IDF rooms , as required by building program.
Schematic Design – These are the initial planning documents and design drawings which assist departments in the early stage of the project.	Specification of outlets and Telecommunication IDF Rooms as related to cabling distances and riser pathways. Outside Plant conduit routes from campus MPOE/MDF.
Design Development—As the architectural design process progresses, overlays are developed to show the various structures and systems planned for the building.	Definition of outlet type and placement per room, horizontal cable pathway and conduit sizing and routing.
Construction Documents—These documents depict the final design before bid submittal is undertaken.	Review of detailed drawings and specifications for all outlets, pathways, Telecommunication IDF Room designs, cabling terminations, workmanship, testing.
Submittals, Shop drawings, RFIs – These documents are provided by the contractor to clarify the construction scope.	Review of paper and electronic documents to ensure that field conditions and minor changes will still maintain a resultant infrastructure that meets the WVMCCD standards.
Record Document Drawings – These drawings and documents represent the project as it is finally constructed ("as-builts") and are deliverable prior to final inspection of the project.	Review of actual cabling as constructed ("As-Builts"), drawings with cable numbers/labels, test results (documented on CD/DVD/electronic media).

The Architect shall **guarantee** that where other Designers or Engineers need a separate wiring infrastructure to support their systems, that those consultants coordinate their design and infrastructure requirements with the WVMCCD-IS staff. This includes, but is not limited to design items such as cable type, cable color, use of separate pathways and

discrete support systems. When there are devices that need dialtone or TCP/IP data communication connection from a building to any other location on-or-off the Campus, the Architect shall ensure that the Engineers/Designers for those systems coordinate with WVMCCD-IS such that the connectivity requirements are installed by a certified contractor in accordance with these standards.

As full participants in the design process, comments and requests submitted by WVMCCD-IS **must** be incorporated into the reviewed documents in full for the next review of documents, or an explanation must be provided to WVMCCD-IS, regarding the status of comments and requests. WVMCCD-IS will suspend further reviews until all comments and requests have been addressed or incorporated into current documents and drawings.

2.3 TELECOMMUNICATION INFRASTRUCTURE DESIGNER ROLE

WVMCCD-IS requires the Architect to retain the services of a Telecommunication Infrastructure Designer for the design of the Network Cabling Infrastructure who is a current RCDD (Registered Communication Distribution Designer) as credentialed by BICSI. The Architect shall incorporate comments, communication drawings and/or specifications from WVMCCD-IS in conjunction with the Telecommunication Designer into the various document packages. See Section 7 for further details.

3 Architectural

When an architect is designing a building, many technology infrastructure elements must be incorporated in the design. The Telecommunication IDF Rooms are special-purpose, dedicated rooms that provide an operating environment exclusively for voice and data communications. Each technology has specific functions and termination requirements. Other technologies (Security, EMS, Fire Alarm, Building Automation, Audio-Visual, etc.) must have their own individual spaces within the building, separate from the Telecommunications IDF Rooms. These rooms are typically identified and placed during the Schematic Design Phase. Key considerations so that the Architect can correctly size and place the Telecommunication IDF Rooms are outlined below.

Given the rapid development of new products requiring network connectivity, the Telecommunications IDF Rooms must be designed to accommodate both current and future systems and equipment. This generally is implemented as a 30% increase in sizing, over and above the forecast size and space needs. The Telecommunications IDF Rooms shall house only equipment directly related to the voice/data cabling infrastructure and the specific electrical and environmental support systems for the Telecommunications IDF Rooms.

3.1 TELECOMMUNICATION ROOM LOCATIONS

The centralized placement of the Telecommunication IDF must be selected to maximize the room utility. The following elements shall be addressed:

- Telecommunications IDF Rooms will be **centralized** in the building. For cost efficiencies, WVMCCD-IS prefers fewer rooms, that are larger, rather than multiple rooms of smaller size. This provides for cost and space efficiency for the cabling, network equipment and operations staff.
- The Telecommunication IDF Room **must be** placed to maximize the number of outlets that the room can service.
- The Telecommunication IDF Room **must be** placed to that a maximum cable length of **250** feet is designed between the outlet and the patch panel.
- The Telecommunication IDF Room **must be** located so building entrance cables will not be exposed for a cable length distance of more than 50 feet from the point of building entrance per the California Electrical Code, Articles 770-50 and 800-50.2. This cable distance includes service loops and termination slack.
- Doorways must open outward into the corridor to allow the effective use of space inside the room. Access must be directly from hallways, not through offices, classrooms or utility spaces.
- The Telecommunication IDF Rooms **must be** vertically stacked in multistory buildings.
- The Telecommunication IDF Rooms **must not** be located in any place that may be subject to water or steam infiltration, humidity or leaks from nearby piping for water, sewage or steam, heat, and any other infrastructure that introduces a corrosive atmospheric or other adverse environmental conditions.
- The Telecommunication IDF Rooms **must not** be located near electrical power supply transformers, elevator or pump motors, generators, x-ray equipment, radio transmitters, radar transmitters, induction heating devices, and other potential sources of electromagnetic interference (EMI).
- The Telecommunication IDF Rooms **must not** be located such that cabling, conduits, duct work, venting or chases from other infrastructures pass through the rooms. In particular, there can be no points of leakage or maintenance that could pollute the Telecommunication IDF Rooms or require maintenance contractors enter the Telecommunications IDF Rooms. Hatches and access panels for other infrastructures must be located such that access through a Telecommunications IDF Room is not required.
- The Telecommunication IDF Rooms **must not** share space in electrical closets, boiler rooms, washrooms, janitorial closets, and storage rooms, nor be equipped with hatches that lead to other maintenance spaces.
- The Telecommunications IDF Rooms **must not** be located in a raised floor/depressed slab area.
- The Telecommunication IDF Rooms **must not** be located near sources of mechanical vibration which could be conveyed to the room and the sensitive network equipment via the building structure.
- The Telecommunication IDF Rooms **must not** be located below level of the water table unless preventive measures against water infiltration are employed. The room shall be free of water or drain pipes.

- Systems such as access control systems, fire alarms panels, building management systems, etc. **must not** be located in any Telecommunication IDF Room.
- To facilitate the delivery of heavy network equipment, the Telecommunication IDF Rooms **must be** level with the main entrance, foyer or elevator. Access to the Telecommunication IDF Rooms cannot include separate stairways or elevation changes.
- Acoustic noise levels in the Telecommunication IDF Rooms must be maintained at a minimum level by locating noise-generating equipment outside the Telecommunication IDF Rooms. Likewise, the walls of the Telecommunication IDF Rooms must be of sufficient construction to insulate adjacent offices from noise made by the network equipment.
- Telecommunications IDF Rooms **must be** constructed as fire-rated rooms. Penetrations through Telecommunication IDF Room walls must supply sufficient pathway for cabling, with appropriate fire-stopping materials to restore the rating of the walls.

3.3 TELECOMMUNICATION IDF ROOM SIZING

The size of an IDF room is determined by the amount of connectivity that is required. WVMCCD-IS has standardized on specific sizes for the Telecommunications IDF Rooms:

- Basic – 10’ long x 11’deep, for up to five 48-port station patch panels and backbone cabling installed on one relay rack.
- Standard – 14’ long x 11’ deep, for up to ten 48-port station patch panels and backbone cabling, terminated on three relay racks.
- Large – 20’ long x 11’deep, for up to twenty 48-port station patch panels and backbone cabling, terminated on five relay racks

These room sizes take into account the space required for operating clearances, cabling terminations and network switch and UPS equipment installation. The shape of the room is very relevant because a rectangular room offers the greatest efficiency and minimum space. It is not acceptable to assign an equivalent square footage to the room, because the racks and network equipment may not fit. Typical room layouts are included in Section 10.

If an IDF also functions the main point of voice/data backbone connection for a building (aka BDF), an additional length of 6’ must be added to the room to accommodate 1 or 2 relay racks with 12” wide vertical wire management.

3.4 TELECOMMUNICATIONS IDF ROOM GENERAL DESIGN

3.4.1 Flooring

The floors of all Telecommunication IDF Rooms shall be smooth, level and covered with an Asphalt tile, or similar tile. The flooring material shall have anti-static properties. Bare, unfinished concrete and carpeting is not acceptable. The floor shall be grounded to the wall electrical outlets to prevent the build-up of electrical static.

Floor loading capacity in the Telecommunication IDF Rooms shall be sufficient to bear both the distributed and concentrated load of the installed equipment. The distributed loading shall be at least 250 lbs/sq. ft. and the concentrated loading shall be at least 1,000 lbs over the area of greatest stress.

Note: Sequencing of the flooring installation in Telecommunication IDF rooms is critical. Flooring must be installed before racks are bolted to the floor. Drawings must reflect this requirement. IDF flooring may be required well in advance of the installation of the main flooring in the building. Contractor coordination is essential so that the build-out of the IDF is not delayed.

3.4.2 Doors

All single doors to any Telecommunication IDF Rooms shall be a minimum of 3’6" wide and 80" high, without doorsill, and be fitted with the custom WVMCCD-IS key lock and electronic card reader. Where key locks are provided, the doors to the Telecommunication IDF Rooms shall be installed with a restricted IDF-specified key set that is used across the campus only for the door locks on Telecommunication Rooms. Doors will swing completely open towards the corridor wall 180 degrees, to avoid restricting usable space in the room and facilitate delivery of equipment to the room.

3.4.3 Ceilings and Clearances

The minimum clearance height in the room shall be 10 feet without obstructions. A dropped ceiling shall not be installed. Open ceiling spaces are preferred.

The following clearances for equipment and wall-mount fields in the Telecommunication Rooms are required:

- Allow a minimum of 36-inches of clear working space in front and behind equipment.
- Allow for 36-inches of clearance in front of wall-mounted equipment and panels.
- Provide aisles at least 36-inches wide.
- In corners, a minimum side clearance of 24 inches is required.
- Additional clearance is required around floor conduit stub-ups, particularly if conduits are located in room corners. Clearance shall be measured from the conduit stub that protrudes the most into the circulation space.

It is important to note that the clearance is measured from the outermost surface of the devices mounted in the rack. UPS equipment depth behind the racks can be as much as

33” from the front rails of the relay rack. The front clearance shall be measured beginning at the base of the foot flange.

3.4.4 Walls

The floor, wall, and ceiling shall be sealed to reduce dust. Finishes shall be light in color to enhance room lighting. All walls shall be installed with plywood backboard and have sufficient support for wall mounted equipment. The walls shall be capable of supporting up to 200 lb.per linear foot of wall space.

Walls will be covered with rigidly fixed, 3/4" void free, fire-rated plywood. The visible side of the plywood shall be painted with two coats of white (or other light-colored) paint. At least one (1) Fire-Rated stamp must be visible per sheet or partial sheet of plywood when painting is completed. Plywood shall be installed starting at +2 feet AFF, through +10 feet AFF, but is dependent on the ceiling height.

3.4.5 Fire Rating

Telecommunication rooms shall be constructed with 1-hour fire-rated walls and ceilings. All penetrations shall be firestopped after cable installation to retain the F and T rating of the room. If a sprinkler system is required in the room, all sprinkler head shall be installed with wire cages to avoid possible damage and activation.

3.5 CABLE PATHWAY

During the initial design of a new building, the architect must work with the Telecommunications Designer to ensure adequate space for cabling pathway. This requires coordination with other systems that use ceiling pathway, in particular HVAC, electrical, fire water, etc. Horizontal and vertical BIM modeling and other methods to spatially plan and allocate pathway used in the design phase or early construction coordination will minimize ceiling space conflicts during the construction phase.

3.5.1 Cable Support Systems

The main routing and support systems for communication cables to use are:

- A cable or wire tray system
- J-Hooks/slings
- Conduit sleeves and home runs, pull boxes

Cable Trays

In main corridors and cable paths, the use of a cable tray system is the required method. This can be a basket tray, or solid tray. Where the cable tray is exposed in an open ceiling, a solid bottom/side tray is required. Tray may be painted to match the room design, However under no circumstances can the cables be painted in any manner.

Cable trays are installed in accessible/re-enterable ceilings in the main corridors of a building. To facilitate ongoing maintenance access after building acceptance, a minimum clearance of 12" is needed above the cable tray, and a minimum clearance of 24" is required on one side. The size of the cable tray is determined by the number of cables that will route through it and the manufacturer's weight loading. A maximum of 30% fill shall be designed so that future growth can be sustained. A consistent width of cable tray, used throughout the entire building, is preferred.

Cable trays are sized for exclusive use of voice/data cabling. Cable trays will be independently supported and seismically braced. Other cabling and support systems (cabling, devices, conduit, backboxes, etc.) shall not be attached to the sides/bottom of the tray or pass through the voice/data wire basket tray. The Architect shall design for all overhead pathways so conflicts do not occur during construction,

J-hooks/Slings

For distribution from the main cable path to station outlet locations, J-hook or cable sling suspension is acceptable. J-Hooks/slings are included in the scope of the cable installation contractor. J-hooks/slings shall not support more than 25-cables. Multiple J-hooks/slings may be stacked when cable bundles exceed 25 cables. J-hook/sling routing is typically decided in the field during construction. A J-hook/sling support is required over every outlet to hold the service loop before cables route to termination.

Conduits/sleeves

Conduits sleeves are required for penetration through any wall. It is not acceptable for the contractor to drill a hole through sheetrock for cable routing. Sleeves shall be indicated on the drawings.

Wherever there is inaccessible ceiling space that must be used for data pathway, the architect shall provide sufficient above-ceiling space for conduit runs to span the length of the inaccessible ceiling space. As a rule of thumb, the architect shall use an estimate of one four-inch conduits required for every 48 cables. The exact number and size of conduits shall be determined by the Telecommunications Designer in the detailed design.

Where cable bundles route through fire-rated walls, fire-rated pathway such as the EZ-Path products may be designed. Cable bundles are not to exceed the manufacturer's rating.

Outlet Pathway

All wall outlet locations shall be installed with 5" square Telecommunications-specific backboxes and a 1-1/4" conduit for every four cables. "Ring-and-string" is not acceptable. The RANDL 5 Square Telecommunications Outlet box is the preferred product.

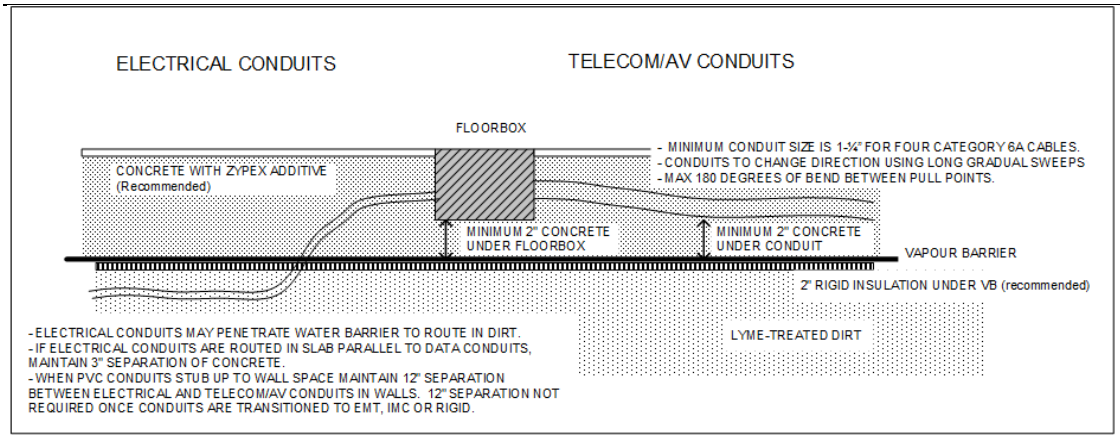
3.6 FLOOR OUTLETS

Where floor outlets are required, special attention must be given to design of floorbox, poke-thru and conduit routing.

Outlets in the floor boxes in the first floor slab-on-grade design, must be installed to meet the following minimum requirements:

- At no time shall the conduit for the data cables run below the membrane barrier or be in the soil.
- Supporting conduits shall run **in the slab** and shall be PVC schedule 40 or better. A minimum of two (2) inches of concrete shall be under and over the conduits.
- Supporting conduits shall be sized for 20% fill to allow for additional cabling.
- Telecommuications conduits feeding floorboxes will be dedicated runs and not chained through multiple floorboxes. Telecommunications conduits will stub up to the nearest wall and not route with more than 180 degrees of bend.
- Telecommunications conduits shall be sized as 1-1/4" for up to four cables. If cables are divided between different compartments of a floorbox, separate conduits shall be installed to each compartment.
- Floorboxes will be of metal construction to support the anticipated weight and foot traffic. This includes the lids, covers and top of the floorbox that will be exposed to traffic. The choice of brass, brushed aluminum or other metallic finish shall be selected according to the floor type and room design.
- Floorboxes will have lids that can be screwed down to hinder unauthorized access.
- Outlets in floorboxes should be angled or vertically mounted so that water and dirt ingress does not flow into the data jack openings.
- Floorboxes may support a combination of data and electrical outlets. If so, the design of the floorbox must be such that all data and electrical ports can be connected with cables without causing any obstructions that would limit the use of any jacks/plugs. Electrical conduits shall maintain a separate of 12" of dirt and 3" of concrete from Telecommunications conduits.
- Floorboxes will be equipped with lid inserts for carpet or tile according to room décor. The insert will provide a completely flush surface for the floorbox lid when closed.

To maintain the "dry space" rating of the floorbox, the following design has been approved:



All floorboxes in a slab over grade shall be designed and built according to this drawing.

In upper floors of a multi-storey building, the use of poke-thrus can be accepted if the following design requirements are met:

- Poke-thrus shall provide discrete compartments for the voice/data cabling.
- Outlets shall be recessed in the poke-thrus. Poke-thrus that provide jack access flush with floor level are unacceptable.
- Poke-thrus shall be of metal construction to support the anticipated weight and foot traffic. This includes the lids, covers and top of the poke-thru that will be exposed to traffic. The choice of brass, brushed aluminum or other metallic finish shall be selected according to the floor type and room design.
- Poke-thrus lids shall be completely flush against the floor. Poke-thrus that provide even as much as a 1/4" protrusion above the floor are considered a tripping hazard.
- Poke-thrus lids shall provide an adjustable slot so that patch cords and power cords can be routed to equipment without the need for the lids to be left open.
- Poke-thrus shall be equipped with conduits that sleeve the cabling to the accessible ceiling space in the room below. Poke-thrus will not be provided if the lower floor does not have accessible ceiling space.
- Cables terminated in poke-thrus shall route through the ceiling space of the lower floor, and back up through a vertical chase to the IDF on the same floor as the poke-thru. The Architect shall ensure that sufficient vertical riser conduits in accessible and separate chases are provided. The vertical riser conduit(s) will be placed in the nearest available wall as close to the poke-thrus so that the cable tray on the lower floor is not used for upper floor cables routed through poke-thrus. It is not acceptable for the cables from a poke-thru to route to the lower floor, use the cable tray in the lower floor to route to the lower floor IDF, and then use riser conduits in the IDF to terminate in the upper floor IDF.

4.0 TELECOMMUNICATION OUTLET STANDARDS

It is very important for the proper design of outlet locations that the Electrical and Telecommunication Designers are aware of furniture configurations. Furniture layout drawings will be needed by both Electrical and Telecommunication Design team members to correctly locate power and communication outlets. The layout of power and data outlets is NOT the responsibility of the furniture designer. It is the expectation of WVMCCD-IS that the Architect will supply background drawings with furniture layout to the design team. If furniture placement is unknown, outlets will be designed by WVMCCD-IS to best facilitate a variety of connectivity options and future furniture reonconfigurations. When modular furniture is used, furniture designer must take into consideration the number of voice and data cables that will be run through modular walls so as to not exceed wall pathway space and ensure for proper cable installation.

The design standards shown below are established independently of the furniture layout. Refer also to Section 7 for additional cabling details.

4.1 General

Telecommunications Outlets are provisioned with 5” square RANDL-style backboxes and single-gang faceplate fittings. Each Telecommunications outlet will have one 1-1/4” conduit that extends from the backbox to the accessible ceiling space, with no more than 180 degrees of bend, cumulatively. Telecommunications outlets will not be cascaded between boxes.

In offices, the **REQUIRED** voice/data outlet placement is **+18”** above the finished floor (AFF) and within two feet of a general-purpose, single-gang electrical outlet. Electrical outlets will be placed at the same +18” height. This height is specified because desks that have modesty panels, file drawers, or other storage placed against the wall will obstruct access to the electrical and telecommunications outlets that are typically constructed at +18”.

In conference rooms and classrooms, telecommunications outlets that are distributed around the room walls may be placed at +18” AFF.

In rooms with built-in counters, work surfaces and cupboards, the outlets shall be placed at +6” above counter/surface height, coordinating the placement of the electrical outlets at the same height.

Outlets will not be placed such that they are located inside of cupboards and cabinets unless this specific purpose is desired (such as for a concealed fax machine, printer, TV or computer).

Refer to Section 9 for detailed diagrams of outlet types.

4.2 Single-Person Office (~80 sq. ft.)

In a single-person office, two telecommunications outlets shall be installed, on opposite long walls, not including the wall with the door. The electrical and data outlets shall be located at +18" A.F.F. Each outlet shall be provisioned as a Type A (2V2D) outlet. This configuration is specified because:

- One-person offices are often turned into two-person offices as need dictates.
- Furniture configuration invariably blocks one or more outlets.
- Multiple outlets allow for future reconfiguration of the furniture without the need for long patch cords and electrical extension draping on the floor.
- Telecommunication outlets are adjacent to electrical outlets which are usually placed on each wall. In an office, the expectation that if an electrical outlet is available, a data connection is adjacent.

Placement of the telecommunication outlets is independent of the furniture layout. WVMCCD-IS will determine the precise layout during the design process.

4.2 Two-Person Office or Administrator's office. (~110-120 sq. ft.)

A two-person or administrator's office is larger than a single-person office. Three or four Type A (2V2D) outlets shall be distributed on the walls, specific outlet locations determined by room shape and furniture layout. The electrical and data outlets shall be located at +18" A.F.F.

4.3 Conference Rooms

Conference Rooms will require one Type A (2V2D) telecommunication outlet at 18" AFF for every 10-feet of wall space on all sides of the room. The wall that is considered to be the "front" of the room shall have one Type A (2V2D) telecommunication outlet at +18" AFF under the "whiteboard", LCD or screen location. If an LCD display is provided in the conference room, a Type C (4D) telecommunications outlet shall be provided behind the LCD display. One or more floorboxes with Type A (2V2D) telecommunications outlets will be provisioned, depending on the size/shape of the conference room table. One floorbox is required for every six (6) feet of table length, rounded up according to size. Cabling will terminate in the floorbox. If chases are available, patch cords may be installed to route up to the table surface for connections.

Power and communication outlets will be flush mounted on/in ceiling or high on the wall for each of the following purposes:

- projector Type B (2D)
- wireless access point Type C (4D)
- IP camera Type B (2D)

4.4 Cubicle/Partitioned Offices (Modular furniture 6'x8' or 8'x 10')

Modular furniture is commonly used to subdivide a large room into discrete cubicle work areas. The type of furniture system to be used shall be conveyed to both the Electrical and Telecommunication Designers. WVMCCD-IS requires a furniture system that has a dedicated data channel as part of its construction.

Each cubicle or partitioned office will require one Type A (2V2D) outlet, each outlet provisioned with four cables. For every group of six cubicles, an additional Type A (2V2D) outlet will be provided for shared printer/fax devices.

Cubicle and partitioned offices will require "feed points" for cabling. A feed point is a large conduit (typically a two-inch conduit) used to route multiple communication cables into the raceway system of the modular furniture. The mounting height and exact location of the feed points will depend upon type of modular furniture system to be installed. A feed point with a two-inch conduit will provide cabling to a maximum of four (4) outlet locations or sixteen cables.

Cabling that routes through modular furniture will be installed as home runs from the faceplate in each cubicle to the serving Telecommunications IDF Room. ***Splicing of voice and data cables is not permitted.*** Conduits routing to the feed points and the toe plate raceway system within the modular furniture must be able to hold sufficient cables for each cubicle in the modular furniture system at a maximum fill ratio of 30%. Multiple feed point conduits will be installed in a distributed manner to provide sufficient space for the required number of cables, so that the size of the furniture raceway is not exceeded.

When laying out a modular furniture system, it is very important to consider how power and communication cable will be connected to the furniture system. If adjacent to the modular furniture, the use of solid walls and columns to route to the feed point is preferred. In walls with partial windows, feed points and outlets shall be placed on the solid section of the walls.

The use of flexible metallic conduit, smurf tubing or other moveable pathway to route cables from wall feed points into the modular furniture is not permitted because it induces stress to the cable when pulling. If the offset of the furniture system data channel from the wall is less than twelve inches, flexible conduit/split duct may be used. Where there are distances greater that twelve inches from the wall to the modular furniture, the feed point shall be extended using metallic surface mount raceway. This will adequately protect the cabling from damage during the life-span of the building. It is unacceptable for cabling to be wrapped in shrink tubing or spiral tubing and be left suspended or exposed between the wall and the furniture system for more than twelve inches. All cabling must be securely covered and protected from damage.

4.5 Wall Mounted Telephones

In order to comply with the ADA Accessibility Guidelines, the mounting height of the Type D (1V) outlet box for Wall Mounted Telephones shall be +42" AFF, as measured to the base of the faceplate. The wall-mount telephone location will be designed with a clearance of 12" on all sides of the outlet box, so as to facilitate the installation of different shapes of telephones. If a wall mounted telephone is to be installed above a counter top, the clearance for the box shall be 12 inches above the counter top. If a wall mounted telephone is to be installed near cabinetry, designers must ensure that door-swings do not interfere with the operation of the telephone.

Wall-mount telephones will be installed in storage rooms, classrooms, hallways, electrical rooms, IDFs and other spaces as dictated by the particular room purpose. Telephones are required in any space that will be accessed by a student.

4.6 Work Rooms

Faculty or Administrative workrooms will vary in size and function. These workrooms may be equipped with shared departmental resources including:

- Facsimile machines
- Laser Printers
- Desktop computers
- Multi-function copiers

A variety of supplemental office devices, such as pencil sharpeners, laminators, electric staplers, etc. may also be located in the work room.

To facilitate the use of these devices, numerous Type A (2V2D) telecommunication and power outlets are needed. Workrooms are typically configured with counters and storage cupboards. Along counter tops where facsimile and printers may be placed Type A (2V2D) telecommunication outlets, with appropriate electrical outlets, will be distributed every six feet. These will be placed at +6" above counter height. For self-standing copier machines, a Type A (2V2D) telecommunication outlet will be provided at +18" AFF beside the device, with appropriate dedicated electrical outlets.

At the entrance to the workroom, a Type D (1V) wall-mount telephone outlet will be required. This outlet will be situated to avoid space conflict with door-swings, cupboards, fire extinguishers, water coolers, panels and any other fixture or device that could interfere with the accessibility of the telephone.

4.7 Instructional Classrooms

Instructional Classrooms that have a specific teaching wall orientation will be provided with the following telecommunications outlets:

- At the entrance to the classroom closest to the teaching wall, a Type D (1V) telecommunication outlet for a wall mounted telephone will be provided. This outlet shall be positioned such that it does not interfere with light switches or access to the door. The mounting height shall be +42" AFF to ensure compliance with ADA requirements. A clearance of 12" on all sides as measured from the center jack, shall be maintained. This includes tackboards, whiteboards, thermostats, light switches, etc. The wall-mounted telephone outlet shall be located such that there is adequate space for the Campus Emergency documentation to be located adjacent to the telephone.

- At the instructor's station, one or several outlets will be provided for connectivity to instructor's computer(s), AV devices or a telephone. The current standard requires 2V and 6D connections provisioned as a Type A (2V2D) and Type C (4D) in floorboxes or wall locations, depending on the room design.

- At each the projector outlet, a Type B (2D) telecommunications outlet is provided for data connectivity and control.

- Above the classroom T-bar ceiling, a Type B (2D) telecommunications outlet is provided for a wireless access point. This shall be provisioned on a plenum surface-mount box. See Section 4.15 for additional details.

- If the classroom will have a IP camera, a Type B (2D) telecommunications outlet in the accessible ceiling space adjacent/above each camera location will be installed. A one-inch conduit to the camera backbox will be provided to route the patch cord from the data outlet to the IP camera. If cameras will be provisioned as a future AV expansion, the backbox and stub-up for the telecommunications outlet will be provided, and blanked, so equipment/connectivity can be added in the future.

- At the back of the classroom, one or more Type B (2D) telecommunications outlets will be provided for connectivity to future printers, roll-up AV equipment or other apparatus requiring data connections.

4.8 Computer Labs

Computer labs vary depending on the type of activity conducted in the lab. Computer labs will be custom designed with the participation of WVMCCD-IS and College staff. Since computer labs may be rearranged, it is important that the communication outlets provide as much flexibility as possible. In addition to the connectivity for the student computers, the telecommunications infrastructure described for classrooms will apply to computer labs.

4.8.1 Computer Lab - wall outlets

In some Computer Labs, the student computers will be oriented towards a whiteboard or teaching wall upon which the Instructor's workstation may project images and perform demonstrations. This lab is typically sized for a class of 45 student computers and an instructor's computer. The lab may also contain 3-4 printers, scanners and other network devices. The tables are typically arranged to allow the students to face in one direction and not need to twist around to watch the instruction. Tables are often positioned against the walls. Printers, scanners and other network devices are distributed around the room as space permits.

The preferred outlet arrangement for this layout is to provide a concentration of outlets on the walls, aligned with each row of computer tables. Each outlet will have 4-8 data jacks as one or more Type C (4D) outlets, depending on the number of student computers it serves. Tables will be placed flush against the walls to prevent the stretching of power or data cables across aisles or walkways. Patch cords of varying lengths will route from the wall outlets, through imbedded troughs in the tables, to the computer connection. All cabling will be hidden so students cannot change the connections.

Multiple Type C (4D) additional data outlets will be provided on side and back walls to service printer/scanner/other data device locations.

4.8.2 Computer Lab – depressed slab

In new buildings with rooms that are designed for permanent computer labs, the preferred computer lab design includes a depressed slab to allow for the raised floor environment without losing room space due to ramps or stairs. The raised floor environment will be design as:

- A minimum depth of 2-4 inches, with removable floor tiles to grant unhindered access to the floor space.
- A matrix of power and Type C (4D) telecommunication outlets that provides sufficient density to computer tables. Typically, this will be telecommunication outlets each equipped with two to four data jacks, spaced every four feet with adjacent power receptacles.
- The electrical outlets shall be designed such that computers and network devices plugged in to **every** network jack and power outlet can be powered on concurrently. A design estimate of four computers per 20 amp circuit applies. The number and location of communication and power outlets will vary with room size and orientation. Each matrix will be custom designed with WVMCCD-IS and College staff according to room requirements.
- The removable floor tiles will be provided with notched access so that patch and power cords can be routed from the under-floor outlets to the computers. Floor tiles will be movable so that as room configurations change, cable notches can be positioned underneath tables to avoid extending cables across circulation paths.

Placement of floor outlets will be coordinated with the final furniture plan.

4.8.3 Computer Lab – floorboxes

In new buildings with rooms that are designed for permanent computer labs, the computer lab design may be provisioned as a matrix of floorboxes. This will be designed as

- Floorboxes will be provisioned with a maximum of four data and four electrical outlets so that cords will be a manageable length and quantity.
- Floorboxes will be positioned in a matrix so that up to four computers can be supported by each floorbox. One dedicated electrical circuit is provided per floorbox.
- Floorbox lids are positioned to feed into the cable management system of the furniture so that cords are concealed from student access or damage by feet, backpacks, etc.
- Floorboxes are positioned for specific table length as determined by furniture selection.
- Floorboxes will be positioned to accommodate multiple table configurations.

4.9 Lecture Halls

In certain locations, lecture hall seating may be provided with data and power access for each student chair. The room purpose and selected furniture will determine the precise configuration of the outlets. Lecture Halls will be custom configured for each building.

4.10 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
- Auditoriums
- Athletic and Television Broadcasting Control Rooms
- Scoreboards, Electronic Advertising Boards, etc.
- Outdoor gathering/congregation locations.

At the time of design, the requirements for each of these locations will be individually determined with WVMCCD- IS and College staff. For provisioning to outdoor “classrooms” or presentation locations, outdoor wireless or security camera installations, the following guidelines will be followed:

- The most important aspect of the design is the outside plant pathway to any location requiring voice, wired data, wireless data or audio-visual connectivity.
- The minimum conduit size to the connection location will be a two-inch conduit for data. If AV connectivity routes to the same location, a separate two-inch conduit will be provisioned.
- Conduits will finish in an appropriately sized pull box, minimum size 18”x24”

- Conduits will be 30” below grade.
- If a large amount of connectivity is needed, such as for an amphitheatre, a pedestal or outdoor NEMA enclosure shall be provisioned to contain an outdoor rated IDF.
- All cabling materials shall be outdoor-rated.

4.11 Maintenance Spaces

A Maintenance space is defined as any room that contains materials, supplies, equipment or tools used for the performance of maintaining systems on campus. These can include but may not be limited to:

- Janitorial Closets
- Electrical Rooms
- Security Rooms
- Mechanical Rooms
- Control Rooms
- Boiler Rooms
- Garages

In these spaces, the minimum communications outlet shall be an outlet for a wall-mount telephone. The wall-mount telephone location will be designed with a clearance of 12” on all sides of the outlet box, so as to facilitate the installation of different shapes of telephones. This outlet will be located on the same wall as the doorway to the space, with sufficient clearance so that the outlet is not obstructed by light switches, equipment or storage shelves. If the door swings into the room, the outlet will be located on the wall beside the door lock, i.e NOT beside the door hinges, so that the door cannot swing into the room and damage the telephone.

If the Maintenance Space will also be used as an office for maintenance personnel, the space will be equipped with additional telecommunication outlet(s), located on the wall within three feet of a general purpose electrical outlet. One telecommunications Type A (2V2D) outlet will be provided for each desk area assigned to the Maintenance Space.

If the Maintenance Space contains panels, control systems or other devices that need to remotely communicate status and operation via modem or network connection, each of these devices will be separately equipped with dedicated station cables. The definition of which devices/panels need cabling will be done in conjunction with engineering specialists for each device type. These devices perform building automation (BAS) functions and can include HVAC monitors, JACEs, elevators, EMS panels, electrical panels, lighting control panels, etc. Note: all devices will be provisioned with a Type B (2D) outlet that terminate on a faceplate or surface-mount box (SMB), outside of the panel or device. A patch cord will be used for connection. Under no circumstances will data cables be hand-crimped, or will a cable extend directly from an IDF to a device or termination point inside the device panel.

It is important to note that cascaded mini-switches that may come as part of the BAS device will not be connected by WVMCCD-IS to the campus network. If more than two data connections are required, sufficient cables will be provided as identified in the design and submittals phase.

4.12 Building Rooftops

Control equipment that is located on building rooftops frequently requires special provisioning of communications connectivity. This equipment can include cellular/wireless antennas, broadcasting equipment, telescopes, communication relays, etc. Some of these systems may 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 250 feet of a Telecommunication IDF Room.

If a weatherhead, mast, or other metal support apparatus are installed as part of the roof equipment, it must be installed with lighting arrestors, and grounded to the electrical system, and not in any way connected to the IDF busbar or data metal infrastructure.

Rooftop components and the cabling requirements are evaluated with the specific purpose of the devices. The project must include:

- Pathway to the specified device location
- NEMA3R enclosure for termination
- Outdoor rated cabling, quantity and type designed according to need
- Firestopping and conduit sealing to prevent intrusion of vermin, dust/dirt, moisture, etc.

4.13 Storage Areas

Large storage areas that will be accessed by WVMCCD staff on a daily basis will be provided with a Type D (1V) outlet for a wall-mount telephone. If the storage area will be provisioned with general purpose electrical outlets, at least one Type A (2V2D) telecommunications outlet will be provisioned on each wall where there is an electrical outlet. Frequently, storage areas are redefined in purpose and may change into small meeting rooms, offices or other work areas requiring connectivity.

4.14 Wireless Support

WVMCCD-IS enables pervasive wireless on the campuses. Wireless connectivity is a **supplement** to the wired network connections for ad hoc or guest access on campus. As a minimum, wireless access points shall be provisioned in the following areas:

- Classrooms – ceiling mounted.
- Student Assembly areas – cafeterias, foyers, common rooms, lounges, sitting/study areas, etc.

- Faculty areas – supplemental to the wired access in the offices, generally provisioned in corridors or central areas to serve several offices.
- Theatres, auditoriums – multiple locations to support sufficient wireless access

WVMCCD-IS will provide the location of access point outlets during the design phase. These must be built EXACTLY as designed so that the optimal wireless distribution will result. Note that although current generation 802.11a/b/g/n/ac/ax access points may be powered through the network switches, future standards will not. As such, WVMCCD-IS **requires** the provisioning of an electrical outlet at every data outlet that will serve an access point.

Inside a building where a wireless access point will be installed, a Type C (4D) telecommunications outlet with a two data cables shall be installed on a 5" square backbox adjacent to a power outlet in the ceiling. The backbox must have independent suspension and not be installed or suspended on cable tray, ductwork, ceiling support structures, piping, etc.

The outlet will be placed no higher than 12" above the ceiling tiles, and will be situated so that it is not blocked by ductwork, fire sprinklers, piping or any other apparatus. The ceiling grid underneath the outlet will be clearly labeled with the outlet number.

As needed, wireless will be provisioned to the building exterior. The location of an exterior mounted access point or antennae shall be custom designed with each building project. To facilitate this connectivity, each roof corner and IDF will be provisioned with a 2" conduit stub up to an 8"x8" NEMA box on the roof. If additional wireless is required for signaling to open spaces like plazas, playing fields or stadiums, refer to section 4.10 above for requirements.

4.15 Security Devices (including IP cameras)

TCP/IP-enabled security devices, such as cameras and control panels, will be connected to the network. These devices may be located on building exteriors, corridors, offices, security cabinets, etc. Connectivity to these devices requires the same cabling infrastructure as provided for any other data connection. The data contractor will install the cabling, in accordance with these standards, routed back to the IDF patch panels. Pathway and routing to these security devices will be designed on an individual basis.

All security devices that connect to the data network will be provisioned with a MINIMUM of two data cables terminated on a faceplate or surface mount box. A patch cord will provide connectivity to the device. Field termination (crimping) of cables is expressly forbidden and will not be connected to the network.

In the event of a security device location that is beyond 250 feet from an IDF, a solution using Commscope powered, single mode fiber cabling will be designed. If outdoors, outdoor rated infrastructure will be specified.

4.16 Future Provisioning

In any location that may require a future Ethernet-connected device, a 5” square backbox, single gang mud-ring and blank cover, with 1-1/4” conduit stub-up will be provided. These locations will be evaluated and identified during the design phase.

5.0

Electrical

The following information is the basic guidelines for the Electrical Engineer or Designer. These design guidelines are to be considered to be minimum requirements. The Electrical Engineer shall contact WVMCCD-IS in the Schematic Design phase to determine if there are any special requirements. It is the expectation of WVMCCD-IS that the information from this Standard shall be included in drawings and specifications. In the electrical specifications, separate sections shall be written to specify:

- Conduits for Telecommunication Use
- Outlet boxes for Telecommunication Use
- Telecommunication Cable Tray
- Telecommunication Grounding System
- Electrical systems designed to power Telecommunication Equipment

These specification sections and drawings are to be made available for review by WVMCCD-IS. Unless otherwise noted, it is expected that the work listed in this section will be installed by an electrical contractor.

5.1 General Power Requirements

The plentiful distribution of electrical circuits is critical to ensuring that equipment does not experience power surges or lulls as everyone "powers on". A dedicated circuit will be installed for every four computers. Other circuits will be installed for shared use between offices for supplemental office devices. It is recommended that the outlets for computer usage be designed as surge protected power outlets with receptacles that use a different color. These outlets shall be defined for computer usage. Outlets for computer usage **SHALL NOT** be remotely accessible for automatic or programmed power shutdown.

Power outlets shall be mounted within two feet of communication outlets and at the same mounting height. Telecommunications outlet heights shall define the height of the adjacent electrical outlets.

5.2 Telecommunication IDF Room Power Requirements

Each Telecommunication Room shall have its own dedicated electrical panel. The electrical service shall be at least 100 Amps. The estimated electrical load for Telecommunication Rooms shall not exceed 80% of the panel. The IDF HVAC system and lighting shall not use the same electrical panel as that used to support Telecommunication IDF Room equipment.

The Telecommunications IDF Room shall be provisioned with dedicated outlets for the equipment racks and convenience outlets.

1. To provide power to equipment racks/cabinets, electrical outlets will be provisioned along cable runway and between racks/cabinets. Each rack/cabinet will be provisioned with the following circuitry:

    - One (1) dedicated 20a, 120 V circuits in quad-plug outlet.
    - Two (2) L6-30R receptacles, when discrete UPSes are used

    OR

    - Four (4) L6-20R receptacles, when a centralized UPS is provided
    - One (1) extra L6-30R is required per room, for support of the PDU.

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    These outlets will be positioned at the top of the rack/cabinet using the StarLine Track Busway. The Busway will be mounted above the back of the racks, and positioned so that it does not obstruct cable runway or lighting. The outlets shall be phase-distributed across the racks. All outlets will be provisioned with 6' drop-down pigtails so that the receptacles are in easy reach for connection to the network equipment.

2. Convenience outlets in Telecommunications Rooms shall be mounted at +18 inches AFF (just below the plywood backboard). Horizontal spacing between convenience outlets shall not exceed six feet around the edge of the space. Convenience wall outlets can be split circuited, i.e. outlets on the same wall will be wired to the different circuits. No more than four (4) outlets shall be on the same circuit. Each outlet will be clearly marked with the circuit number. All convenience outlets shall be 120v 20 Amp, quad-plug outlets.

5.3 LIGHTING

It is important that proper work lighting be provide in all Telecommunication IDF Rooms. Lighting shall:

- Have a minimum of 50 foot candles measured 3' above the finished floor in the middle of all aisles between racks or cabinets.
- Be provided as two discrete banks, one on each side of the racks. At least one bank of lights, the nearest to the door, shall be emergency powered.
- Be controlled by one or more switches located near the entrance door(s) to the Telecommunication IDF Rooms.
- Not be powered from the same electrical distribution panel as the telecommunications or network equipment in the Telecommunication IDF Rooms.
- **May be connected to timing devices or light sensors** which would shut the lights off while work is in progress, but each IDF MUST have sensors located in both the front and rear of the room to prevent lights from shutting off while work

is in progress. Dimmer switches shall not be used in the Telecommunication IDF Rooms.

- Emergency lighting and signs should be properly placed in the Telecommunication IDF Rooms where absence of light would hamper an emergency exit.
- Be located a minimum of 8'6" above finished floor.
- Be placed so that the lighting separately illuminates both the front and back of the rack/cabinet. If the Telecommunication IDF Room has wall-mount fields then additional wall mounted fixtures will be required to provide sufficient illumination while a technician is working at the field. A lighting fixture placed directly over the racks is inadequate because the rack equipment blocks the light from adequately illuminating the areas during maintenance work.
- If the Telecommunications IDF Room is powered on a UPS or generator feed, the lights for the rooms shall be powered from that same feed.

5.4 GROUNDING

In addition to the standard building electrical grounding system, a Telecommunications Ground System will be designed per J-STD- 607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications. This Telecommunications Ground System shall be installed to support the Telecommunications IDF Rooms and cabling infrastructure.

A Telecommunications Main Grounding Busbar (TMGB) shall be located in the Building Telecommunications BDF Room. The TMGB shall be a predrilled copper busbar provided with standard NEMA bolt hole sizing and spacing. The TMGB shall be electrotin-plated for reduced contact resistance. The TMGB shall be a minimum size of 0.25 inches thick, 4 inches wide and 12 inches in length. The TMGB shall be insulated from its support by a 2 inch separation.

The TMGB will be bonded to the electrical panel ground bus bar and to building steel or ground rod by conventional welds, exothermic welds clamp-and-braze method, or UL approved compression type connectors. Exothermic welds are the preferred method. Because of the high temperatures involved, copper materials may be bonded to iron or steel. The mold size must match the cable or conductor cross section. The size of the weld metal charge must match the size of the mold being used. The connection between the TMGB and the main electrical bonding point is to be 3/0 insulated copper ground wire.

In each Telecommunications IDF Room, a Telecommunications Grounding Busbar (TGB) shall be installed. The TGB shall be a minimum size of 0.25 inches thick and 2 inches wide and 6 inches long. The TGBs shall be bonded to the electrical panel serving the rooms were the TGB is installed, bonded to building steel, and bonded in series to the main TMGB.

Attachment of metallic structures to the grounding busbars shall be as follows:

- All metallic structures (racks, cabinets, cable runway, etc.) shall be attached to the TGB using grounding straps. Use minimum of #6 AWG, green jacket, stranded grounding wire between all equipment racks and the existing telecommunications grounding busbars.
- Metallic straps will be used to join segments of cable runway, relay racks, equipment and other metallic structures.
- All metallic structures will be stripped of the paint coating at the point of grounding connection to ensure that the metallic straps and ground wires mate to the metal structure with sufficient contact.
- Devices which have discrete grounding requirements such as building entrance protectors will be individually grounded. Cascading of ground wires is not acceptable. A separate ground wire shall also be provided for attachment to test tools.
- Non-telecommunications devices shall NOT be grounded to the TGB provided in the BDF/IDF rooms.

All busbars shall be mounted on the backboard at +96" AFF.

5.5 TELECOMMUNICATION PATHWAYS

The main types of horizontal pathways are:

- Ceiling distribution.
- Cable basket tray.
- In-floor ducts (one- level or two- level).
- Cellular floors.
- Conduit.
- Access (raised) floors.

Many buildings require a combination of the above systems. WVMCCD-IS requires an overhead distribution method based on the use of cable tray and J-hooks/slings for routing, and conduit stub-ups from outlet boxes.

5.5.1 Cable or Wire Basket Tray

For bundles of cables beyond 25 cables, the required method to support telecommunication cables is the use of cable tray. Design of the size and location of the wire basket tray will be coordinated with WVMCCD-IS. In general, the design of the cable tray will follow the guidelines described below.

- Cable trays shall be sized as 18" or 24" wide trays, depending on the number of cables and the manufacturer's weight limitations with a maximum fill of 30%.
- The choice of solid or basket tray shall be determined by the tray path.

- Cable trays shall be solid bottomed if routed through open ceilings. No cabling shall be exposed in the tray, or when entering/leaving the tray.
- For above T-bar or dropped ceiling, basket tray is acceptable. Spline or Snake tray is not considered an adequate suspension system.
- Cable trays are dedicated to telecommunications cabling infrastructure.
- Cable tray routes will follow main corridor routes with accessible ceiling spaces. Cable tray routing shall be coordinated with other trades during the design phase, such that access is not blocked by ductwork, piping, etc.
- The tray shall be placed in the hallway ceiling space in such a manner that at least 12-inches of space is available above the cable tray and there is at least 24 inches of clearance on at least one side of the tray.
- The Cable tray system will be suspended independently, a minimum of six inches above the T-bar ceiling.
- The Cable tray support shall be an independent trapeze support system which shall not be utilized by any other trade.
- The Cable tray support structure and cable trays shall be seismically braced and grounded per the manufacturer's installation instructions.
- Cable trays shall extend into the Telecommunications IDF Rooms sufficiently to provide a smooth cable transition to the cable runway. When changes in elevation occur, waterfalls and other supports shall be installed to ensure that cables are not bent, or pinched as they transition from one support structure to another.

All metallic cable trays must be grounded, but shall not be used as grounding conductors for equipment. Clearly mark all cable trays and grounding conductors in accordance with ANSI/ TIA/ EIA- 606 and J-STD- 607.

5.5.2 J-Hooks/Slings

Typically, information on the general placements of J-hook will not be included on the electrical drawings. The Cabling Contractor is better equipped to install J-hooks/slings as needed while adjusting the placement to appropriately support the cable runs as the cables are being installed. Unless instructed otherwise by WVMCCD-IS, the installation of J-hooks/slings shall be covered in the work assigned to the Cabling Contractor.

J-hooks can be replaced with "saddle" or sling type products. For additional installation information, refer to the Telecommunications Designer section and sample specifications.

5.5.3 Metallic Divided raceways

For new construction, divided metallic raceway is not acceptable. Dedicated surface-mount metal raceways can only be considered for remodeled areas where flush-mount outlets are not possible. WVMCCD-IS must approve the installation during the design phase. New buildings shall be provisioned with backbox and conduit stub-up outlets that finish flush to the wall surface.

Where surface-mount raceways are being installed, the telecommunication raceway shall be above the power. The design of the telecommunication raceway shall be based upon the following:

- Only metallic raceway is acceptable.
- Metallic raceway dedicated for the data cables is required. No other low voltage cabling (AV, clock/speaker) cables shall route with the data cables.
- Data outlets will be terminated in pairs, with two jacks per single gang fitting to reduce the number of fittings. Data jacks require custom fittings to fit the jacks. It is unacceptable to use adapters that fit four data jacks in a two-plug electrical fitting because there is inadequate space for the patch cords to be installed.
- The mounting height of the raceway is typically +6" above counter height. Sufficient power outlets shall be provided with each two-jack communication outlet.
- In outlet locations, the jacks will protrude into the raceway cavity and possibly pinch the cable connections. Raceways shall not be filled greater that 20% and extensions may be required to avoid cable pinching at outlet locations.
- Conduit stub-ups from the raceway must be sized like dedicated wall outlets: one 1-1/4" conduit per four cables. Conduit stub-ups from the raceway must be sized to support the maximum number of cables in that segment of the raceway plus 20% growth. Larger conduits can be used to support more cables, as follows:
    - 1.5" conduits – 10 cables
    - 2" conduits – 16 cables
- If the raceway system is to support a computer lab facility then each communication faceplate shall be sized for two cables. Unless specified otherwise, the telecommunication outlets shall be spaced every five feet and aligned with the table layout.

5.5.4 Inside Conduits

The Electrical Engineer will design conduits conforming to EIA/TIA 569 Commercial Building Standard for Telecommunications Pathways and Spaces. Where the term "conduit" is used, it refers to hardwalled conduits of EMT, IMC or rigid construction. Flexible conduit is not permitted. The following design considerations will be observed:

- Run in the most direct route possible (parallel to building lines)
- An accessible pull box must be added to a conduit run if it contains more than the equivalent of two 90 degree turns in any dimensional plane.
- Contain no straight through or 90 degree condulets (also known as LBs).
- Contain no flex-conduit material.
- Contain no continuous sections longer than 100 ft. For runs that total more than 100 ft in length, insert pull points or PBs so that no segment between points/

boxes exceeds the 100 ft limit. It is recommended that total conduit runs be kept to 150 ft or less (including the sections through pull boxes).

- All conduits shall have a minimum bend radius 10-times the diameter of the conduit.
- Conduit stub-ups that are trade size 2-inch or less shall have no more than a 45 degree bend above the wall.
- Equip all conduits with a plastic or nylon line (also called a fishtape or pull cord) with a minimum test rating of 200 lb.
- Minimum trade size for communication EMT conduits is 1-1/4" for use with all communication back boxes or J-boxes.
- All communication conduits from outlets shall stub up above the dropped ceiling space to a J-hook placed above the end of the conduit.
- Conduits will stub up to an accessible ceiling area. No communication conduit is to stub out in a hard ceiling area, unless access-panels are provided. Access panels shall be a minimum of 3'x4' in dimension
- The conduits shall be reamed at both ends and equipped with bushings.
- Conduits which feed modular furniture are considered "feed points". These conduits are sized according to the number of cables and outlets served, typically as 2-inches in diameter. These conduits may terminate on backboxes for use as a pull point during cabling installation. The use of flex conduits to enter the modular furniture cabling channel is unacceptable. Flexible metallic conduit up to two feet in length will be accepted to route between feed points and modular furniture. For distances greater that two feet, metallic raceway is required.
- Conduits between Telecommunication Rooms that provide pathway for riser and backbone cables shall be sized as a minimum of three (3) 4-inch conduits. If the conduits penetrate from below, the conduits will stub up at least 3 inches. If the walls of the Telecommunications room are penetrated, the conduits shall stub out 1 to 2 inches.
- Conduits that continue through the IDF room shall be suspended with an independent unistrut or trapeze system. Conduits shall not be attached to cable tray suspension systems or other suspension systems used by other trades.
- Conduits must be fire-stopped after cabling is installed.

5.6 Outside Plant System Underground Conduits

The Outside Plant Conduit System provides inter-building pathway for communication cable(s) and services. The conduit system is typically a combination of a number communication vaults, maintenance holes (MH), hand-holes (HH), pullboxes and conduit runs.

Maintenance Holes are typically used in main and branch conduit systems that require four or more trade size 4 conduits. Because of the maintenance vehicular traffic on campus, all manhole/pullbox locations shall be considered as placed in traffic areas and designed with H-20 lids. Unless directed to the contrary by WVMCCD-IS, the typical Maintenance Hole shall have center conduit window and be a Type A configuration as defined in ANSI/TIA/EIA-758. The Maintenance Hole shall be a pre-cast unit and shall

contain all necessary hardware such as, but not limited to cable racking, pulling iron, and provisions for bonding and grounding.

Hand-holes differ from Maintenance Holes in that they provide full access the entire space inside the hole, i.e. you can stand in a Hand-hole with your head above finished grade. Hand-holes are usually pre-cast and also require the same hardware as a Maintenance Hole.

It is the expectation of WVMCCD-IS that the following information will be used in the design of the Telecommunications Conduits and annotated as needed on the Electrical Site Plan.

5.6.1 Underground Conduits

- All buildings will be provided with a minimum of three (3) 4-inch conduits fed into the Building Telecommunications BDF Room from the nearest site maintenance hole.
- Telecommunications conduits are to be 4” in diameter, schedule 40 PVC or equivalent.
- If the conduits penetrate from below, the conduits will stub up at least 3 inches.
- If the walls of the Telecommunications IDF Room are penetrated, the conduits shall stub out 1 to 2 inches, and conduits shall pass through the wall at an upward angle so water will not drain into the room.
- Telecommunications conduits shall be positioned in the trench using pre-formed, interlocking conduit spacers, and not hand-fashioned rebar/wire apparatus.
- Telecommunications conduits shall be placed a minimum of 30” from finished turf, and preferably 36”.
- Telecommunications conduits shall maintain a separation of 12” of packed soil or 3” of concrete from electrical conduits.
- A slurry cap shall be installed above the telecommunications conduits.
- A metallic location tape shall be placed 12” above the top of the conduits.
- Changes in direction for conduits will occur outside of the maintenance or handhole at a minimum of 20 feet from the maintenance or handhole. The conduit runs will contain no more than cumulatively, 180 degrees of bend between pull boxes, vaults/manholes or the Building Telecommunications Room. This includes the turn from horizontal to vertical when entering the Building Telecommunications Room from below.
- The maximum length between pull boxes/vaults shall be 500 feet.
- Conduit bends shall be sweeps. All conduits shall have a minimum bend radius 10-times the diameter of the conduit.
- The conduits will have plastic bushings at the building side end.
- A 3/8” nylon pull rope with a minimum of 200 pounds of pulling tension will be installed in all conduits and or innerduct.
- A measurement tape shall be installed in one conduit of a parallel bank of conduits.

- All conduits, sub-channel or innerducts shall be sealed at the building end to prevent rodents, water, or gases from entering the building.

Note: WVMCCD-IS does not typically install innerduct in Outside Plant conduits.

5.7 VAULTS

Vaults and maintenance holes provisioned for telecommunications are typically dedicated pathway for fiber data and voice copper backbones. Fire Alarm fiber backbones are also routed through telecommunications vaults in a dedicated conduit through the outside plant system. Telecommunications vaults and maintenance holes will adhere to the following design requirements:

- Minimum size of the telecommunications vault is 4'x 6'. All vaults and maintenance holes must be sized for the current conduit need with a minimum of 30% spare capacity, WVMCCD-IS prefers the PG&E 4686 vault as a standard vault for use on campus.
- Conduits shall penetrate the narrow end of the vault at right angles. Cabling will be pulled straight through the vault. Directionality changes to cable routing will occur in the conduit path.
- Vaults will contain cable support rails on long walls so that cables will not accumulate on the bottom of the vault.
- All cabling will be suspended on the cable support rails with ample slack. Cables will not be stretched taunt or "banjoed" through a vault. Cables will be labeled with permanent labels at the rail suspension.
- Maintenance holes shall be equipped with corrosion-resistant pulling irons and a ground rod.
- Vaults will be provisioned with H-20 traffic rated lids.
- Preferred placement of vaults is in paved areas. Vault placement in turf or landscaped areas is to be avoided so as minimize water accumulation from irrigation.
- Vaults will have a 12" sump drain hole so as to allow water egress.
- Vault and maintenance hole lids will be marked as "Communications" cast on or equipped with markings that will withstand outdoor heat and moisture environmental erosion. Maintenance hole numbers shall be etched on the lids after installation. Coordinate with WVMCCD-IS for maintenance hole and pull box numbering.
- Conduits will enter maintenance holes through knock-out panels or pre-cast conduit openings. All conduits will be sealed to prevent the intrusion of water, rodents or other matter. If duct plugs are used, the pull ropes shall be tied to the duct plugs at either end of the conduit run.

5.8 TELECOMMUNICATION OUTLETS

Close coordination between the Architect, the Electrical Engineer and Telecommunication Designer is required to ensure that Telecommunication outlets are not placed behind casework, panels, storage cupboards, or other items that would mask access to the outlets.

Telecommunications outlet locations in offices must be coordinated with the furniture layout, particularly in the case of modular furniture/cubicles and built-in furniture. Power outlets shall be installed within two feet of each telecommunications outlet box. Electrical outlets locations are coordinated to be installed at the same height as the telecommunications outlet, which is **+18" AFF.**

5.8.1 Wall Outlet Boxes

The standard telecommunication outlet shall consist of a 5" square RANDL Telecommuications outlet box with one (1) 1-1/4" trade size conduits that will stub out to the closest accessible ceiling space. The end of the conduit stub-up shall be angled such that the cables are not bent against the conduit edge as they transition to J-Hook/sling or cable tray infrastructure. All conduits shall be equipped with bushings. Stub-ups will be equipped with a J-Hook/sling directly above or be within 6" of a cable tray run. The outlet box shall have a single gang mud ring. Mounting height shall be +18 inches AFF in offices and +6" above counters, and +18 inches AFF for outlets in classrooms, and conference rooms. Specialty heights for LCD displays, utility rooms and display cases will be coordinated during the design discussions. The typical communications outlet will contain four Category 6A cables.

5.8.2 Wireless Access Point Outlets

Placement of access point locations shall be designed with the direction of WVMCCD-IS. For support in conference rooms, classrooms, corridors and other specified areas, ceilings will be installed with telecommunications and power outlets to support wireless access points. The cabling shall be terminated on an outlet backbox, identical to those used for wall outlets. An independent support for the backbox and its **15'** service loop is required. A power outlet, adjacent to the telecommunications outlet is required. The data and power outlets shall be separately suspended in the ceiling space, independent of all other infrastructure support systems.

The outlet shall be accessible by the removal of the ceiling tile directly below it. Under no circumstances should the outlet be mounted higher than 12" AFC in the ceiling cavity such that maintenance access requires a WVMCCD staff person to crawl into the ceiling cavity. Likewise, the outlet shall not be obscured by ducting, pipes cabling or other apparatus that would interfere with maintenance access.

For wireless support to areas exterior to the building, a 2" conduit shall be routed to a weatherproof mounting where an external access point or antennae may be installed. These locations will be custom identified and designed for each building project. Placement of the exterior wireless apparatus will require the design coordination with the

structural engineer and architect. The fundamental design requirements are to provide as robust a wireless signal as possible, with a minimum of visual and structural impact. Exterior wireless connections will require penetrations through the roof or exterior wall such that water-tight routing of data cabling and power to the wireless location is available. At the exterior access point location, a mast or dish type of antennae is installed, with connection to either an exterior or interior mounted access-point device. Since the wireless product offerings are rapidly changing, specific devices and their mounting requirements will be coordinated during the construction phase.

5.9 FLOOR OUTLETS

Refer to the Architectural Section for additional details about floorboxes.

5.9.1 Floorboxes

Floor boxes will be used in limited locations where connectivity is needed for islands of computers/desks, in order to alleviate the incidence of power and data cables straddling across floors. Refer to Section 3 Architectural for basic information about floorbox construction and installation.

- Floorboxes may contain cabling for voice/data, audio-visual and power.
- Floorboxes shall be installed to maintain a completely discrete separation between voice/data, audio-visual and power compartments. Each cabling system will be provisioned with separate conduits to the compartment for that cable type.
- Voice/data compartments shall be provisioned with a- 1-1/4” conduit that may contain up to four cables. The quantity and distribution of cabling in a floorbox will be determined during the design phase

For each floorbox location, a review of the connectivity density and need will determine the type of box to be used. The selection of floor box will be coordinated with WVMCCD-IS.

5.9.2 Floor Poke-thrus

WVMCCD-IS prefers that the use of floor poke-thrus be minimized and considered only on an exception basis. Poke-thrus must be of metal construction. Poke-thrus that provide plastic fittings and outlet covers do not provide sufficient durability for the foot traffic that is prevalent in WVMCCD rooms.

If floor type requires poke-thru apparatus, the poke-thrus must conform to the following:

- Each poke-thru must be provisioned with a discrete conduit for the data cables. The conduit must be trade size 1-1/4” as a minimum. All poke-thru conduits shall be equipped with appropriate bushings and hardware so that the cable is not damaged during installation.

- Poke-thrus may contain voice/data, audio-visual or power cabling. Poke-thrus with combinations of cabling are acceptable if the voice/data, audio-visual or power conduits are completely discrete.
- Cabling from the poke-thru must be routed back to the Telecommunications Room on the floor where the poke-thru is installed. Cabling from poke-thrus shall not be terminated on the lower floor.
- Poke-thrus must be equipped with appropriate jack fittings to match the Systimax data/voice jacks.

5.10 Fire Stopping of Penetrations

Each Telecommunications IDF Room is designed as a 1-hour fire-rated room. This will require either a cable tray entrance with suitable fire-stop system or numerous 4-inch sleeves through the wall suitably fire-stopped around and inside the sleeves with intumescent materials that will preserve the fire rating of the wall. Alternative fire-stopping products such as EZ-path sleeves are acceptable if they are installed in sufficient quantity to maintain the 40% fill ratio and fire rating of the cabling penetration.

The drawings shall show the location and type of fire stop systems to be used. All penetrations are to be sealed at the completion of the cabling installation. If the cable contractor returns to run additional cable, the seal will be broken, cable installed and then the systems will be re-sealed by the cable contractor.

5.11 Equipment Specifications

All network (switch, router, wireless), computer, Voice/Voicemail or other active equipment shall be procured in a discrete bid and acquisition process that is independent of the building construction. As such, specifications and bid documents shall NOT include descriptions of active components or equipment. A building-wide UPS that supports the electrical panels from multiple IDFs may be included in specific building designs. This will be evaluated on a project-by-project basis.

6 Mechanical (HVAC)

The following information is the basic guidelines for the Mechanical Engineer. These design guidelines are to be considered to be minimum requirements. The HVAC Designer shall contact WVMCCD-IS to determine if there are any other or special requirements. In addition to the requirements of the Telecommunication Rooms, WVMCCD-IS has a vested interest in how thermal dissipation of desktop devices and special equipment is handled.

6.1 GENERAL

- All Building and Telecommunications BDF/IDF Rooms require HVAC 24 hours per day and 365 days per year, controlled independently of adjacent rooms. If the building's HVAC system cannot meet this requirement, then a stand-alone HVAC system with independent controls for the various Telecommunication Rooms shall be installed.
- The HVAC unit will not be powered from the same electrical panel as the Telecommunication IDF Rooms.
- BTU load estimates will be provided during the design phase.
- Placement of a wall-mounted split system or HVAC duct work will be such that the cold air blows onto the front of the network switches in the rack. The air flow will not be blocked by cable runway, service loops or any other infrastructure in the Telecommunication IDF Room.
- If copper drains are required, the copper pipes shall route along walls away from cabling and equipment, to minimize the possible impact if a seal/weld starts leaking water or condensation, Drip pans shall be installed as needed.
- In larger or critical installations, the air conditioning system (or that part of a larger system) may have to be connected into a backup generator system. Provisions must be made so the telecommunications or network equipment will not be exposed to excessive operating temperatures due to a loss of power to the air conditioning system. This shall be coordinated with WVMCCD-IS.
- A positive pressure differential with respect to the surrounding areas shall be provided.
- The ambient temperature and humidity shall be measured at the distance of 5' above the floor level. After the equipment is in operation, the measurement can be taken at any point along an equipment aisle centerline. The normal temperature range is 65^{O}F to 80^{O}F with a humidity range of 20% to 55% relative.
- Since the Telecommunication IDF Room(s) are fire-rated, fire/smoke dampers will be required for supply and exhaust air.
- Other than feed/drain piping for BDF/IDF HVAC systems or fire suppression lines that terminate in the BDF/IDF, no water feed or drain piping will pass through the BDF/IDF.

6.2 Coordination with Maintenance and Operations

While WVMCCD-IS will act as a focal point for all issues associated with Telecommunication IDF Rooms, computers and network equipment, the Mechanical Engineer must coordinate with the WVMCCD Facilities department to address global HVAC design for each renovated space. This includes identification of all mechanical control equipment (JACEs, EMS panels, controllers, etc.) that require a modem or ethernet connection, such that proper cabling can be designed into the project.

Note that all mechanical control equipment (JACEs, EMS panels, controllers, etc.) will be installed in mechanical spaces and provisioned with telecommunications outlets as need. Mechanical control equipment (JACEs, EMS panels, controllers, etc.) will NOT be located in the Telecommunications BDF/IDF Rooms.

7 Telecommunications

This section clearly describes the roll of the Telecommunications Designer. Although some electrical engineers have training in the design of a telecommunications infrastructure as a side specialty, WVMCCD-IS requires that the A&E team provide a specialist whose primary job responsibility is Telecommunications Design.

7.1 TELECOMMUNICATION DESIGNER

The primary role of the Telecommunication Designer is to act at the direction of WVMCCD-IS to provide a Telecommunication Cabling Design for WVMCCD new building and modernization projects. The Telecommunication Designer shall be retained by the Architect as part of the design team. The Designer shall:

- Ensure all information in this Standard is followed by the Architect and other Designers.
- Identify discrepancies and bring them to the attention of the design team for correction. If the discrepancies are not corrected by the Architect or other Designers, the discrepancy is to be immediately brought to the attention of WVMCCD-IS
- Develop a Telecommunication Cabling Design based upon the current, published EIA/TIA Standards, the latest BICSI Manuals and this Standards document. The design documents shall include, but may not be limited to:
  - Drawings which consist of:
    - Legend
    - Site Plan showing OSP conduits, vaults, routing, etc.
    - Floor plans showing outlet locations and the type and number of communication cable(s) to be installed at each outlet, in walls, floors, and above-ceiling spaces.
    - Cable Infrastructure (cable pathway, outlet boxes locations, conduit, cable tray routing)
    - Telecommunication BDF/IDF Room detailed drawings
    - Single Line Drawing for copper and fiber riser and OSP backbones
    - Other construction details, including photographs of the existing infrastructure as needed to clarify the work.
  - Project Manual Specifications or Scope of Work (SOW) documentation
- Act as the point of coordination between the Architect and other Engineering teams who may depend on the voice/data infrastructure, or be designing parallel cabling infrastructures (e.g. security, EMS, etc.) All outlets for any system requiring telephone or data connectivity shall be shown on the Telecommunications Drawings.
- Review all design issues and decisions with WVMCCD-IS or its representative.

The Telecommunications Designer is responsible for coordinating with the Architect and other Designers for all Telecommunication IDF Room locations. In larger buildings, multiple Telecommunication IDF Rooms will be needed. Most frequently, this will occur

when the building has multiple floors, or when the Telecommunication IDF Rooms are situated so that the wiring length will exceed 250 feet. Every building will be examined on an individual basis. WVMCCD-IS requires the placement of centralized Telecommunications BDF/IDF Rooms, of larger size, that can service a greater area of the building.

Before actual design work commences, the Telecommunication Designer will meet with WVMCCD-IS to review these standards and determine any project-specific cabling infrastructure design requirements.

7.2 WVMCCD PRODUCT STANDARDS

The cabling materials standards were established to specify an ***Infrastructure System*** with data cabling components from Commscope Systimax. This includes, but not limited to, fiber optic backbone and riser cable, copper station cables, patch panels, faceplates, surface mount blocks and jacks, constructed in a homogeneous, standardized fashion based on Category 6A cabling infrastructure. This includes the specification of the Systimax product line as the standard, so across all buildings, the faceplates, patch panels and cabling will have the identical design, implementation, appearance and labeling. This will ensure a consistent functionality and maintenance across all buildings.

7.3 OUTSIDE PLANT

The outside plant consists of the Outside Plant (OSP) cables, support and routing structures and terminations needed to inter-connect the new building to the campus. The supporting structure includes underground (in conduit) cables, conduits, maintenance holes (MH), hand holes (HH), pull boxes (PB), and vaults. The outside plant must be designed and installed to the NESC and TIA-758 standards for Outside Plant construction. Direct buried cables and aerial cable runs are not acceptable.

7.3.1 Outside Plant Fiber Optic Cables

WVMCCD-IS has specified that each building will be provisioned with single mode fiber backbones installed as a home run to the Main Telecommunications Room servicing that area or section of campus. WVMCCD-IS has designed a backbone architecture at each campus with the following points of connection:

West Valley:	New Telecom Building
	IS Building
	Fox Center
Mission Campus:	IS Building
	Gillmor Center

OSP Fiber Optic backbone cables shall consist of Zero water peak single mode fiber. Commscope Systimax TeraSPEED cabling is the required product.

7.3.2 OSP Fiber Optic Cable Sizing

During the course of the construction projects, new and modernized buildings will be equipped with outside plant backbone cables to the Main Telecommunications BDF Room. This will consist of a 48-strand, single mode fiber cable for the data connectivity.

For Fire Alarm and AV backbones, a 12-strand single mode fiber backbone cable is required. These are discrete backbone cables routed to termination points in rooms other than the Telecommunication BDF/IDF Room.

7.3.3 General Installation Guidelines for Optical Fiber Cables

These guidelines shall be included in the workmanship descriptions in the specifications.

- Use pulling compound when necessary; pulling compound must be a water-base pulling lubricant that will not deteriorate the cable or conduit.
- All cable/cabling shall be kept 30 inches away from any heat source; i.e., steam valves, etc.
- Cables shall be pulled free of sharp bends, kinks, twists, or impact damage to the sheath.
- Cables shall not be pulled across sharp edges. All conduits and sleeve with rough edges will be provided with bushings on both ends. Cables shall not be forced or jammed between metal parts, assemblies, etc.
- Cables shall not be pulled across access doors and pull box covers. Access to all equipment and systems must be maintained.
- Cable splicing will not be permitted at any point within a cable run.
- Conduits will not be filled to greater than a 40% fill.
- Outside Plant Conduits must have appropriately size pull-boxes every 500 feet. When the conduit routes through up to a total of two 90 degree bends (180 degrees total) in any direction/plane, additional pull-boxes are also required. Outside Plant Conduits shall conform to the additional design guidelines detailed in Section 6 of this document. Cabling will not be installed in conduits that do not meet these specifications.
- Backbone cables will be installed with a 30 foot service loop in the Telecommunications BDF Room and in the vault at each building end. The service loops will be coiled neatly in the nearest pull box, vault or maintenance hole to the building's exterior wall.
- Cables will be labeled in each vault, pull-point, building entrance, service loop and termination point.
- Cable mountings and service loops on backboards inside Telecommunications BDF Rooms will be installed efficiently in wall-mount cable managers to organize use of the backboard space. All cables will be routed at right angles, in accordance with the manufacturer's bend radius specifications for the type of cable being routed. Cables will be velcro-wrapped every 4 to 6 feet.

- All outside plant cables will be terminated within 50 feet of the entrance point. This is a maximum measurement for cable length inside the building and includes lengths for service loops, routing, backboard support and patch panel mounting.
- Polarization for entire system shall be maintained as described in TIA-568.
- All optical fiber cables for data connectivity shall be terminated on SC connectors in rack-mounted optical fiber patch panels. No fiber will be left unterminated.
- Single mode fiber provisioned for Fire Alarm or AV backbones will be terminated in LC connectors, in separate wall-mount patch panels adjacent to the specific control panels in the designated rooms for each building.

7.3.4 Copper Outside Plant Cables

Buildings will be cabled with a limited size of multi-pair copper backbone cables for connectivity to analog telephones, facsimile machines and other devices. All pair counts for backbone copper cabling will be verified with WVMCCD-IS during the design phase. The cabling will be home runs, with no splices. The design of the backbone cabling and routing will be determined in conjunction with WVMCCD-IS staff to appropriately identify, telecom rooms or the MPOE where adequate connectivity is available.

Physical Characteristics:

- Backbone UTP copper cables shall consist of a core of 24 AWG solid annealed copper conductors, color-coded in accordance with telephone industry standards.
- As a minimum, UTP copper backbone cables will be UL Verified Category 5 and will meet or exceed the Category 5 requirements in ISO/IEC 11801, CENELEC EN50173 and TIA 568C.
- The cable will be designed for use in the outdoor environment, with a gel-filled design to be used in wet locations. This includes an aluminum steel with polyethylene (ASP) sheath and a core of solid-copper conductors, dual insulated with foam skin and plastic, and surrounded by a gel filling compound. ANMW is preferred.
- Outside Plant Cable installations will meet all ISO/IEC 11801 requirements for a horizontal link. No more than 4 cross-connections are allowed, including the protection devices at each end.

7.3.5 General Installation Guidelines for Copper Cables:

These guidelines shall be included in the workmanship descriptions in the specifications.

- Use pulling compound when necessary; pulling compound must be a water-base pulling lubricant that will not deteriorate cable or conduit. Adhere to all manufacturers' requirements regarding pulling tension and allowable lubricants.

- All cable/cabling shall be kept 30 inches away from any heat source; i.e., steam valves, etc.
- Cables shall be pulled free of sharp bends, kinks, twists, or impact damage to the sheath.
- Cables shall not be pulled across sharp edges. All conduits and sleeve with rough edges will be provided with bushings on both ends. Cables shall not be forced or jammed between metal parts, assemblies, etc.
- Cables shall not be pulled across access doors and pull box covers. Access to all equipment and systems must be maintained.
- Cable splicing will not be permitted at any point within a cable run.
- All outside plant backbone cables will be installed in conduit. Aerial and direct burial runs are not permitted.
- Conduits will not be filled to greater than a 40% fill.
- Conduits must have appropriately size pull-boxes every 500 feet. When the conduit routes through up to a total of two 90 degree bends (180 degrees total) in any dimensional plane, pull-boxes are also required. Outside Plant Conduits shall conform to the additional design guidelines detailed in Section 6 of this document. Cabling will not be installed in conduits that do not meet these specifications.
- Backbone cables will be installed with a 30 foot service loop. At each building, the service loops will be coiled neatly in the pull box or nearest hand hole to the building. Cable mountings and service loops on backboards will be installed efficiently to minimize the backboard space consumed. All cables will be routed at right angles, in accordance with the bend radius specifications for the type of cable being routed. Cables will be tie-wrapped every 4 to 6 feet.
- Cable shall be continuous and without splices.
- All actual cable distances will be verified.
- All outside plant cables will be terminated within 50 feet of the entrance point. This is a maximum measurement and includes lengths for service loops, routing, backboard support and patch panel mounting inside the building.
- Copper service loops will be provided around the periphery of the backboard, securely mounted to D-rings or other cable management apparatus.

7.3.6 Copper Protection

All copper backbone cables that extend between buildings will be terminated at both ends on protector blocks. In the West Valley and Mission College MPOEs, the protector terminal is a rack-mount Porta Systems XLBET. OSP cabling shall splice onto tails provided by the fused terminals. All splicing apparatus, including splice case, splice modules, grounding, etc., shall be included in the project.

In the MPOE, if insufficient fused terminals are available, the project shall add panels, in rows of 300 pairs, fully populated with fuses, regardless of the pair count needed for that specific building project.

In the buildings:

- All pairs of the copper backbone cable shall be protected.
- The protector blocks will be housed within a covered case. Protectors will be sized for the termination of all pairs in the copper backbone cable.
- The protector blocks shall be fully populated with solid-state or gas-tube protection fuses on **all** pairs.
- The protector blocks will contain an integrated 110 block for extension to the building cross-connect blocks, or patch panels as determined for each building.
- The protection block shall have an integrated 26 AWG stub.
- The protection blocks shall be grounded with a #6 AWG copper bonding conductor between the protector ground lug and Telecommunications Grounding Busbar.
- Copper extension cables shall be installed from the protector blocks to the copper patch panels, extending one pairs per jack. See also section 7.6

In the event that copper backbone cabling is added to building areas where existing cabling is not protected, the Contractor shall retrofit the existing cabling with protector blocks according this standard.

7.4 RISER CABLING

WVMCCD campuses have a limited number of multi-story buildings. In addition, the layout of the buildings may require several distributed closets to allow station cabling to stay within the 250 foot length limitation, or to accommodate difficult or limited cabling pathways. As such, the installation of "riser" cabling includes vertically stacked Telecommunication IDF Rooms, or horizontally dispersed Telecommunication IDF Rooms.

7.4.1 Fiber Optic Riser Cable.

Buildings that contain multiple Telecommunications IDF Rooms will require fiber backbone cabling installed between the rooms. All riser fiber backbones will consist of, at a minimum, a 24-strand single mode fiber cable. Multimode cabling is not used. The standard is Commscope TeraSPEED zero-water peak single mode fiber.

The type of riser cable will be UL listed OFNP rated. This type of cable will be placed in vertical shafts and plenum spaces with the use of conduit. Innerduct is not required for stacked risers. Filled-core Outside Plant or indoor/outdoor cable will not be used for interior backbone cable.

7.4.2 Riser Multi-pair Copper Cable

The riser pair count shall be determined in discussion with WVMCCD-IS. Cable sizes will be rounded to the next multiple of 25, 50 or 100 pairs.

The cable shall be Category 5 UL listed CMP rated. All pair counts for riser multi-pair copper cabling will be verified with WVMCCD-IS during the design phase. All riser pairs will be terminated on patch panels, one pair per jack.

7.5 OPTICAL FIBER TERMINATIONS

7.5.1 Fiber Patch Panels/Shelves

Optical fiber patch panels shall meet or exceed the following specifications:

- Must be rack mounted (for data).
- Must be configured in duplex SC style termination configurations.
- Must be completely covered.
- Must be available as a 4U high-density shelf for Main and Building Telecommunication Room installations, or 24-connector 2U sliding trays for smaller Telecommunication room backbone terminations where fiber counts are less than 24 fibers.

For Fire Alarm and AV fiber, the fiber patch panels will be wall-mount and placed above the Fire Alarm panel or in the AV equipment room. Locations will be coordinated during the design phase.

7.5.2 Optical Fiber Connectors - Data

Field termination is required for **all** fiber strands in the telecommunications closets.

- All connectors are to be glass-in-ceramic SC-compatible duplex connectors with caps to prevent contamination.
- SC connectors shall meet TIA-568 standards.
- Connectors must have a locking feature to the coupler to prevent optical disconnect.
- Adhere to all manufacturer installation guidelines.
- Single mode duplex connectors shall be blue.
- The maximum insertion loss per each mated field installed connector pair shall not exceed 0.75 dB.
- The total optical attenuation through the cross-connect from any terminated optical fiber to any other terminated fiber shall not exceed 1.5 dB.
- Single mode fiber shall have a return loss greater than or equal to 26 dB.
- The connectors shall sustain a minimum of 500 mating cycles without degrading this performance.

Note: For AV and Fire Alarm backbone connections, the cabling will terminate on LC connectors.

The connector ends, length and quantity of fiber patch cords will be determined in the design phase. Duplex patch cords for all fiber strands pulled are required, and will be included in the project scope.

7.6 COPPER BACKBONE TERMINATIONS

All **new** copper backbone cables will be extended from the protectors to be terminated on rack-mounted patch panels, one pair per RJ-45 jack. This will facilitate moves and changes via patch cords from the station jack instead of cross-connect wire. For backbone cables, this means new cabling will be extended from the wall-mounted Building Entrance Protectors to rack mount patch panels.

7.7 HORIZONTAL STATION CABLE

The current cabling standard is the Commscope SYSTIMAX Category 6A standard previously referred to as Augmented Category 6. To support a complete Category 6A channel, all cabling components will be certified for Category 6A transmission. This includes patch panels, patch cords and outlet jacks.

Plenum cabling rated as "CMP" is required for all new installations of cabling at WVMCCD sites. Although functionally identical, station cabling for different transmissions systems shall be cabled with different colors cable sheaths for ready identification. The cable sheaths will be blue for data and white for voice. **Other low-voltage subsystems must specify cabling with different color sheaths, so as to avoid confusion with voice/data cabling**. The Telecommunications Designer will coordinate with designers of other cabling systems to ensure that cable sheath colors are kept discrete.

7.8 VOICE/DATA JACKS

Although the cabling infrastructure for voice and data jacks is functionally identical, at the work area outlet, the modular jacks shall be color coded to designate the preferred purpose of the jack. The jack colors are white for voice and blue for data.

Voice/Data jacks shall be 8-position modular jacks and shall be Category 6A performance as defined by the references in this document including TIA 568 performance requirements. All pair combinations must be considered, with the worst-case measurement being the basis for compliance.

Modular jack performance shall be third-party verified by a nationally recognized independent testing laboratory.

- The jack shall be a punched down on a 110-IDC connector.
- The punch down scheme shall be T-568B.
- The jack shall be Power Sum rated, with a Power Sum NEXT performance equal to or better than the Category 6A pair-to-pair NEXT performance specifications, and shall have a mark to indicate compliance.
- The jack shall have all of its housing components made of fire-retardant UL 94V-0 plastic.
- The jack shall have a protective cap that snaps in the back of the module to provide strain relief for the conductors after termination.
- The jack shall have a minimum Insulation Resistance of 500 mega ohms.
- The jack shall be FCC Part 68, Subpart F compliant.
- The jack shall be IEC-603-7 compliant.
- The jack durability shall be greater than 750 mating cycles (cable insertion/removals).
- The jack maximum Current Rating shall be 1.5 amperes.
- The jack shall have caps on the front which designate “GS” for voice and “DATA” for data. All jacks will be installed with the color-coded caps.

Every station cable and patch panel jack shall be provisioned with a Category 6A patch cord. Coordinate lengths and quantity with WVMCCD during the design phase.

7.9 WORK AREA OUTLETS

The standard work area outlet configurations used on the Campus are as follows:

- **Type A:** Voice/Data outlet is defined as two (2) voice and two (2) data cables, terminated in a four-port faceplate, usually at a height of +18” A.F.F. Typical installation: offices.
- **Type B:** (wall) Data outlet is defined as two (2) data cables, terminated in a four-port faceplate with two blanks, usually at a height of +18” A.F.F. Typical Installation: classroom. This same outlet type shall be installed in above-ceiling spaces for connection to access points, projectors, IP cameras, etc.
- **Type C:** (wall) Data outlet is defined as four (4) data cables, terminated in a four-port faceplate. Height varies with installation. Typical installation: computer lab.
- **Type C:** (ceiling/confined space) Data outlet is defined as two (2) data cables, terminated in two (2) two-port, plenum SMB above the ceiling space or confined space. Typical Installation: LCD display, security gutter.
- **Type D:** Voice outlet is defined as one (1) voice cable, terminated in a one-port metal faceplate, for wall-mount telephones at a height of +42” A.F.F. Typical installation: classroom, corridor. Telephone clearance required as 12” on all sides from center jack.

All outlets are provisioned with a 5" square RANDL Telecommunications outlet box with a 1-1/4" conduit stubbing up into the ceiling space.

Note that except for wall-mount telephones, all outlets are provisioned in pairs or quads numbers. Single-cable outlets are NOT permitted. Any of these outlet types may be designed for above counter use, in which case, the height is modified to be +6" to +8" above the finished counter height. Refer to Section 9 for typical faceplate drawings.

7.10 OUTLET DISTRIBUTION

The typical outlet styles described in the preceding section will be installed according to room function. In addition to the general outlet information detailed in Section 3.11, the following specific outlets types are required for each room:

Room Type	Outlet Types
Single-Person Office (~80 sq. ft.)	One (1) Type A outlet on three walls (+18" A.F.F.)
Two Person or Administrators office (110-120 sq. ft.)	Three (3) or Four (4) Type A outlets distributed on walls according to furniture layout. (+18" A.F.F)
Cubicle/Partitioned Office	One (1) Type A outlets per cubicle and one additional Type A outlet per group of six cubicles. Routing will be through modular furniture communications raceway/trough as available. Outlet provisioned with custom fittings to hold jacks securely in cubicle toe-plate.
Conference room (variable size)	One (1) Type A outlet (+18"AFF) on front wall by "whiteboard" or presentation screen. One (1) Type A outlet every ten feet of wall within three feet of electrical outlets, minimum one outlet per wall. One (1) Type A outlet in each floor box, one floorbox for each six foot length of table. One (1) Type B outlet centered in ceiling by location for ceiling projector. One (1) Type C outlet behind each LCD display, if provisioned in that space. One (1) Type B outlet above ceiling for wireless AP.
Instructional Classroom	One (1) Type A and One (1) Type C outlet at instructor's station. One (1) Type B outlet above ceiling by location for each ceiling projector. One (1) Type B outlet every ten feet of rear wall within two feet of electrical outlets, minimum one outlet per wall. One (1) Type D outlet at main entrance to classroom, for wall-mount telephone. One (1) Type C outlet above ceiling for wireless AP.

	One (1) Type B outlet for IP camera, if provisioned.
Work/Prep room	One (1) Type D outlet at room entrance. Multiple Type A outlets distributed every six feet above counter top. One (1) Type A outlet at photocopier location.
Storage Rooms[1]	One (1) Type D outlet at room entrance. One (1) Type A outlet on every wall where there is an electrical outlet.
Maintenance Rooms	One (1) Type D outlet at room entrance. Multiple voice/data cables to system controllers that have modem or Ethernet connection requirements. If an office/desk for maintenance personnel are included in the maintenance room, add: One (1) Type A outlet for every desk location.
Rooftops	One (1) two-inch conduit to roof, terminated in sealed NEMA 3R 8"x8" can. Cabling provisioned according to connectivity needs. Multiple voice/data cables to rooftop HVAC or other controllers that have modem or Ethernet connection requirements routed in conduit with weatherproofing.
Outdoor equipment (e.g. Emergency Phones, corridors, foyers, parking lots, bus stops, defibrillator stations)	One (1) Type D outlet or cable with custom termination located at every location as required by security device. OSP cable required for all below grade or routing to building exterior. If data connectivity is required, 6-strand single mode powered fiber solution will be provided. Specific cabling requirements will be defined in the design phase.

Each computer lab must be custom designed, incorporating the size, purpose, furniture layout and floor type into the detailed design. As a minimum the following outlet layout is required:

Room Type	**Outlet Types**
Computer Lab (slab floor)	Instructional Classroom outlets as described above. Multiple Type C outlets distributed around room periphery, flush mounted at +18" A.F.F. Number and exact location of outlets varies with room size and placement of computer tables in room. Power poles, wiremold and pancake raceway prohibited.
Computer Lab (floorbox/poke-thru)	Instructional Classroom outlets as described above. Multiple Type C outlets distributed in floor boxes or poke-thrus

Specialty locations such as theaters, auditoriums, press boxes, large lecture halls, pools, playing fields and for scoreboards and advertisement boards require custom design according to the proposed functionality. It should be assumed that each specialty device

[1] Storage rooms are often converted to offices.

will require a data or voice connection for current or future connectivity. As a minimum, four Category 6A cables shall be provisioned for each location. Where cabling runs below grade in conduit or is routed in conduit to the building exterior, outside plant cable shall be required. Cables will be provisioned within the 250 foot length limitation for data connectivity or will be custom designed with single mode fiber.

7.11 FACEPLATES

The standard faceplate configuration is single-gang faceplate providing for four ports of connectivity. Configurations of any additional number of ports are subject to the approval of WVMCCD-IS.

- The faceplate housing the jacks shall provide a symmetrically centered appearance for the modules.
- Snap-in inserts shall be provided to cover any unused openings in the faceplate. Inserts are removable for future installation of additional jacks.
- It shall be possible to install the jacks in wall-mounted single- and dual-gang electrical boxes, utility poles and modular furniture (cubicle) access points using manufacturer-supplied faceplates and/or adapters.
- The faceplate housing the jacks shall have a labeling capability using built-in labeling windows, to facilitate outlet identification and ease network management.
- The faceplate housing the jacks shall accommodate up to a maximum of four modules in a single-gang form.
- The faceplate housing the jacks shall provide flexibility in configuring multimedia workstation outlets that respond to present of future network needs such as audio, video, coaxial and optical fiber applications.
- The color of the faceplate shall be coordinated with the color of the surrounding electrical outlets, usually as Electric Ivory or Electric White. No metal faceplates will be allowed, except as required for extra durability at wall-mount telephone locations.

The required product is the Commscope Systimax MLE faceplate.

7.12 COPPER PATCH PANELS

7.12.1 Station Patch Panels

Category 6A patch panels will be used for termination of all voice and data station cabling. Category 6A patch panels shall meet or exceed the following specifications:

- EIA/TIA Category 6A standard.
- Rack mounted with front-facing RJ-45 patch panels and using rear-facing snap-in termination managers for cable installation.
- Angled design to facilitate patch cord access.

- Will be T568-B wired.
- Have a paired punch down sequence to allow pair-twist within ½-inch of the termination. Equipped with Cable Termination Manager modules to ensure minimized untwisting of station cabling during installation.
- UL listed.
- Made of rolled edge black anodized aluminum construction.
- Must have 48 ports with rear cable suspension racks.
- Must be from the same manufacturer as the other connectivity products (cable, jacks, faceplates, etc.).

Rear patch panel cable management will include the cable support bars/troughs. Category 6A requirements dictate that the cable is to enter perpendicular to the termination and the cable bar facilitates this requirement. All cable bundles on cable support bars will be managed with Velcro straps. Tie-wraps are not acceptable. Cable socks are suitable for routing, but must be transitioned to Velcro bundles at patch panel terminations.

Station patch panels will be organized according to the following design:

- A maximum of five (5) patch panels will be provisioned per relay rack.
- Data will be divided into D1 and D2 patch panels (Note: There are no D3, D4 jacks.)
- Voice station cables will be terminated onto separate patch panels.

In all drawings, the contractor shall be instructed to "Verify patch panel layout with WVMCCD-IS before installation".

7.12.2 Voice Backbone Patch Panels

Voice backbone cables shall be extended from the Protector terminal to rack-mounted patch panels. The patch panels shall conform to the following specifications:

- EIA/TIA Category 5 standard.
- Rack mounted with front-facing RJ-45 patch panels and rear-facing 110 blocks.
- Angled jack mounting to facilitate patch cord access.
- Wired with one pair punched down per jack, 25th pair coiled as a test point.
- Have a paired punch down sequence to allow pair-twist within ½-inch of the termination.
- UL listed.
- Made of rolled edge black anodized aluminum construction.
- Must have 48 ports with rear cable suspension racks.
- Must be from the same manufacturer as the other connectivity products (cable, jacks, faceplates, etc.).

7.13 GROUNDING AND BONDING

The Telecommunication Designer will work with the Electrical Designer to insure a Telecommunication ground system is installed per J-STD-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications. This Telecommunications Ground System shall be installed to support the Information Technology Rooms and Infrastructure. The design of the grounding infrastructure is described below.

A Telecommunications Main Grounding Busbar (TMGB) shall be located in the Building Telecommunications Room. The TMGB shall be a predrilled copper busbar provided with standard NEMA bolt hole sizing and spacing. The TMGB shall be electrotin-plated for reduced contract resistance. The TMGB shall be a minimum size of 0.5 inch thick, four inches wide and 24 inches in length. The TMGB shall be insulated from its support by a 2-inch separation.

The TMGB will be bonded to the electrical panel ground bus bar and to building steel or ground rod by conventional welds, exothermic welds clamp-and-braze method, or UL approved compression type connectors where practical. Exothermic welds are the preferred method. Because of the high temperatures involved, copper materials may be bonded to iron or steel. The mold size must match the cable or conductor cross section. The size of the weld metal charge must match the size of the mold being used. The connection between the TMGB and the bonding point is to be 3/0 insulated copper ground wire.

In each Telecommunications room, a Telecommunications Grounding Busbar (TGB) shall be installed. The TGB shall be a minimum size of 0.5 inch thick and two inches wide and 12 inches long. The TGBs shall be bonded to the electrical panel serving the rooms were the TGB is installed, bonded to building steel, and bonded in series to the main TMGB.

All metallic structures (racks, cabinets, cable runway, etc.) shall be attached to the TGB using grounding straps. Use minimum of #6 AWG, green jacket, stranded grounding wire between all equipment racks and the existing telecommunications grounding busbars. Metallic straps shall be used to join individual segments of cable runway, relay racks, equipment and other metallic structures. All metallic structures will be stripped of the paint coating at the point of grounding connection to ensure that the metallic straps and ground wires mate to the metal structure with sufficient contact.

The electrical contractor shall install and bond the main components of the system (busbar, ground rod, ground wire to grounding source, etc.) The cabling contractor shall install the connectivity to the metal components of the cabling system, including voice protectors, racks, cable runway, cabinets, patch panels, etc. All TMGB and TBGs shall be mounted on the backboard at +96” A.F.F.

7.14 RACK/CABINET LAYOUT (ELEVATION)

All equipment in racks must follow the general guidelines provided below in regards to placement within the rack or cabinet.

Fiber Patch Panels: All fiber patch panels shall be placed at the highest point possible in the rack or cabinet. Fiber patch panels will have integrated cable management in the front and cable guides in the rear.

Copper Patch Panels: All copper patch panels will be installed below the fiber patch panels. The copper patch panels shall be divided according to the following station cabling:

a) voice patch panels: contains all voice V1 and V2 jacks
b) data "D1" patch panels: contains all data D1 jacks from every outlet
c) data "D2" patch panels: contains all data D2 jacks from every outlets

Placement of the copper patch panels on the racks shall be individually designed for each Telecommunications Room. In all drawings, the contractor shall be instructed to "Verify patch panel layout with WVMCCD-IS before installation".

7.15 FLOOR MOUNTED RACKS

All racks will be floor-mounted, open, self-standing relay racks. Racks shall meet the following physical specifications:

- 19-inch wide rack mounting space.
- 84 inches high.
- Lightweight aluminum construction.
- Black polyurethane finish.
- Equipped with four (4) ¾-inch bolt-down holes.
- Each rack shall have double-sided tapped holes with standard EIA hole pattern.
- Zone 4 seismic installation rated.

Each rack will have an integral vertical cable channel with a minimum of 6.5" of channel space to facilitate the vertical cable management of the cables entering the rack from the under floor and above ceiling cable tray. Each rack will be supplied with a bag of bolts matching rack color and threading. All racks will be installed with a minimum of 3' of clearance from the mounted equipment on front and rear sides. All racks shall be properly anchored to the slab floor using all four (4) holes. Per DSA approved design, the anchoring will use Hilti ½" anchor bolts which pass a 45 lb torque test.

Per grounding described above, each rack will be grounded separately to the TGB with a minimum #6 AWG copper wire.

7.16 FLOOR MOUNTED CABINETS

When Telecommunication IDF Rooms must coexist with infrastructure for other electrical or low voltage systems, the Telecommunication infrastructure will be completely concealed in lockable telecommunication cabinets. **This is typically only specified in semi-permanent spaces, not permanent Telecommunication IDF Rooms.**

Floor-mounted cabinets are required. These cabinets will be

- Self-standing structures.
- Sized as a 24”W x 24”D x up to 84”H.
- 19-inch wide rack mounting space.
- Lockable, with common key set for all cabinets from one manufacturer.
- Black in color, with smoked glass, removable front and back doors and vented side panels.
- Equipped with circulation fan.
- Equipped with manufacturer provided seismic kit, rated for Zone 4.
- Contain internal adjustable rails upon which patch panels, wire managers and network equipment shall be installed.
- Contain knockouts for fans and cable routing. Any knockouts used for cable routing will be wrapped with bushings to prevent the rough edges of the knockout from damaging the cabling.
- Zone 4 seismic installation rated.

All cabinets shall be mounted with a minimum of 3 feet clear access in front, back and sides of cabinets. All cabinets shall be properly anchored to the slab floor using manufacturer-provided seismic bracing kit. Per DSA approved design, the anchoring will use Hilti ½” anchor bolts which pass a 45 lb torque test.

Per grounding described above, cabinets will be grounded to the TGB with a minimum #6 AWG copper wire.

7.17 CABLE WIRE MANAGEMENT

Vertical cable management will be provided for all racks. Vertical cable managers with covers are required on all racks and in between racks to facilitate cable management and routing between the racks. The vertical cable managers will be the finger-duct style with integrated cable guides, designed for Category 6A cabling. A minimum size of a 12”Wx 8”D channel is required on each side of the rack.

Vertical cable managers will be double-sided with lockable hinged covers that can be opened in either direction or removed completely. Pass-through slots will provide access from the front to rear cable channels. Vertical cable managers will be sized to extend the complete length of the relay rack. The covers will be one piece for the entire height of the rack.

All cable bundles inside of cable managers will be managed with Velcro straps. Tie-wraps are not acceptable.

7.18 CABLE RUNWAY

All exposed cabling run horizontally in a Telecommunications IDF Room must be routed using cable runway (ladder rack).

- Cable runway shall be appropriately secured to walls and top of equipment rack/cabinet per manufacturer recommended guidelines.
- Cable runway shall be sized to be 18" wide.
- Cable runway shall be equipped with waterfalls and other cable guides to correctly support the cables as they transition to from the runway to the patch panel terminations.
- Cable runway shall be grounded to the TGB using a minimum #6AWG ground wire. Metallic straps shall be used to join individual segments of cable runway. All metallic structures will be stripped of the paint coating at the point of grounding connection to ensure that the metallic straps and ground wires mate to the metal structure with sufficient contact.
- In new construction, all cable runway will be black in color. In existing spaces, installation of additional ladder rack should match manufacturer and color of existing ladder, if any exists.

7.19 CABLE PATHWAYS

In accessible main corridors, the use of a cable tray system is the preferred method for the main cable path. At least 12" of clearance is required above the cable tray and the cable tray must have a minimum clearance of 24" on one side, preferably both sides. Cable tray shall be independently secured to ceiling deck using a trapeze system and grounded per the manufacturer recommended guidelines. Cable tray may be basket design if concealed fully in ceiling spaces. Solid sided/bottomed cable tray is required if tray will be visible. Where cable tray crosses inaccessible ceiling spaces, the tray shall be transitioned to 4" conduits of equivalent cross-sectional area. WVMCCD-IS prefers that a standard size of cable tray be used throughout a building project, Typically, this is an 18" wide, by 4" deep tray, but the tray will be sized based on 40% fill of manufacturer's rated dimensions.

No apparatus, backboxes and/or alternate cabling systems shall be attached to the cable basket tray.

For distribution from the main cable path to discrete outlet locations, J-hook/sling suspension is acceptable. Cables shall be supported every 4 feet. A J-hook/sling shall be installed above every outlet location, upon which a 10' service loop of station cabling will be attached. J-hooks/slings shall be independently supported and not attached to

existing conduit, ceiling/lighting structures or other suspension apparatus. J-hooks shall be installed according to the manufacturer's instructions. J-hooks/slings shall be installed such that the hook is suspended 12" above the level of the cable tray so that cables will not be bent, kinked or stressed as they leave/enter the J-hook/sling infrastructure.

J-hooks/slings will not be overfilled beyond their specified capacity. Where dense cable runs create large bundles of cables and cable runway is not available, the cable bundles will be split and supported on multiple J-hook/sling routes. Cable bundles will not exceed 25 cables. Bundles of cable will be secured to the J-hook/sling, or use integrated clips to prevent cables from spilling out in the event of an earthquake or other disturbance. J-Hook/sling installation is included in the work of the cable installation contractor.

7.20 CABLE INSTALLATION METHODS

The Contractor shall adhere to cable installations methods that will ensure that the cabling construction is not adversely effected in any possible manner. This includes strictly adhering to the manufacturer's installation methods and workmanship described as follows:

1. When placing cable, the contractor shall maintain the following clearances from sources of electro-mechanical interference (EMI):
    - Main Power panel: 6 feet
    - Power cable - 12 inches
    - Fluorescent Lights - 12 inches
    - Heat source: 30 inches
    - Transformers – 6 feet
2. All power feeds crossing the path of the UTP cables at right angles must be a minimum of 12 inches in distance from the UTP cables.
3. The cables shall be placed at a minimum of 18 inches above the ceiling.
4. The cables are to be as accessible as possible.
5. Pull conductors together where more than one is being installed in a raceway. Cable bundles in suspension systems, or on wallboards must be velcro-wrapped every 4 feet. Strapping to any other wires (e.g. lighting ceiling grid, etc.) will not be permitted. Station wire cannot be attached to electrical conduit, gas or sprinkler piping, or other code-restricted items.
6. Use pulling compound when necessary; pulling compound must be a water-base pulling lubricant that will not deteriorate cable sheath or conduit.
7. No cabling is allowed to rest on any ceiling tile or suspension system.
8. Cables shall be pulled free of sharp bends, kinks, twists, or impact damage to the sheath.
9. Cables shall not be pulled across sharp edges. Bushings will be installed on rough sleeve or conduit edges before cable installation takes place. Cables shall not be forced or jammed between metal parts, assemblies, etc.
10. Cables shall not be pulled across access doors and pull box covers. Access to

all equipment and systems must be maintained.

11. Insulation shall be removed to expose shielding and conductors to the exact length required by manufacturer for proper termination of plugs and pins and as specified in TIA 568/569.
12. Pins and plugs, upon termination, shall not be damaged in any way.
13. Cable guides and suspensions (J-hooks, cable runway, waterfalls, etc.) shall be provided to ensure that the cable path is securely suspended and adheres to the manufacturer's bend radius.
14. Cable splicing will not be permitted at any point within a cable run.
15. Cable mountings on backboards will be installed efficiently (no divers), to minimize the backboard space consumed. All cables will be routed at right angles, in accordance with the bend radius specifications for the type of cable being routed. Cables will be velcro-wrapped every 4 feet and routed through a support structure for a neat appearance and manageability. Wall support structures will be designed and can include a wall-mounted section of cable tray, ladder rack or metallic raceway.

7.21 FIBER OPTIC CABLE TESTING AND TEST RESULTS

General Test Requirements

- The tester shall be capable of performing the tests required by TIA-568-C, and TIA-526-7.
- A manufacturer-certified calibration facility shall have calibrated the tester dated no more than 60 days prior to the start of testing.
- All testing procedures and testers shall comply with applicable requirements of TIA-568-C.
- End-to-end attenuation testing using an approved Power Meter and Light Source per TIA-526-7
- Backbone single mode fiber shall be tested at both 1310nm and 1550 nm in accordance with TIA-526-7 power meter method A.1 and OTDR method B.
- The acceptable link attenuation for backbone 8.3 to 10/125 single mode fiber based on distance shall be 1.0 dB/km @ 1310 nm and 1550 nm for inside plant.

All fiber optic cables will be tested and results will be submitted for all fibers in an electronic format and provide one (1) soft copy of the test results showing graphically, the entire length of the fiber. The Contractor shall submit (1) copy of software capable of viewing the electronic test result files. These shall be provided to WVMCCD-IS before punchlist is completed.

7.22 BACKBONE COPPER CABLE TESTING AND TEST RESULTS

The Contractor shall perform tests on the copper backbone cable (OSP and riser). The tests shall be performed from each termination block on each pair on 100% of the copper cable pairs. The end-to-end test shall include the following:

- DC Continuity
- Reversals
- Shorts
- Opens
- Overall loop resistance/cable length
- Attenuation
- Splits
- Transpositions
- Grounds
- Presence of AC voltage.

The technician will examine open and shorted pairs to determine if the error is a termination issue. If not correctable, the technician shall tag bad pairs at both ends, and make note on the as-built documentation. If copper backbone cable contains more than one percent (1%) bad pairs, the Contractor shall remove and replace the cable at the Contractor's expense.

The cable test results shall be submitted in electronic format, with the resulting file formatted with one detailed test result per 8.5-inch x 11-inch page. Test Result Summary pages are not acceptable. Files exported and saved as *.txt files will NOT be acceptable, but must be provided in the native format of the tester. The Contractor shall submit (1) copy of software capable of viewing the electronic test result files. These shall be provided to WVMCCD-IS before punchlist is completed.

7.23 UTP HORIZONTAL CABLE TESTING AND TEST RESULTS

General Test Requirements

All horizontal UTP cabling will be tested and certified to meet Category 6A standards when all pairs are terminated on a patch panel port and at an outlet port. If the overall distance between patch panel and outlet, or patch panel to patch panel, is less than 50 feet in length, then a patch cable must be added to the link to achieve the desired minimum length of 50 feet in order to verify Category 6A testing parameters.

- Testing shall conform to TIA-568.
- Testing shall be accomplished using a UL certified tester.
- Any cable failing the prescribed certification testing shall be removed and replaced at the Contractor's expense.

The Contractor shall provide Category 6A, channel test results on all pairs of cable, including but not limited to cable length, wire map, Insertion Loss, PSANEXT, and PSAFEXT up to 500 MHz. Testing will span the complete channel across the entire 1-

500MHz frequency. The cabling shall also conform to Category 6A test results for NEXT, PSNEXT, FEXT, ACRF, PSFEXT, PSACRF, PSAACRF and Return Loss up to 500 MHz. Summary test results are not acceptable.

All cables will be tested and the results and submitted in electronic format, with the resulting file capable of being formatted with one detailed test result per 8.5-inch x 11-inch page.

Files exported and saved as pdf files will NOT be acceptable, but must be provided in the native format of the tester. The Contractor shall submit (1) copy of software capable of viewing the electronic test result files. These shall be provided to WVMCCD-IS before punchlist is completed.

7.24 CABLE TESTING VALIDATION

After installation is completed and the Telecommunication Contractor has completed testing, the WVMCCD-IS reserves the right to separately test the installed cables, up to 100% using the Telecommunication Contractor testing equipment or with WVMCCD-provided computer/network equipment. Cables that have been tested and fail to meet performance requirements as stated in the specifications shall be removed and replaced with all new material and re-tested at no cost to the College. The Telecommunication Designer will verify that these requirements are reflected in the RFP or specification details.

7.25 IDENTIFICATION AND LABELING

WVMCCD-IS will work with the Telecommunications Designer to implement a consistent and unique labeling format across all IDFs in the buildings. All labels shall:

- Horizontal cables shall be marked at each end, on the sheath indicating the Telecommunications Room and jack number to which the cable is wired.
- Backbone cables shall be marked at each endpoint and at all intermediate pull/ access points or junction boxes. Label shall indicate origination and destination Telecommunication Rooms, sheath ID and strand or pair range.
- Meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- Be pre-printed or laser printed type.
- Where used for cable marking, a label with a vinyl substrate and white printing area and a clear “tail” that self laminates the printed area when wrapped around the cable shall be provided. The label color shall be different than that of the cable to which it is attached.
- Where insert type labels are used, provide clear plastic covers to go over label.
- The Contractor shall confirm specific labeling requirements with the Owner or Owner’s Representative prior to cable installation or termination.

<u>Telecommunications IDF Room Naming</u>

Each Telecommunications IDF Room will be named and numbered with an individual numeric identifier. The number is assigned by WVMCCD-IS.

Fiber Backbone Cable Labels

All backbone fiber cables (riser cables) will be labeled at each end of the cable bundle at the furthest point where the sheath is intact (before breakout). If the riser cables pass through multiple pullboxes, Telecommunications rooms and riser openings, they will be labeled at each opening.

All outside plant backbone fiber cables will be labeled at each end and in each handhole/maintenance hole that they pass through. Labels will be heat and water-proof so they do not decay when exposed to the elements. All labels must be visible at point of access.

All cables will be labeled according to the guidelines as set forth in the EIA/TIA 606-B standard. This shall include:

- The origination point
- The destination point
- The type of cable (SMF, 50MMF)
- The fiber strand count

Labels will be color-coded according to purpose.

Fire Alarm – RED
Data – YELLOW
AV – WHITE OR GREY

Optical Fiber Patch Panel Labels

Fiber patch panels shall be marked using adhesive labels indicating the range of fibers installed in it. Each panel shall be labeled with the origination and destination Telecommunication Spaces and the strand count. Each fiber strand shall be labeled with a unique strand ID.

All fiber patch panels will be labeled according to the guidelines as set forth in the EIA/TIA 606-B standard. This shall include:

- Name of source Telecommunications room
- Name of destination Telecommunications room
- Fiber pair number

Riser/Backbone Copper Cable Labels

All riser copper cables will be labeled at each end of the cable bundle at the furthest point where the sheath is intact (before breakout). If the riser cables pass through multiple pull points, Information Technology rooms and riser openings, the cables will be labeled at each opening.

All outside plant backbone copper cables will be labeled at each end and in each handhole/maintenance hole that they pass through. Labels will be heat and water-proof so they do not decay when exposed to the elements. All labels must be visible at every point of access.

All cables will be labeled according to the guidelines as set forth in the EIA/TIA 606-B standard. This shall include:

- The origination point
- The destination point
- The type of cable
- The pair count

Copper Protector Labels

Copper protectors shall be marked using adhesive labels indicating the range of copper backbone pairs installed in it. Each panel shall be labeled with the origination and destination Telecommunication Spaces and the pair count.

All protectors will be labeled according to the guidelines as set forth in the EIA/TIA 606-A standard. This shall include:

- The origination point
- The destination point
- The type of cable
- The pair count

Where protectors terminate multiple backbone pairs, each backbone will be clearly and discretely labeled.

Faceplate/Outlet Labels

All faceplates/outlets for station cable terminations will be labeled. This includes wall outlets, wall phones, faceplates in floor boxes and all other termination points. For faceplates equipped with a label trough and plastic cover, the Contractor shall include the jack designation in the label trough. If upper and lower troughs are available, the Contractor shall divide the jack labeling horizontally, labeling the top two jacks in the upper trough and the bottom two jacks in the lower trough.

All faceplates/outlets will be labeled according to the following guidelines:

- Name of Telecommunication Space the cable routes to.
- Unique faceplate/outlet number, incrementing numerically.

WVMCCD-IS shall issue a detailed outlet numbering scheme for each building, prior to the commencement of cabling.

Station Cable Labels

All station cables will be labeled at each end of the cable within 6 inches of the termination. At the patch panel end, all labels must be visible and not be placed inside wire management. Station cables will also be labeled on the faceplate. All cables will be labeled according to the guidelines as follows:

- Name of the Telecommunications room where the cables terminate.
- Faceplate/outlet number
- Jack Type – V for voice and D for data
- Jack label –numeric (1,2) labeled left to right.

Copper Patch Panel Labels

All ports on the station patch panels shall be labeled with the station cable labels described above. Cables will be terminated in ascending outlet and jack order, and be so labeled.

Patch panels which provide cabling connection to voice riser and backbone pairs shall be labeled using a similar convention as the backbone/riser cable labeling. The patch panel will be labeled with the cable name including:

- The origination point
- The destination point
- The type of cable

Each jack will be labeled for each pair in the riser/backbone cable.

7.26 ROLE OF WVMCCD-IS

As described at the beginning of this document, WVMCCD-IS will take an active role in all aspects of the design, construction and acceptance of the network infrastructure. WVMCCD-IS will involve College IT in meetings, inspections and reviews as need be. To ensure that the design and installation of the Telecommunications Infrastructure is performed according to these standards, WVMCCD has engaged the services of a Telecommunications Consultant who will work with WVMCCD-IS in the review, inspection and testing of the infrastructure.

Inspection

WVMCCD-IS shall participate in the inspection and acceptance of all cabling installations. During the construction process, inspections will be coordinated with the Inspector of Record and Engineering teams. As a minimum, periodic inspections will occur at the following phases of construction:

1. Submittals Review and Approval
2. RFI clarifications
3. Fiber Reel testing (prior to installation)
4. Cable tray/J-hook installation
5. Telecommunications room construction (rack/cable runway installation)
6. Cable installation
7. Cable termination
8. Labeling
9. Testing and review of test results
10. Final construction inspection
11. Manufacturer's inspection and warranty approval

WVMCCD-IS will participate in the acceptance of all construction projects to verify that the installation is compliant to these standards and the design documents.

Commissioning

WVMCCD-IS shall also participate in the commissioning of the cabling infrastructure system. This will include a complete end-to-end test of the installed infrastructure, to ensure each jack and termination is functioning according to the specifications.

Ongoing Operations and Maintenance

WVMCCD-IS is responsible for the ongoing operations, maintenance and future expansion of the cabling infrastructure. An important aspect of this task is the ongoing design and documentation of adds, moves and changes as the infrastructure is updated during the course of its operation. At the conclusion of each construction project, in addition to the test results, WVMCCD-IS will be provided with a set of editable CAD files which contains a complete set of as-built documentation for the cabling infrastructure and electrical outlets which provide power to devices connected to the cabling infrastructure. Two sets of printed drawings in D-size format will be provided, one of which will be delivered directly to WVMCCD-IS staff. These CAD files and any background building images or other CAD XREF files, etc., and associated printed documents, shall become the property of WVMCCD. The CAD files must be in a format readable by standard CAD programs such as AutoCAD.

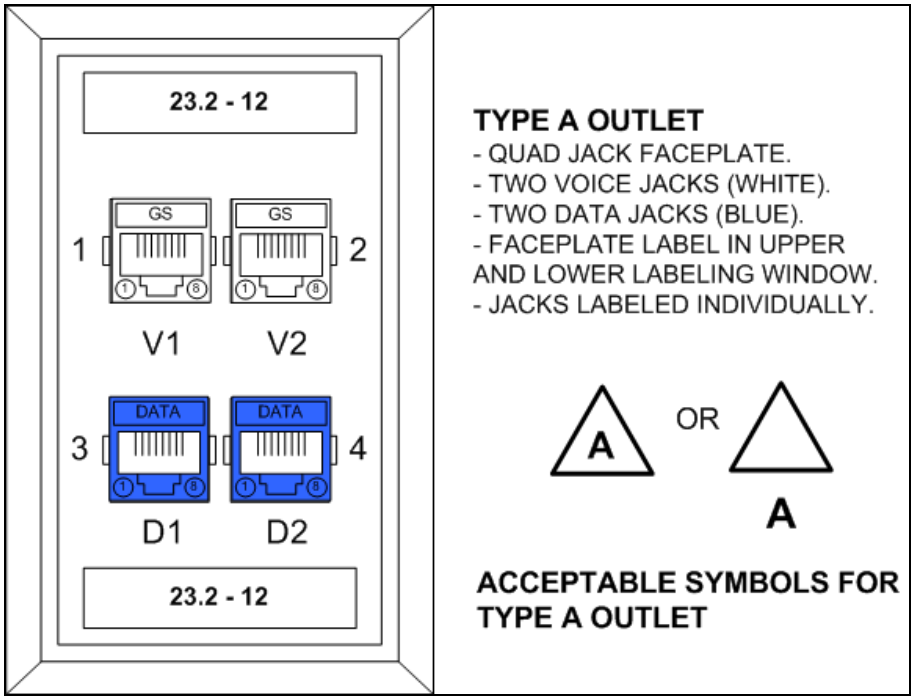
8 Standards

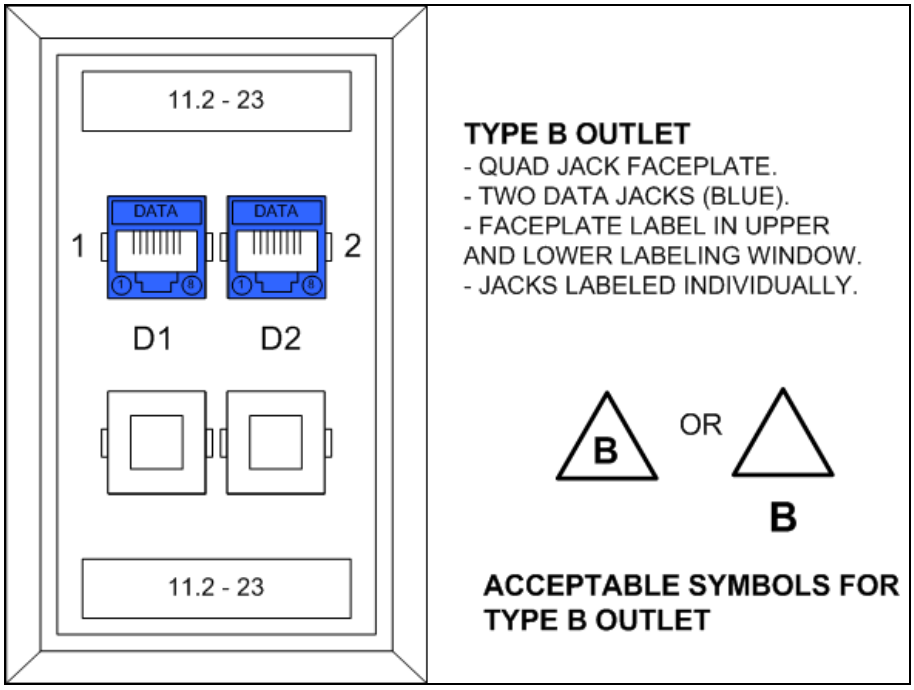
Telecommunications Industry Association (TIA) Measurement of Optical Power Loss Of Installed Single-Mode Fiber Cable Plant – OFSTP-7.	TIA 526-7
Telecommunications Industry Association (TIA) Measurement of Optical Power Loss Of Installed Multimode Fiber Cable Plant	TIA 526-14
Telecommunications Industry Association (TIA)/ Electronic Industries Alliance (EIA), Commercial and Building Telecommunications Cabling Standard	TIA/EIA 568
Telecommunications Industry Association (TIA) Commercial Building Standard for Telecommunications Pathways and Spaces	TIA 569
Telecommunications Industry Association (TIA) Residential Telecommunications Cabling Standard.	TIA 570
Telecommunications Industry Association (TIA) Optical Fiber Cable Color Coding	TIA 598
Telecommunications Industry Association (TIA)/ Electronic Industries Alliance (EIA), Administration Standard for the Telecommunications Infrastructure of Commercial Buildings	TIA/EIA 606
American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA)/ Electronic Industries Alliance (EIA), Commercial Building Grounding and Bonding Requirements for Telecommunications	J-STD-607
Telecommunications Industry Association (TIA) Customer-Owned Outside Plant Telecommunication Cabling Standard	TIA-758
Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual	most recent Edition
Building Industry Consulting Service International (BICSI) Customer-Owned Outside Plant Design Reference Manual	most recent Edition

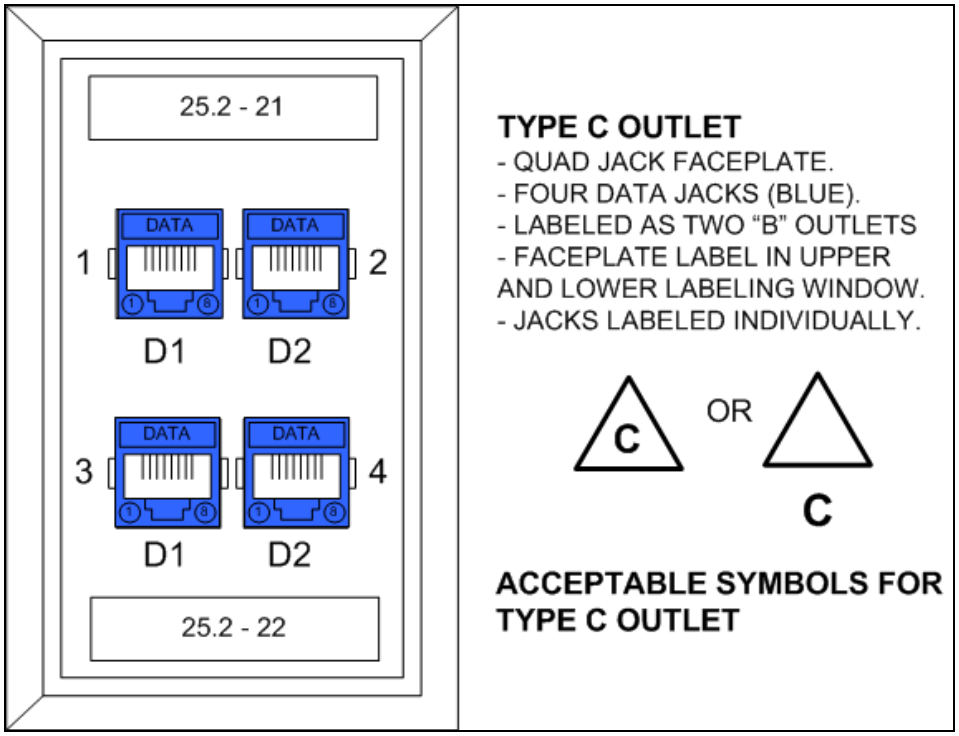
9 Standard Drawings

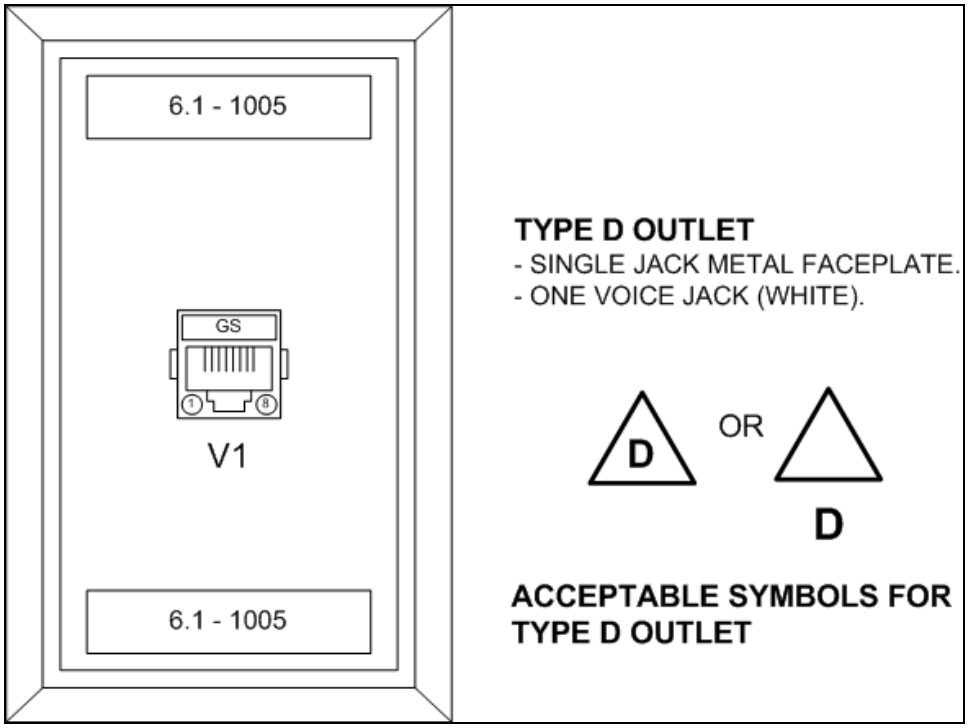
Note: A&E teams are not allowed to create their own outlet types.

9.1 TYPICAL FACEPLATES






25.2 - 21
DATA
DATA
1
2
D1
D2
DATA
DATA
3
4
D1
D2
25.2 - 22
TYPE C OUTLET
- QUAD JACK FACEPLATE.
- FOUR DATA JACKS (BLUE).
- LABELED AS TWO "B" OUTLETS
- FACEPLATE LABEL IN UPPER AND LOWER LABELING WINDOW.
- JACKS LABELED INDIVIDUALLY.
C
OR
C
ACCEPTABLE SYMBOLS FOR TYPE C OUTLET


6.1 - 1005
GS
V1
6.1 - 1005
TYPE D OUTLET
- SINGLE JACK METAL FACEPLATE.
- ONE VOICE JACK (WHITE).
D
OR
D
ACCEPTABLE SYMBOLS FOR TYPE D OUTLET

10 Typical Telecommunications Room Layouts

Standard specification sections are available as templates for incorporating into the project manual of construction projects. These specifications provide the basis of content and **must** be reviewed and updated for each construction project.