

PPS Division 27: Communications Standards

27 00 00 GENERAL

1. Portland Public Schools (“PPS”) Division 27 Structured Cabling and Design standards define the requirements for quality and workmanship for the installation of low voltage electrical cabling, telecommunication equipment, and related products. PPS bases these standards on applicable, current published codes and standards including but not limited to those from the National Electrical Code® (NEC), National Fire Protection Association (NFPA), American National Standards Institute (ANSI), Underwriters Laboratories (UL®), Telecommunications Industry Association (TIA), and Building Industry Consulting Service International (BICSI).
2. This document is intended primarily for use by consulting architects, engineers, designers, and contractors working for PPS (“the District”) on projects in new or existing facilities requiring the design and installation of telecommunications distribution systems; including IP cameras, wireless access points, and any other devices or systems that require structured cabling. Users are encouraged to confirm that they have the latest revision of the **PPS Division 27: Communication Standards** document.
3. In the case of PPS standards, the latest available edition or draft furnished by the District’s project representative shall be the controlling document.
4. PPS has written these standards primarily for new, greenfield construction projects. Changes and/or exceptions for remodeling/retrofitting projects are called out as separate sections following the main section of a given category.
5. Appendix items which are referenced in this standard or which may be relevant to a project which incorporates work of this section are found on the PPS website at <https://www.pps.net/Page/15497>.

Design Requirements

1. Design firms must hold a current BICSI Registered Communications Distribution Designer®(RCDD) certificate and stamp all design drawings.
2. Designer to use site room numbers documented on the PPS E911 floor plans. These plans may be requested by email to tririga-admin@pps.net.
3. Audio-video designer for auditorium spaces is to have a Certified Technology Specialist (CTS) certification from AVIXA®.
4. The telecommunication distribution system design shall provide a cost-effective standards-based structured cabling system that can support current and future voice, video, and data applications over a common cabling plant. The system shall support at a minimum Ethernet application, including 1000BASE-T and 1000BASE-TX in the horizontal link, and 10GBASE-X in the backbone connections.
5. The telecommunication distribution system shall be a hierarchical star topology consisting of backbone cables connecting to a campus MDF.

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6. Horizontal cables shall be installed from each Telecommunication Outlet (“TO”) to the nearest telecommunications room (“TR”) serving that area and floor of the building.
7. Design must fully comply with District Standards. Design team to provide a written summary of any items that are not in compliance with the rationale for the deviation from the Standard for review and approval by the District.
8. Design team to provide a list of the applicable standards from the TIA TR-42 Committee and all National, State, and Local codes, with acknowledgment that the team owns a current copy of the stipulated documents, and that the resulting design complies with referenced standards.
9. Projects including Work of this section may require work governed by other sections in order to furnish a complete and operational system. Therefore, the project may include other requirements such as selective demolition or building mechanical systems additions and alterations. See **Coordination with Other Trades, Standards, Codes, and Publications**, and **Other Reference Materials** below.

Contractor Requirements

3. Workmanship shall be of the best quality and in compliance with all applicable codes, standards, and common work practices. Experienced, licensed low voltage Electricians shall be employed and shall be under the direct supervision of an experienced foreman.
4. The Contractor is responsible for a complete installation including all materials, equipment, labor to install, and successful testing required for a high-quality installation to be in complete operating condition.
5. The Contractor shall furnish and install all materials, including those not specifically included in the contract documents, which are necessary for the proper integration of the system so that the system provides the functions described in the project contract documents.

~~1. The General Contractor shall utilize a single, qualified Access Control System (ACS) Integrator for all aspects of the ACS who shall be solely accountable for the complete operational delivery and performance of the ACS. The ACS Integrator shall demonstrate relevant experience and certifications in both physical installation and software programming of integrated access control systems. Submit ACS Integrator qualifications for District review and approval.~~

~~2. The ACS Integrator shall be responsible for:-~~

- ~~a. Procurement and installation of all ACS hardware and cabling.~~
- ~~b. All ACS software programming, configuration, and database management.~~
- ~~c. Comprehensive system testing, commissioning, and integration.~~
- ~~d. Providing all necessary documentation and training.~~

6. All major components installed as part of a project shall be listed with Underwriters Laboratories.

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7. The Contractors responsible for category cable installation shall be certified to install the product set specified. A minimum of 50% of the cabling contractor's personnel working on the project must be certified installers. Contractors shall provide certification, test results, and the manufacturer's warranty certificate to the Contractor and the District.
8. Installers shall hold the required electrical license for the work being performed. Journeymen electricians are required at the rate of one journeyman to one apprentice. The site foreman shall hold an active BICSI Technician credential.
9. The Ethernet Cabling vendor cable testing personnel shall use an approved cable analyzer/ tester. Personnel operating the tester shall be certified to operate the tester in compliance with UL requirements.
10. The fiber and category cable tester shall be ASNT NDT Level IIIe certified.

Category / Class	Frequency Range (MHz)	Minimum Accuracy Requirement
Category 5e / Class D	1-100	Level IIe
Category 6 / Class E	1-250	Level III
Category 6A	1-500	Level IIIe

11. Infrastructure cable for non-Ethernet-based security, access control, building automation, paging systems, lighting, and HVAC systems shall be installed to industry standards and per the manufacturer's written instructions. These systems shall provide separate dedicated raceway from the Ethernet data-communications cable.
12. PPS retains the right of interpretation and application of standards and certifications, and all questions about interpretation shall be resolved by PPS or their authorized representative.
13. Temporary structures are dismantled and removed when a building is completed, and the jurisdiction has provided the permanent certificate of occupancy. These temporary workspaces have a primary influence on the quality, safety, speed, and profitability of all construction projects. Temporary structures shall comply with these structured cabling standards. Any deviations from the PPS structured cabling standards shall be approved by the PPS OTIS Project Manager.
14. Unless notified otherwise, all contractors shall remove all packing materials resulting from the project work.
15. When upgrading cabling systems, existing systems being replaced shall be completely removed to point of origin. Abandoning cables is not allowed. If re-terminating cables as part of a retrofit, teams are to pre-test cables prior to re-termination. When existing cabling systems are adjusted, Contractor is to re-test and re-certify system and provide a new warranty certificate.

Contractor Project Requirements

1. Telecommunications Systems shall be assembled and installed under the direction of a qualified

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Telecommunications Contractor.

2. The Telecommunication Drawings use symbols and schematic diagrams to indicate items of work. These symbols and diagrams will not typically identify dimensions, nor will they identify inclusion of specific accessories, appurtenances, and related items necessary and appropriate for a complete, properly installed, and fully operational system.
3. The Contractor shall furnish and install articles, products, materials, and/or use methods related to the execution of the design, whether or not specifically identified in this Standard or project contract documents, which will provide a complete and proper functioning communication system. If errors or discrepancies are discovered, the Contractor shall notify the District promptly and in writing.
4. Work shall not proceed until actual field conditions and requirements are verified by the Contractor.
5. Contractor shall conform to the schedule approved by the District. Liquidated damages clauses may be used for schedule-critical projects.
6. Contractor must use and reference the room numbers that are shown on the drawings; room numbers at PPS sites may differ from those shown on the drawings. In all cases, room numbering shown on District drawings shall govern.
7. Contractor personnel shall wear identifying name tags.
8. Contractor and all their employees engaged on a project shall not loiter on the PPS grounds and shall not enter facilities when not explicitly authorized to do so.
9. PPS sites are tobacco- and cannabis-free: no smoking, chewing, or vaping is permitted on any Portland Public Schools property.
10. Beyond common courtesy, there shall be no direct communication or interactions between the Contractor's staff and PPS employees/faculty.
11. The Contractor shall maintain a clean, safe workspace that is always free of leftover food and debris.
12. The Contractor shall provide the schedule for any noise-generating work for review and approval by the District.
13. The Contractor and all their employees engaged on a project shall not use profanity while working on PPS sites or with District personnel.
14. Neither the Contractor nor any of its Subcontractors of any tier shall use any employee at the site who has pled guilty to or been convicted of any felony crime involving the physical neglect of a child, physical injury or death to a child, sexual offenses against or sexual exploitation of a child, child prostitution, or other similar offenses as defined by the most current State statutes, or similar laws of another jurisdiction. The Contractor shall remove from the Work and the work site any employee who has engaged in such actions, or anyone whom the District reasonably

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considers objectionable.

15. Without limiting the generality of the foregoing, Contractor shall ensure by appropriate provision in each subcontract agreement that the Contractor may remove from the Work and work site any subcontractor or subcontractor's employee who has engaged in such action. The Contractor shall, at no change to the Contract Sum or Contract Time, remove from the Work and work site any employee or other person pursuant to this Section. Failure to comply with these requirements is grounds for immediate termination of the Agreement for cause.
16. Contract, Subcontractor, and material suppliers shall be responsible for all additional requirements as indicated in the Contractor Agreement.

Warranty

1. The Contractor shall furnish 3- and 5-year extended manufacturer's warranty options coordinated across all products and systems included in the Work, for the District's review and approval.

Submittals, Substitutions (Post-Bid)

Please see PPS Facility Standards: Division 1 – General Requirements for further information.

2. General Requirements

- a. Submittals shall be made electronically as .PDF files.
- b. Product information, divided by Specification Section and in the same order as listed in the specification, shall be provided for all materials and equipment.
 - i. Contractor shall submit all documents for a given section at one time.
 - ii. Contractor shall not combine submittals for multiple specification sections.
- c. Each submittal shall include a cover letter indicating:
 - i. Project name and address
 - ii. Contractor name and contact information
 - iii. Name and contact details of the Contractor's representative
- d. Each submittal shall clearly indicate specific product model numbers and options.
- e. Submittals received that do not conform to all items listed above will be returned without review and will need to be resubmitted.

3. Submittal Review

- a. The PPS OTIS Project Manager or their delegated representative shall review all questions and submittals related to the Work for conformance with the project requirements. This includes, but is not limited to:
 - i. Pre-bid questions.

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- ii. Contractor and personnel qualifications with bid.
 - iii. Voluntary alternates and unit pricing with bid.
 - iv. Pre-construction submittals and Shop Drawings.
 - v. Close-out documents:
 - a. As-Built Drawings,
 - b. Certificates, and
 - c. Warranty Documents.
 - b. On average, allow five working days for District review. Submittals received by the District after 1:00 p.m. will be considered received the following working day.
 - c. No equipment or materials shall be ordered/purchased prior to review and acceptance by the District.
 - d. Submittal acceptance by the District does not absolve the Contractor of the responsibility of receiving project acceptance and approval as required by applicable codes and the Authority Having Jurisdiction (AHJ).
4. Substitution requests are due at the Pre-Bid deadline for questions:
- a. All products seeking approval either as “approved equivalent” or otherwise shall be submitted as a product substitution request prior to bid. All substitution requests will be considered only if submitted to the District not fewer than 7 working days prior to the project bid date. Acceptance or rejection of a proposed substitution is at the District’s sole discretion, with no exceptions. Requests for substitutions shall not be considered approved unless approval is issued in writing by the District.
 - i. A request for product for substitution, “approved equivalent”, or otherwise, places the burden of proof on the Contractor to provide documentation that the submitted product meets or exceeds the specifications and project requirements.
 - ii. Substitution requests shall include:
 - a. Product being substituted.
 - b. Reason for product substitution.
 - c. Manufacturer’s product data sheet(s) clearly indicating that all requirements in the project documents have been met.
 - b. For equipment, cabling, wiring, materials, and all other products indicated or specified as no substitutions or no alternates, the District does not expect or desire requests for substitutions or alternate products other than those specified. The District reserves the right to reject proposed substitution requests and submissions of alternates without review or justification.

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5. The following submittals are due with the Bid:
 - a. Voluntary alternatives that realize substantial cost savings, if any.
 - b. Unit pricing relating to the Work as identified in the Contract Documents.
 - c. Current documents certifying that the Contractor and assigned project personnel are manufacturer-authorized and trained for the work being performed.
6. The following submittals are due at the Pre-Construction Phase:
 - a. Manufacturer's Product Information.

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- b. Shop Drawings.
 - i. In addition to the required .PDF submittal, generate electronic shop drawings in AutoCAD® .DWG file format and post on e-Builder. File names should clearly identify the project name and number. Drawings shall include the Contractor's title block, and readily printable Plot/Drawing tabs with view-window at scale to match the Bid Documents.
 - ii. Contractors shall provide in-progress shop drawings at any time during construction upon request.
 - iii. Drawings shall indicate:
 - a. Proposed routing of all main pathways.
 - b. Proposed location of all sleeves, firestop penetrations, and floor penetrations.
 - c. Proposed system field wiring diagrams provided by the system manufacturer.
 - d. System function diagrams and/or details, not included in the Bid Documents or subsequent Addenda, that are required for a complete and operable system.
 - e. Final location of all contractor-installed devices and hardware.
 - iv. Acceptable drawing sizes include:
 - a. ANSI D size (34" x 22")
 - b. ANSI E1 size (42" x 30")
 - c. Manufacturer's product data for proposed firestop system and current documentation of successful completion of said manufacturer's training.
 - d. IP paging system submittals are due prior to IP paging systems programming. Include shop drawings with redlines.
7. The following submittals are due at Project Closeout (see also **Project Closeout** below)
- a. As-Built Drawings
 - b. Operation and Maintenance Manuals
 - c. Warranty Documents and all Certificates
 - d. Document all deviations from Design Documents and PPS Standards on the Record Set Drawings.

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Project Closeout

1. In addition to the required .PDF submittal, modify the reviewed and accepted AutoCAD® shop drawings to include revisions based upon completion of work, and post these as-built drawings on e-Builder. File names should clearly identify the project name and number. Drawings shall include contractor title block, and readily printable plot/drawing tabs with view-window at scale to match the bid set.
2. Drawings shall indicate:
 - a. Location and routing of all main pathways.
 - b. Location of all service loops.
 - c. Label annotations for all service loops.
 - d. Location of all sleeves, firestop penetrations, and floor penetrations.
 - e. Location of all changes to equipment and/or devices added, deleted, relocated, or otherwise affected during the execution of the Work from Bid Drawings.
 - f. Network cable IDs, including system function diagrams and/or details not included original shop drawings.
 - g. Contractor shall annotate all jack locations with information that duplicates the labeling on the cable and faceplate on their as-built drawings.
 - h. Contractor shall annotate AP hostnames at the relevant locations on their as-built drawings.
 - i. Acceptable drawing sizes include ANSI D size (34" x 22") and ANSI E1 size (42" x 30")

Controlling Documents

1. Where the project documents and standards appear to conflict with one another, the most stringent requirements shall be applicable. If recommended vendor's standards or approach conflict with these standards, the PPS Technology ("OTIS") Project Manager shall be consulted for review and approval.
2. Any exceptions to these standards shall be reviewed and approved by the PPS Technology Project Manager or their delegated representative, on a per-exception basis. Manufacturers and part numbers provided in the standards are considered basis-of-design and pre-approved product sets. Alternatives may be provided by Contractors through the substitution request process; Contractor to provide documentation showing product performance equivalence. Any non-standard product must be approved by PPS in writing prior to purchase or installation.
3. A list including the current, pre-approved part numbers will be provided upon request by the OTIS Project Manager.
4. PPS retains the right to require designs that exceed codes and national standards.
5. Audio/Video design is required to be provided by an experienced, certified AVIXA® CTS-D.

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Coordination with Other Trades

1. Contractors shall coordinate their work with other trades involved in a given project. This coordination will include, but not be limited to, the following MasterFormat® divisions:
 - a. ***Division 02 Existing Conditions***
 - b. ***Division 06 Wood, Plastics, and Composites: Rough Carpentry***
 - c. ***Division 09 Gypsum Wallboard, Supports ~~For~~ Plaster and Gypsum Board , Painting and Coating***
 - d. ***Division 10 Visual Display***
 - e. ***Division 11 Equipment***
 - e.f. ***Division 12 Furnishings***
 - f.g. ***Division 23 Heating, Ventilating, and Air Conditioning***
 - g.h. ***Division 26 Electrical***
 - h.i. ***Division 28 Electronic Safety and Security***

Definitions

1. PPS / Owner – The terms as used in this document represent Portland Public Schools.
2. OTIS – Office of Technology and Information Services; governs all use of technology within PPS and typically performs the role of *Owner* within the projects or portions of projects governed by these standards.
3. Shall – Requirement - Shall is used to indicate a contractually binding requirement, meaning it must be implemented, and its implementation verified prior to project close-out.
4. Will – Is used to indicate a statement of fact.
5. Should – Goals, non-mandatory provisions. *Should* is used to indicate a goal that must be addressed by the design but is not formally verified.
6. Active Equipment – Energized equipment used for transmitting analog or digital signals (e.g., switches, routers).
7. Architectural Structure – Walls, floors, floor/ceilings, and roof/ceilings that are load-bearing.
8. Authority Having Jurisdiction (“AHJ”) – The entity responsible for interpretation and enforcement of any applicable building and building systems-related codes.
9. Backboard – A wood panel used for mounting connecting hardware and equipment.
10. Backbone – A facility (e.g., pathway, cable, conductors) between an MDF and any other communication space such as an IDF.
11. BAS – Building Automated Systems

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12. CFCI – Contractor-Furnished and Contractor-Installed. *CFCI* is used to indicate project features, systems, equipment, or components that are required to be procured and installed and verified according to the documented contract requirements by the project Contractor. Communication spaces: *Communication spaces* are locations where telecommunications cables are terminated and cross-connected to the associated resources. These spaces must comply with the NFPA 75 standard for the protection of information technology equipment.
13. DMARC – Also known as Demarcation point, MPOE. *DMARC* is the first point of presence within a building for the hand-off from outside services (ISP, telephone, cable) to the LAN. This occurs as soon as possible upon entering the Owner premises within the MDF.
14. Electrical metallic tubing (“EMT”) – *EMT* is zinc-coated steel to comply with UL-797, generally used as conduit.
15. Horizontal Distribution Frame (“HDF”) – “HDF” is a legacy term at PPS; the current term is “IDF”. An *HDF* is an environmentally-controlled, enclosed architectural space designed to contain telecommunications equipment, cable terminations, or cross-connect cabling.
16. Intermediate Distribution Frame (“IDF”) – An *IDF* is an environmentally-controlled enclosed architectural space designed to contain telecommunications equipment, cable terminations, or cross-connect cabling.
17. Main Distribution Frame (“MDF”) – An *MDF* is the structure with terminations for connecting the cabling of a facility in such a manner that interconnection or cross-connections may be readily made. The MDF is located at the entrance facility or main cross-connect location that serves a building or campus.
18. Mesh – A wireless networking topology where each device or network is connected to all other devices or networks by multiple paths.
19. MPOE – Main point of entry; see also DMARC.
20. OFCI – Owner-Furnished and Contractor-Installed. *OFCI* is used to indicate project features, systems, equipment, or components that are required to be procured by the District and installed and verified according to the documented contract requirements by the project Contractor.
21. OFOI – Owner-Furnished and Owner-Installed. *OFOI* is used to indicate project features, systems, equipment, or components that are required to be procured, installed, and verified according to the documented performance requirements by the District. OFOI installation work may be completed by contractors under separate agreements managed by the District.
22. SMR – Surface Mounted Raceway. *SMR* refers to a surface-mounted raceway system used for routing telecommunication cabling to outlets on existing solid walls or walls with fire-blocking.
23. Temporary Structure – Structures erected to aid in the construction of a permanent project. Temporary structures are used to facilitate the construction of buildings and other structures by providing office space and work environment support. Temporary structures are dismantled

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and removed when the permanent building or structure is completed, and the jurisdiction has provided the permanent certificate of occupancy.

24. Telecommunications Room (“TR”) – A *TR* is an enclosed architectural space designed to contain telecommunications equipment, cable terminations, or cross-connect cabling.
25. THHN – Thermoplastic High Heat-Resistant Nylon-Coated. *THHN* is used to designate wires with a thin flame-resistant insulation that is covered by an abrasion-resistant nylon jacket.
26. Wireless Access Point (“AP”) – A standalone hardware device with software that acts as a wireless communications hub for users of wireless devices to connect and to bridge those devices to the wired network.
27. Work Area Outlet (“WAO”) – A wall or floor outlet consisting of copper or fiber optic cabling.

Standards, Codes, and Publications

1. ANSI/TIA 526-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant-OFSTP-14A.
2. ANSI/TIA 568 Commercial Building Telecommunications Cabling Standards
 - a. ANSI/TIA 568.0 Generic Telecommunications Cabling for Customer Premises
 - b. ANSI/TIA 568.1 Generic Telecommunications Infrastructure Standards
 - c. ANSI/TIA 568.2 Balance Twisted-Pair Telecommunications Cabling and Components
 - d. ANSI/TIA 568.3 Optical Fiber Cabling and Components
 - e. ANSI/TIA.568.4 Broadband Coaxial Cabling and Components
3. ANSI/TIA-569: Telecommunications Pathways and Specs
4. ANSI/TIA-598: Color Coding of Fiber Optic Cables
5. ANSI/TIA-606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
6. ANSI/TIA-607: Generic Telecommunications and Grounding (Earthing) for Customer Premises
7. ANSI/TIA-758: Customer-Owned Outside Plant Telecommunications Cabling Standard
8. ANSI/TIA-4966: Telecommunications Infrastructure Standard for Educational Facilities
9. TIA-526-7: Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant
10. ANSI/BICSI 008 - Wireless Local Area Network (WLAN) Systems Design and Implementation Best Practices
11. ANSI/BICSI 001: Information and Communication Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities
12. NFPA-70, NEC

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Other Reference Materials

1. ANSI/BICSI® N1-2019, Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure
2. American Society for Nondestructive Testing (“ASNT”)
3. BICSI® Outside Plant Design Reference Manual (“COOSP”)
4. BICSI® Electronic Safety and Security Reference Manual (“ESSDRM”)
5. BICSI® Telecommunications Distribution Methods Manual (“TDMM”)
6. BICSI® Wireless Design Reference Manual (“WDRM”)
7. National Electrical Manufacturers Association (“NEMA”) UL® 467 Standard for Grounding and Bonding Equipment
8. UL® 2043 Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and their Accessories Installed in Air-Handling Spaces
9. UL® 2239 Conduit, Tubing, and Cable Support Hardware American Standards Association (“ASA”)

Designer, Architect, and Contractor Standard Requirements

6. Unless a specific revision is named, all the referenced standards are to be the most current version, including addenda, in publication at the time project work is requested or anticipated to be bid.
7. In addition to the referenced telecommunications standards, all project documents shall comply with and may exceed codes and requirements of the local AHJ.
8. Installers shall comply with the requirements of current NEC, NFPA, BICSI, and ANSI standards as well as all applicable state, national, and local codes.
9. Installers shall comply with manufacturers’ written instructions and the approved contract documents when installing cabling systems and equipment under Divisions 27 & 28.
10. Designs shall include audio DSP, audio amplification, main AV input/output matrix, and the main AV system controller.

27 05 26 GROUNDING AND BONDING

General

1. This section describes the characteristics of the major components of the telecommunications grounding and bonding infrastructure.
2. All grounding and bonding connectors shall be listed by a nationally recognized testing laboratory (“NRTL”) as required by the NEC. Note: Connectors are listed for the application (e.g., above ground or direct buried).

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3. All grounding and bonding conductors shall be copper and may be insulated. When conductors are insulated, they shall be listed for the application. The minimum bonding conductor size shall be a #6 AWG stranded THHN, green in color. Note: Conductors are listed for the space in which they are intended to be placed, such as riser systems or plenum spaces.
4. Grounding and bonding conductors shall not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3' in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a #6 AWG stranded THHN minimum, green in color.
5. Maximum acceptable resistance between any two points of the grounding/bonding system shall be 5 ohms or less. Refer to BICSI TDMM for two-point bonding measurement criteria.
6. Each telecommunications bonding backbone ("TBB") conductor, and each grounding equalizer ("GE") shall be green or marked with a distinctive green color.

Telecommunications Primary Bonding Bar ("PBB")

1. The telecommunications primary bonding bar ("PBB"; formerly known as "Telecommunications Main Ground Busbar, or "TMGB") serves as a dedicated extension of the building grounding electrode system and is exclusive for the telecommunications infrastructure.
2. The MDF requires a 20-inch PBB connected to the Main Distribution Panel with #4 AWG copper.
3. The PBB serves as the central attachment point for the telecommunications bonding backbone(s) ("TBB") and equipment. Typically, there is a single PBB per building. For buildings with more than one electrical service entrance, each of which serves telecommunications equipment, the Contractor shall consult with the project's licensed Engineer.
4. The ideal location of the PBB is in the telecommunications entrance facility. However, the PBB should be located to minimize the length of the bonding conductor for telecommunications system. The PBB serves telecommunications equipment that is located within the same room or space. Extensions of the PBB (i.e., other telecommunications busbars in other telecommunications spaces) shall be SBBs.
5. The PBB shall:
 - a. Be a predrilled copper busbar provided with holes for use with standard sized lugs.
 - b. Be sized in accordance with the immediate application requirements and with consideration of future growth.
 - c. Have minimum dimensions of 1/4" thick x 4" wide, variable in length and listed by a NRTL.
 - d. The PBB shall be insulated from its support. A minimum of 2" separation from the wall is recommended to allow access to the rear of the busbar.

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- e. All metallic raceways for telecommunications cabling located within the same room or space as the PBB shall be bonded to the PBB. However, for metallic pathways containing grounding conductors where the pathway is bonded to the grounding conductor, no additional bond to the PBB is required.

Telecommunications Bonding Backbone (“TBB”)

1. The TBB is a conductor that interconnects all secondary bonding busbars (“SBBs”, formerly known as telecommunications grounding busbars, or “TGBs”) with the PBB. The TBB originates at the PBB and extends throughout the building using the telecommunications backbone pathways. The TBB connects to the SBBs in all telecom rooms and ISP entrance rooms.
2. Each IDF requires a 10-inch SBB connected to the PBB with a #4 AWG or larger.
3. The interior water piping system of the building shall not be used as a TBB.
4. The TBB shall be a copper conductor. The minimum TBB conductor size shall be a #6 AWG stranded THHN, green in color.
5. The TBB should be sized at 2 kcmil per linear foot of conductor length up to a maximum size of 3/0 AWG. The TBB may be insulated. If the TBB is insulated, the insulation shall meet the fire ratings of its pathway. The sizing of the TBB is not intended to account for the reduction or control of electromagnetic interference.
6. The TBB shall be connected to the PBB. The intended function of a TBB is to reduce or equalize potential differences between telecommunications systems.
7. While the TBB will carry some current under AC power ground fault conditions, it is not intended to serve as the only conductor that provides the only ground fault current return path.
8. The TBB conductors shall be installed and protected from physical and mechanical damage. Additionally, the TBB shall be installed without splices.

Secondary Bonding Busbar (“SBB”)

1. The SBB is the grounding connection point for telecommunications systems and equipment in the area served by that telecommunications room.
2. The TBB and all SBBs within the same space shall be bonded to each other with a conductor the same size as the TBB.
3. The bonding conductor between a TBB and a SBB shall be continuous and routed in the shortest possible straight-line path.
4. The SBB may be connected to the PBB (or building steel) with a #6 AWG stranded THHN, green in color, if the distance between them is less than 50’.

Bonding to the Building for Telecommunications Grounding

1. All connectors used for bonding to the metal frame of a building shall be listed for the intended purpose.

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2. In a metal frame (structural steel) building, where the steel framework is readily accessible within the room, each SBB and PBB shall be bonded to the vertical steel metal frame using a minimum #6 AWG stranded THHN, green in color.
3. Refer to ANSI/TIA-607 for bonding of the steel bars of a reinforced concrete building to the SBB or TBB.

27 05 28 PATHWAYS & JUNCTION BOXES

General

1. Pathway shall conform to the requirements of ANSI/TIA 569; i.e., conduit pathways (2" and greater diameter and longer than 15') shall have a pull string in place for future cable pulls. Tie the string on one of the last pulls so as to avoid having to use a fish tape to route a new string for the next pull.
2. This scope entails all low voltage cabling using the telecommunication pathway (including fire alarm, electronic security, lighting control, and other BAS equipment). Where pathways are indicated on the drawings, contractor shall follow the indicated pathways as closely as possible, as field conditions dictate.
3. Following the completion of any cable install, leave a "cleared" pull string in place in all raceways (including stubbed WAO locations and cable trays) to facilitate future cable installation.

Wall Penetrations

1. When passing through wall penetrations, it shall be required that cables supporting systems other than telecommunications use their own path. Mixing telecommunication Ethernet cabling, access control, fire alarm, and BAS systems with different signaling voltages and EMI/RFI tolerances shall not be allowed.
2. All penetrations through fire-rated building structures (walls and floors) shall use a re-enterable firestop. This requirement applies to through penetrations (complete penetration) only. Membrane penetrations through one side of a hollow fire-rated structure shall be sealed with the appropriate fire-rated caulk or putty. Label all firewall penetrations. Any penetrations created by or for the contractor and left unused shall have a re-enterable firestop installed and/or be sealed as part of the contractor's scope of work.
3. Sleeves shall be used for *all* penetrations (whether or not they are fire-rated) in conjunction with cable trays, j-hooks or other pathways to provide a re-enterable system allowing telecommunication and other low voltage cables to be easily removed or added in the future. The only exception to the rule is for continuous conduit runs that pass through a wall.
4. Firestop systems shall be UL Classified to ASTM E814 (UL 1479).
5. All firestop systems shall be installed in accordance with the current NEC, NFPA 5000 and the manufacturer's recommendations, and shall be accomplished in manner acceptable to the local fire and building AHJs.

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6. Where conduit penetrates firewall, fire rating must be maintained.

27 05 29 HANGERS AND SUPPORTS

J-Hooks

1. Determine the size required in each cable path, and lay them out not to exceed 60" apart.
2. Paths shall be as straight as possible following building lines. Support J-Hooks on walls or ceiling wire. J-hooks should follow the same design requirement of 30% fill for future use.
3. Generally, hangers and supports shall be randomly spaced 48" to 60" apart as this best practice can reduce harmonics in a cabling system. The space between hangers and supports shall not exceed 60".
4. Hangers and supports shall be installed at each change in direction and within 18" of the end of any run.
5. If using ceiling wire for support of J-hooks, the wire needs to be independently supported and colored to identify that these are not part of the suspended ceiling system. Hangers and supports shall utilize independent support wires, threaded rods, and specialty clips or clamps, or be securely attached to the building structure. Attachment to the ceiling grid support wires is strictly prohibited.

27 05 33 CONDUITS & BACKBOXES

Inside Plant ("ISP")

1. Conduit will typically enter the telecommunication spaces under slab and shall be 4" in diameter. Conduits entering the telecommunication spaces through the floor shall extend 6" above the finished floor ("AFF").
2. Above-slab and in-wall conduit shall be EMT—minimum Trade Size 1" unless otherwise noted.
3. Under-slab, and in-floor conduit shall be schedule 40 PVC or RMC with an external PVC coating—minimum Trade Size 1-1/4" (this note is for locations outside that of the MDF or IDF backbone and ISP feeds).
4. Flexible metal conduit is allowed for interior/dry location installation, but its use is limited to 20' in length per run. Minimum Trade Size is 1" unless otherwise noted.
5. Liquid-tight flexible conduit is allowed for outdoor/wet location installation, but its use is limited to 6' in length per run. Minimum Trade Size is 3/4".
6. Conduits may only enter the telecommunication spaces from overhead if such is part of an assembly required to bridge inaccessible space directly adjacent to the telecommunication spaces. Such conduits shall be routed to the cable tray. Conduits shall be bonded to the PBB with a minimum of a green #6 THHN wire or bare copper.
7. Service conduits such as ISP, or backbone conduits will typically enter the TRs under slab and shall be 2" to 4" in diameter.

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8. Conduits entering the TRs through the floor shall extend 3" to 6" above the finished floor.
9. Spare conduits shall be included as a part of any construction that entails "hard ceiling" to allow future placement of cables without disturbing the ceiling. A minimum of two unused 4" conduits shall be placed in areas where hard ceilings extend beyond four feet from accessible spaces. One conduit will be used for telecommunications Ethernet cabling with the other reserved for other low voltage systems. Label each respective conduit for its use (e.g., "Telecommunications Ethernet Cabling" and "Reserved for Other Low Voltage Systems").
10. Conduits longer than 100' shall have no more than a total of 180 degrees of bends before a pull box is installed. Sweeping bends in conduits is preferred. The use of LB, LR, condulets, or other tight bend accessories are not acceptable.
11. The following types of conduits are approved for interior uses:
 - a. Rigid galvanized conduit, zinc coated and manufactured in accordance with UL-6, ANSI and Federal Specification WW-C-540 standards.
 - b. Intermediate Metal Conduit (IMC), zinc coated galvanized steel to comply with UL- 1242, Type J and ANSI Standards
 - c. Electrical Metallic Tubing (EMT), zinc-coated steel to comply with UL-797 and ANSI Standards
 - d. Liquid tight flexible metal conduit, zinc steel core with smooth gray abrasion resistant, liquid tight, polyvinyl chloride covering (with integral ground wire wound in steel core), to comply with UL360 and ANSI Standards
 - e. Anaconda Sealtite type U.A or similar Flexible metal conduit, to comply with UL360, ANSI Standards and Federal Specification WW-6-566
12. Metal raceway, bases, covers and dividers shall be bonded and grounded in accordance with applicable code and ANSI/TIA-607.
13. Provide plastic or nylon pull string for all conduits & Communication pathways. Pull string shall have not less than 200-pound tensile strength.
14. Provide pull wire for store front applications. Pull wire shall be number 16 THHN and have not less than 50-pound tensile strength.
15. Surface mounted raceway (SMR) refers to a surface mounted raceway system used for routing telecommunication cabling to outlets on existing solid walls or walls with fire-blocking. Surface raceways are not allowed where access in existing walls is available.
16. See **SURFACE RACEWAYS FOR COMMUNICATIONS SYSTEMS: RETROFIT APPLICATIONS ONLY** for SMR exceptions in retrofit applications.

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Conduit Fittings

1. Rigid Metal Conduit (RMC) Fittings
 - a. RMC fittings shall be hot dipped galvanized or with a sherardized finish.
 - b. Couplings shall be un-split, NPT threaded steel cylinders with galvanizing equal to the conduit.
 - c. Nipples shall be factory made through 8" in length. Running threads shall not be allowed.
2. Electrical Metal Tubing (EMT) Fittings
 - a. Interior/dry locations setscrew-type box connector shall be steel, complete with integral insulated throat bushings, and locknuts.
 - b. Setscrew-type conduit couplers shall be steel.
 - c. PPS will not accept die-cast zinc connectors or couplers.

ISP Backboxes

1. Boxes for interior/dry locations shall have a minimum dimension of 4" square and a depth not less than 2-1/8".
2. Box covers and mud rings shall have the same minimum rating and finish as the box on which they are installed.
3. Mud ring ganging shall be as indicated in the Drawings.
4. Mud ring depths shall be based on wall type/depth including any finish material.
5. Supports for device boxes installed in an acoustical ceiling tile shall be Arlington FS420SCL or similar.

Specialty Systems & Additional Backbox Requirements

1. HDMI & Audio/Video Backboxes
 - a. For retrofit applications, use Pass & Seymour TV1WW.
 - b. For new construction, use RANDL Industries 5 SQUARE back-box with L-52G058 mud ring.
2. See **SURFACE RACEWAYS FOR COMMUNICATIONS SYSTEMS: RETROFIT APPLICATIONS ONLY** for surface applications.

Outside Plant ("OSP")

1. In-ground conduit shall be PVC schedule 40, rigid metallic conduit, PVC-coated rigid conduit/ exposed surface mounted conduit on-building exterior shall be either rigid metallic conduit or EMT (above grade only) using watertight compression fittings.

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2. PVC schedule 40 conduit installed above or below grade as a temporary or permanent raceway will be considered a wet location. These types of installations shall require OSP wet location rated cable to be used.
3. Conduits shall be bonded to the PBB with a minimum of a #6 THHN green or bare wire.
4. Interbuilding conduit will be installed with Maxcell, no innerduct required.
5. Liquid tight flexible conduit is allowed for outdoor/wet location installation, but its use is limited to 6' in length per run—minimum Trade Size is 3/4".

OSP Boxes and Conduit Fittings

1. Exterior boxes not protected by building structure shall have a minimum NEMA rating of 3R.
2. Approved hand holes or vaults for underground circuits shall be manufactured by Utility Vault or approved alternate. See Drawings for type and installation details.

Conduit Supports

1. Conduit Clamps, Straps, and Supports: Steel.
2. Support Channels—recommended manufacturers include
 - a. B-line
 - b. Kindorf
 - c. Unistrut
 - d. or approved equal
3. 12-gauge galvanized or stainless steel, "U" section, 1-1/2" square nominal in section.
4. Hardware: Manufacturer's standard as required to support equipment. Supports and anchors shall be galvanized steel in dry areas, and stainless steel in wet areas.
5. Threaded Rod: Zinc plated steel, 3/8" diameter minimum, sized to support load.

27 05 36 CABLE TRAYS

Mesh Cable Tray (Basket Tray)

1. Commonly referred to as "basket tray", this section addresses the installation of mesh cable tray and may be used for installing between telecommunications spaces and horizontal or backbone pathways. Unlike traditional ladder trays, this system can be formed to adjust to changes in elevation and horizontal direction without the need for application-specific adapters. Corners and changes in horizontal level are accomplished by selective cutting of the mesh in the cable tray at specific points using bolt cutters, and connecting the points cut together by means of manufacturer-specified attachment hardware.
2. The connecting hardware permits all angles, both vertical and horizontal, to be accommodated over the entire route of the cable tray.

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3. Wall-mounted support brackets may be used to support cable tray. Where appropriate, wall bracket supports are installed on a wall along the route of the cable tray. The number of brackets and specific spacing interval is dependent upon the rated load the cable tray must support. Supporting attachments shall be made on a cable tray no more than 610 mm (24") from the ends, and at joints between two sections. Additional support is also required every 1.5m (60") thereafter.
4. Anchors to attach the brackets shall be sized to support the rated load of the cable tray.
5. Cable retaining posts are available in 150 to 300 mm (6" to 12") lengths to allow additional cables to be installed to a depth exceeding that of the cable tray. Without these devices, the cable would not be confined by the edges of the cable tray and may fall from the tray. The load rating of the cable tray and supported elements shall not be exceeded by the addition of cables to this pathway.
6. Cable Tray raceway shall be installed with capacity for a minimum of 50% growth.

27 05 39 SURFACE RACEWAYS: RETROFIT APPLICATIONS ONLY

Surface-Mounted Raceway

1. Surface raceways ("SMR") shall be omitted where access into existing walls is available.
2. When horizontal SMR is required due to lack of access in existing wall space, SMR shall be installed above the work surface height of computer tables.
3. SMR shall be UL® listed and approved for the intended applications by the AHJ.
4. SMR shall be sized to accommodate initial cable requirements plus fifty percent (50%) expansion without exceeding then-current NEC and ANSI/TIA fill ratio requirements.
5. SMR shall be provided with all fittings including but not limited to mounting clips and straps, couplings, flat, bend limiting internal and external elbows, cover clips, bushings, device boxes and other incidental and miscellaneous hardware required for a complete SMR system. Fittings/bends shall be sized to accommodate cable bend radii as specified in ANSI/TIA 568. SMR finish shall match as closely as possible the finish of the wall it is to be mounted on.
6. SMR shall not be installed as a penetrating raceway through walls.
7. SMR shall be securely supported using mechanical fasteners at intervals not exceeding 5' and in accordance with manufacturer's installation instructions.
8. The path of the raceway shall be selected to minimize impact on existing molding, tack boards and other architectural elements. Vertical runs of raceway from the ceiling to outlets shall be installed on walls near corners wherever possible.
9. Raceways may be installed horizontally at the same height as the outlets or near the ceiling.

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10. Entrance end fittings will be supplied at the ends of raceway runs to transition to conduit sleeves through walls, ceilings or floors. SMR shall be installed parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.

Additional Backbox Requirements

1. For retrofit and surface applications using Wiremold raceway (at the projector), devices to be 4" square (2-7/8" depth).
2. Where walls are hollow, nonmetallic recessed boxes shall be used for all HDMI / AV connections.

27 05 53 CABLE AND FACEPLATE LABELING

1. Horizontal (Station) Cables
 - a. All cables shall be labeled the same at both ends. The tag shall be a heat-shrink label secured to the sheath no more than 4" from the end of the cable. Each end of the UTP horizontal cables shall be labeled with the nomenclature F_PP.nn, where F = Telecom room number, PP= patch panel number and nn= port number within the panel
2. Copper Backbone Cables
 - a. All cables shall be labeled the same at both ends. The tag shall be a heat-shrink label secured to the sheath no more than 4" from the end of the cable.
 - b. Cables shall be labeled from MDF to IDF X-X where X-X = IDF number and be numbered 1 and 2.
3. Fiber Backbone Cables
 - a. Cables shall be labeled "From" – "To", specifically: From MDF to IDF-x, where "x" = IDF number
4. Outlets
 - a. All telecommunication outlets shall be labeled sequentially in accordance with ANSI/TIA-606. The labels shall be typed P-touch printer or equivalent. The label shall identify the cable ID and labels shall be installed in a manner that does not cover the faceplate attachment screws.
 - i. Install faceplates per the manufacturer's written instructions. Care must be taken to provide a plumb and level appearance.

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5. Labeling examples:

- a. General: IDF RACK 01 PATCH PANEL 06, PORT 34 = IDF.01.06.34
- b. IP speaker: IDF 06, PATCH PANEL 02, PORT 47, MAC address abcd.ef12.3456 = 06 - 02 – 47 - abcd.ef12.3456
- c. Analog speaker: IDF 06, ZONE CONTROLLER 02, SPEAKER ID 03 = 06 - 02 – 03
- d. Analog speaker zone controller: ZONE ID 1111.2222.3333 = 1111.2222.3333
- e. IP camera: IDF 07, PATCH PANEL 03, PORT 46, MAC address fedc.ba98.7654 = 07 - 03 – 46 - fedc.ba98.7654

27 08 00 COMMISSIONING

1. General

- a. All cables and termination hardware shall be 100 percent tested under installed conditions. All conductors of each installed cable shall be verified usable by Contractor prior to system acceptance. All cables shall be tested according to contract documents, manufacturer's warranty provisions, and best industry practices. If any of these conflict, Contractor shall comply with most stringent requirements. All defects in cabling system installation shall be repaired or replaced to ensure 100 percent useable conductors in all cables installed, at no additional cost to the District.
- b. All results obtained by use of pair-scanner testing shall be collated by WAO number and presented to the District at the conclusion of the testing. Test compilation shall be certified

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by the Contractor's technician performing the test.

- c. Hard copy of the test results will not be accepted, rather solid-state media containing test data in .PDF format is required.

2. Copper Cabling Testing

- a. Copper category cabling shall be tested and certified after installation according to the manufacturer's instructions and written specifications and as required for the cable manufacturer's extended warranty. Test equipment shall utilize the latest firmware and software, and shall have been factory calibrated within the last 12 months. Testing to include the following parameters:

- i. Wire Map
- ii. Cable Length
- iii. Propagation Delay
- iv. Delay Skew
- v. Insertion Loss
- vi. Return Loss
- vii. Near-End Crosstalk ("NEXT")
- viii. Power Sum Near-End Crosstalk ("PSNEXT")
- ix. Attenuation Crosstalk Ratio Far-end ("ACR-F")
- x. Power Sum Attenuation Crosstalk Ratio Far-end ("PS ACR-F")

- b. Provide test results in PDF format and upload to e-Builder
- c. Provide system warranty from cabling manufacturer
- d. See more details in the **Introduction** section's **Contractor Requirements**.

3. Fiber Optic Cabling Testing

- a. All fiber cable paths shall be tested utilizing a power meter to determine the following:
 - i. Loss at both 1310 and 1550 nanometers (Single-mode)
 - ii. Cable length
- b. Test shall include fiber termination and if used, cassette modules.
- c. End-to-end loss, including connectors shall be ≤ 1.0 dB. All strands are to be tested and certified.

4. Cabling Test Reports

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- a. All results obtained shall be collated with their given label as prescribed in **27 05 53 Cable and Faceplate Labelling**.
 - b. Test results shall be submitted to the District in their native format as well as .PDF format.
5. Audio/Video
- a. All audio and video connections shall be tested, specifically:
 - i. By means of a HDMI enabled device connected to the presentation station.
 - ii. Contractor shall focus, keystone the image as necessary to provide a crisp, focused image which fills the display surface.
 - b. Check-out and final connections to the audio system shall be made by a factory trained technician certified by the manufacturer of the products installed. In addition, factory trained technicians shall demonstrate operation of the complete system and each major component to the District.
6. Clocks
- a. Provide as-built drawings with clock labeling.

27 11 00 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

General

- 1. Floors, walls, and ceilings shall be sealed to reduce dust. Flooring materials shall be composed of anti-static properties. Carpet is not acceptable in telecommunications rooms.
- 2. Plywood backboards shall be installed on all walls within telecommunication rooms.
- 3. Backboards shall be constructed AC plywood (3/4" x 48" x 96" (19mm x 1220mm x 2440mm)).
- 4. Backboards shall start at finished floor and extend to a ceiling height to obtain fire rating in communication spaces. Per ANSI/TIA 569 and BICSI CIM, backboards are to be mounted vertically 6" AFF.
- 5. Install backboards with 102" (2,591mm) dimension vertical. Install adjacent sheets tightly and form smooth, gap-free corners and joints.
- 6. Electrical outlets should be 20 Amp, NEMA 5-15, installed at the top of the network racks. Additional convenience quad NEMA 5-15R near rack location for street/utility power.
- 7. Provide one vertical power strip in each equipment rack.
- 8. Paint all six sides with two (2) coats of fireproof paint. Painted finish in the room will be white colored to enhance room lighting.
- 9. Telecommunication spaces will be constructed in accordance with NFPA 75 and housed in a fully sprinklered building in accordance with NFPA 13.
- 10. The telecommunication space shall be separated from other occupancies within the building,

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including atria or other open-space construction, by 2-hour fire rated construction.

11. All interior walls and ceiling finishes in the telecommunication room shall have a Class A rating in accordance with NFPA 101 Life Safety Code.
12. Interior walls and ceiling finishes in fully sprinklered telecommunication areas shall be permitted to be Class B in accordance with NFPA 101.
13. The fire resistance rating shall be commensurate with the exposure but not less than 2 hour.
14. Every opening in the fire-resistant rated construction shall be protected to limit the spread of fire and smoke from one side of the fire-resistant rated construction to the other.
15. Rooms requiring 2-hour fire rating shall have a door rated for 1-1/2 hour fire resistance.

MDF Size and Fit Out Requirements

1. 15' x 10' minimum room dimensions.
2. Ceiling height to be 108" where available, a minimum room height of 96" is required.
3. Out swinging door minimum of 36" wide and 80" high.
4. Equipment not related to the support of the telecommunications room (e.g., piping, ductwork, pneumatic tubing) shall not be installed in, pass through, or enter the Telecommunications Rooms.
 - a. In no case shall water drains, drip pans, or liquid carrying lines be installed in or above the telecommunication spaces.
5. Any system installed in an MDF that does not use structured cabling shall use its own pathway, and the respective cable shall never run across the top of the data racks; examples include, but are not limited to, public safety, door access, burglar alarm, fire alarm, and lighting controls.
6. Any system installed in an MDF that does not use structured cabling shall use its own pathway, and the respective cable shall never run across the top of the data racks; examples include, but are not limited to, public safety, door access, burglar alarm, fire alarm, and lighting controls.

IDF Size and Fit Out Requirements

1. 10' x 10' minimum room dimensions.
2. Ceiling height to be 108" where available, a minimum room height of 96" is required.
3. Out-swinging door minimum clear opening dimensions of 36" wide and 80" high.
4. Equipment not related to the support of the telecommunications room (e.g., piping, ductwork, pneumatic tubing) shall not be installed in, pass through, or enter the Telecommunications Rooms.
5. In no case shall water drains, drip pans, or liquid carrying lines be installed in or above the telecommunication spaces.

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6. The IDF shall be centrally located within a building to ensure that station cable lengths will not exceed 290’.
7. Equipment not related to the support of the telecommunications room (e.g., piping, ductwork, pneumatic tubing, etc.) shall not be installed in, pass through, or enter the Telecommunications Rooms.
8. Any system installed in an IDF that does not use structured cabling shall use its own pathway, and the respective cable shall never run across the top of the data racks; examples include, but are not limited to, public safety, door access, burglar alarm, fire alarm, and lighting controls.

Lighting Requirements

1. Lighting shall be a minimum of 50-foot candles (500 lumens) measured 3’ above the finished floor, both behind and in front of racks. Placement of lighting shall be coordinated to avoid obstacles such as cable trays that obstruct light.
2. Placement of lighting shall be coordinated to avoid EMI from electronic ballasts and other sources on existing communication cables. Lighting fixtures shall be provided on both sides of the communication racks. Lighting shall power on when the door is opened.

HVAC Requirements

1. Individually-controlled HVAC required for all MDF and IDF locations. Temperatures shall be no more than 72°F with no more than 40% humidity.
2. HVAC sizing to be based on maximum capacity for the space.
3. System must remain operable throughout summer and other school breaks.

27 11 16 CABINETS, RACKS, FRAMES, AND ENCLOSURES

General

1. Rack installation shall comply with seismic design criteria according to ASCE Risk Category 4 (standard previously identified USGS Zone 4).
2. For each project, contractors shall consult PPS regarding placement of all floor, wall, and ceiling equipment installation locations and footprints in the MDF and IDF spaces.
3. Racks will be numbered left to right or closest to the entrance to the back of the room. Numbering will start at 1.

27 11 23 CABLE MANAGEMENT AND LADDER RACK

General

1. Provide 12” ladder rack around room and over top of racks for cable routing and seismic bracing.

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2. Ladder Rack shall be installed using the same manufacturer's accessories, including wall angle support, rack to runway mounting bracket, junction splice kit, triangle support bracket, runway radius drop, runway radius (stringer), and runway foot kit.

27 13 13 COPPER CABLES MULTI-PAIR UTP (BACKBONE)

1. For *intra-building* backbones, install 3 x Cat6 terminated on Cat6 data line protectors at each end and extended to 66 blocks.
2. For *inter-building* backbones, install 2 x Cat6 terminated on 66 blocks, rated for wet locations where applicable.

27 13 23 FIBER OPTIC CABLES

Intra-Building (Inside the Building)

1. The intra-building fiber optic cable shall be 12-strand single-mode OS2 between the MDF and IDF. The fiber will meet the specifications listed in ANSI/TIA 568.
2. Fiber to be tested end to end with a power meter for both 1310nm and 1550nm on single-mode fiber.
3. Fiber grounding kits (bullet bonds) shall be installed on each end of armored fiber cables to bond the metallic sheath to the telecom busbar.
4. Fiber assembly shall roll within the wall (Type-C). The final fiber sequence delivered at the LC connector will be as follows:

MDF	1	2	3	4	5	6	7	8	9	10	11	12
IDF	2	1	4	3	6	5	8	7	10	9	12	11

Inter-Building (Entering the Building)

1. The inter-building fiber optic cable shall be 12-strand armored single-mode OS2. The fiber will meet the specifications listed in ANSI/TIA 568.

Fiber Optic Connectors

1. Fiber optic strands shall be terminated with single-mode LC type connectors.
2. Connectors shall be fusion-spliced or mechanical.

27 13 23 FIBER OPTIC CABLES: RETROFIT APPLICATIONS ONLY

Fiber Optic Connectors

1. When adding new fiber optic cable, existing fiber optic cable shall remain in operation. Coordinate any cutover or relocation of existing fiber a minimum of five business days prior to work with OTIS. Take care to not disrupt networks that are in production.

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Restoration of Service (Break-Fix)

1. Fiber optic strands shall be terminated with applicable connector type (e.g., SC or LC). The connector shall be appropriate to the type of fiber (i.e., single-mode or multimode).
2. Fusion spliced tails shall be used; however, Corning Unicam terminations may be used to restore service on a temporary basis.
3. Loss at a mated pair not to exceed .35db or current TIA standards.

27 15 13 COPPER HORIZONTAL CABLING

General

1. All low voltage cabling intra-building (inside the building) shall be plenum rated.
2. The bend radius shall be no less than 4 times the outside cable jacket diameter for the cable.
3. Only Velcro® (Hook and Loop) type cable wraps shall be used to bundle.

Category 6 Cabling / Horizontal Station Cable

1. Station cables are defined as the category cable from the MDF or IDF to the end user.
2. Station cables are to be independently supported by approved raceways. Each raceway shall follow building lines and require fill calculations to be completed before installation of cabling.
3. Data network cabling shall be run in its own dedicated raceway without other system cabling. In the case a wire basket tray is used, a divider may be used to provide the best practice approach to separating the cables.
4. The horizontal station cables shall be approved 100 ohm, 4-pair plenum-rated UTP cables. Specific types and colors identified below in "Quantities, Colors, and Typical Locations".
5. The length of each horizontal cable shall not exceed 90m (295') regardless of host device. One end of a horizontal cable shall terminate at the Telecommunications Outlet. The other end of a horizontal cable shall terminate on a rack mounted modular patch panel located in the nearest Telecommunication Room. This includes all systems requiring an Ethernet cable; e.g., electronic security and building automation equipment.
6. In no case shall station cables be run across open spaces or taped to the floor. All cabling shall be installed in an approved raceway and in a quality workmanship manner.
7. Copper-based patch panels shall typically be 48 port.
8. All horizontal station cables shall have 3' service loop coiled at the workstation end of the cable to support future cable relocations. The exception to this includes AP locations where it is preferred to have a 10' loop for flexibility.
9. Add cable slack loops at MDF/IDF of 10'. Using a figure eight pattern with the cable is expected to allow the Contractor to follow the service loop specifications from each manufacturer.

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10. Category 6 cables used in lighting controls and other BAS equipment shall be installed under the same standard as any other telecommunication low voltage cable. Depending on the use of these cables, they may require a separate raceway.
11. All four-pair balanced twisted pair cable installed above slab shall be rated CMP.
12. All four-pair balanced twisted pair cable installed in conduits running at or below slab shall be rated for use in wet locations.

Quantities, Colors, and Typical Locations

1. The horizontal copper cable for phone or work area outlets (“WAO”) shall be Category 6; color to be blue. Provide minimum of two cables per WAO location.
2. Cable identified for AP and projector locations shall be Category 6A; color to be yellow. Provide two Category 6A cables for each AP and projector location.
 - a. For retrofit applications where the projector and Airtame are in the Artome AV cart, provide two Category 6A cables on the teaching wall below the whiteboard projection surface.
3. Cable identified for cameras shall be Category 6A; color to be yellow. Provide one Category 6A cable for all camera locations.
4. Analog cabling (used for elevator phones, area of refuge, and red phones) to be terminated in the nearest MDF or Telecom Room shall be terminated on a 25-pair split 66 block. Any block used for the telecom demarc terminations shall not be used for analog cable terminations.
5. Provide Category 6 cable for one VoIP wall phone near the entry door at all classrooms, gymnasiums, weight rooms, dance and other athletic spaces, maker spaces, and shops.
6. Provide one Category 6 cable and two, 22/6 stranded cables to the campus notification system located in the main office.
7. Category cable used in lighting controls or other BAS equipment shall be of a different color than network data cabling.
8. Provide analog phone connections from the MDF to locations at elevators, areas of rescue, fire alarm; in the office next to the Door Schedule Override button, install an analog wall phone jack/plate for the red phone.

ACT Ceilings

1. 10’ minimum shall be left coiled as high as possible in the telecommunications rooms. Cable shall be coiled in bundles not exceeding 24 cables.
2. For other telecommunications outlets, 3’ minimum shall be neatly coiled and secured with Velcro® at the telecommunications outlet (typically in the ceiling).
3. For APs, 10’ minimum shall be neatly coiled and secured with Velcro® at the telecommunications outlet (typically in the ceiling).

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Hard Lid Inaccessible Ceilings / Non-ACT Ceilings

1. For wireless APs, 10' minimum shall be neatly coiled and secured with Velcro® at the nearest accessible space (if any), such as a drop ceiling outside the classroom in hallway.
2. For other telecommunications outlets, 3' minimum shall be neatly coiled and secured with Velcro® at the nearest accessible space (if any), such as a drop ceiling outside the classroom in hallway.
3. If there is no accessible space nearby, 12" shall be coiled inside the 2-gang back box.
4. Placement of service loops is subject to verification by the District.

Outdoor Installations

1. All cable in mechanical and industrial spaces shall be installed in conduit. This includes locations such as HVAC and boiler rooms, custodial, and any area the cable would be subject to damage.
2. All cabling installed in outdoor or wet locations shall be listed for indoor/outdoor use; no exceptions.

27 15 43 FACEPLATES & CONNECTORS

1. Standard Work Area Outlet - shall be a two-port faceplate, white, thermoplastic with label windows.
2. AP – locations noted on the drawings as wireless access points shall be terminated within a two-port faceplate, white, thermoplastic with label windows, at the height indicated on the drawings.
3. Projectors – locations noted on the drawings as projectors shall be wall mounted on two-port faceplate, white, thermoplastic with label windows, at the height indicated on the drawings.
4. Wall Phone Location – shall be a one-port faceplate, white, thermoplastic with label windows.
 - a. Wall mounted phones must not be able to be hidden by an open door. There will not be anything that is mounted to the surface of a wall, including white boards, within 12-inches of any drop that is to be used for a wall mount phone.
 - b. The mounting of the phones to be between 34 and 48 inches off the finished floor and in accordance with all jurisdictional requirements.
5. Horizontal (Station) Cable for WAO - The termination jack shall be an 8-pin (4-pair) modular jack rated for Category 6. Termination pin-out shall be T568B. Two jacks per location unless noted otherwise. The color shall match the faceplate at the WAO and be black at the patch panel.
6. Horizontal (Station) Cable for wall-phone - The termination jack shall be an 8-pin (4-pair) modular jack rated for Category 6. Termination pin-out shall be T568B. One jack per location. The color shall match the faceplate at the WAO and be black at the patch panel.
7. Horizontal (Station) Cable for APs and projectors- The termination jack shall be an 8-pin (4-pair) modular jack rated for Category 6A. Termination pin-out shall be T568B. Two jacks per location.

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The color shall be yellow at the AP and be black at the patch panel.

8. Horizontal (Station) Cable for Cameras - The termination jack shall be an 8-pin (4-pair) modular jack rated for Category 6A. Termination pin-out shall be T568B. One jack per location. The color shall be yellow at the camera and be black at the patch panel.

27 16 19 PATCH CABLES

1. Networked equipment will be connected using pre-manufactured, tested modular patch cords. These can be of the same manufacture as the cabling system.
2. Data connection ports will be connected to the backbone termination field using RJ45 to RJ45 modular patch cords. All patch cords will match the installed horizontal cable color, factory terminated, and installed to length (maximum 12" of slack). Patch cords and station cable will be equal in Category to the installed cable and be stranded unshielded twisted pair ("UTP").
3. Patch cables will be used between patch panels and active electronics. Lengths will be kept to a minimum while remaining with standard, manufactured lengths. Likewise, station cables will be stranded UTP in lengths that allow proper routing and minimize coils or slack cable length.
4. Patch cables are to be Owner-furnished. Contractor to install patch cord at field end of devices (i.e., projectors, cameras, APs). Owner to install patch cords at switch.

27 21 33 WIRELESS ACCESS POINTS ("APs")

General

1. The low voltage contractor shall install cabling and APs. The contractor shall provide pathways, Category 6A cable, patch panels if needed, and outlets to support placement of APs.
2. The design shall comply with guidelines of TSB-162, Telecommunications Guidelines for Wireless Access Points.
3. The placement of the APs shall provide coverage in all classrooms, offices, work areas, boiler rooms, corridors and public meeting spaces and will be specified or approved by the PPS OTIS Project Manager staff.
4. Power to Wireless Access Points shall be provided by Power over Ethernet ("PoE") switches located in the nearest Telecommunication Room. APs, their mounting brackets, and their endpoint patch cables shall be OFCI. Protective enclosures for gymnasium APs shall also be OFCI.
5. APs shall be installed in the locations as shown on the drawings. Wherever possible, 3' patch cords shall be used to connect the AP to the corresponding telecommunications outlet. Large patch cord cable loops shall not be permitted.
6. In areas with acoustic ceiling tiles where APs are indicated to be ceiling-mounted, APs shall be mounted on the backbone of the ceiling grid rails. In areas where the grid is not able to be used for supporting the AP a tile bridge with a 2-gang recessed backbox with a single gang mud ring shall be used. Tile bridge shall be Arlington FS420SCL or approved with 50-pound weight rating.

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7. In areas with hard (GWB or plaster) ceilings, the AP shall be mounted on a 2-gang surface mounted backbox with a single gang mud ring. Backbox shall be securely affixed to the ceiling with anchors or toggle bolts.
8. In wall mount areas, the AP will be mounted on an Oberon wall mount bracket. The bracket shall be attached to the wall according to the manufacturer's instructions.
9. In gym areas or where exposed to potential damage, AP shall be mounted in OFCI non-metallic enclosures. The enclosure shall be mounted over the data port to provide protection to the data cable and connection.
10. APs are to be mounted horizontally wherever possible.
11. AP height not to exceed 12'. If ceilings are higher than 12', move AP to wall mount not higher than 12'.
12. APs will be configured and labeled by the District prior to installation.
13. Contractor to indicate which AP is installed in each location on as-built documentation.
 - a. The AP as-built documentation will explicitly cross-reference each AP hostname with its associated cable ID.

27 41 00 AUDIO/VIDEO SYSTEMS

General Requirements

1. All audio/video spaces shall have voice/data connection to the nearest telecom rooms.
2. Coordinate with project lighting design to prevent glare on projection surfaces and coordinate height of lights and projectors to mitigate conflicts.
3. Power requirements for electrical for all Audio/Video devices shall be coordinated with the Electrical Engineer and verified in a review of electrical drawings. In *new* buildings, power shall be located behind the projector mount cover.
4. All wiring shall be installed in raceways within walls where possible. All wiring shall be plenum rated. Exposed cabling is not acceptable.
5. All audio system equipment shall be supplied and installed by an authorized factory distributor. The system contractor and manufacturer shall have furnished and installed similar systems continuously for no fewer than five years. Installer shall hold the applicable manufacturer's certification for system being installed.
6. A complete system shall be installed in strict accordance with the manufacturer's written requirements and recommendations.
7. See **27 08 00 COMMISSIONING** for information regarding commissioning of AV systems.

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Classroom Audio/Video Installation

1. The classroom video presentation system will consist of ultra-short-throw wall-mounted projectors or flat-panel displays. Program sound shall be delivered via the classroom audio system.
2. Cables may be run in the area above the dropped ceiling. In such areas, cables shall be supported by Caddy® fasteners/hangers.
3. The contractor shall furnish and install the mounting brackets. Brackets shall be mounted on the wall according to the manufacturer's instructions.
4. Connection from the display to the sound system amplifier shall be via stereo 3.5mm cable.
5. Implement HDBaseT cabling from the short-throw projector to the outlet on the teaching wall. The HDBaseT receptacle on the teaching wall should be recessed and positioned to the side nearest the teacher's workstation for optimal access and utility
6. HDMI cables must be shielded to support transmission requirements for ultra-HD and 4K resolutions, ensuring high-quality audio and video performance without interference. Must support HDMI 2.0
7. Faceplates should be made from durable thermoplastic and equipped with HDBaseT compatible connectors, facilitating a seamless, female-to-female connection between devices. This setup ensures that our A/V systems are prepared for current and future multimedia technologies, offering both high performance and reliability.
8. Classrooms shall have presenter stations on the teaching wall. Presenter locations are typically near a corner opposite the corridor and co-located with AC power. In new buildings, a secondary presenter location should be provided in the opposite corner from the teaching wall location.

Retrofit Elementary and Middle School applications only:

1. The District-furnished Artome AV Cart will house the projector, audio system, and wireless presentation device.

Classroom AV System Controls

1. Audio/Video Playback – System shall be capable of playing Streaming/DVD/PC-based media, from District-provided source equipment.

Classroom Audio Reinforcement

1. Teaching spaces shall be equipped with a Lightspeed 975 amplifier, a TCQ speaker, and a Flexmike. In classrooms with individual paging speakers, a PageFirst option shall be included in designs.
2. System shall have two volume controllable lanyard microphones with batteries and one cradle charger per classroom.

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3. Ceiling mount speakers are preferred and shall be centered in classrooms. Wall mount speakers may be used if needed.
4. Lightspeed amplifiers shall be placed on top of projector mount, co-located with Airtame device.
5. HDMI cables shall have foil-shielded cable pairs with a braid shield overall and be rated for ultra-HD and 4K resolutions.
6. Faceplates shall be thermoplastic with female-to-female HDMI coupler.

Retrofit Elementary and Middle School applications only:

1. The District-furnished AV Cart will house the audio system.
2. System shall have two volume controllable lanyard microphones with batteries and one cradle charger per classroom.

Classroom Video Projection, Display Surfaces, and Wall Mounted Monitors

1. Coordinate with requirements of PPS Facility Standards Division 10, Visual Display Surfaces.
2. OFCI LCD TV will be used in lieu of projectors where the room ceiling height is lower than 9'.
3. Enable wireless broadcasting via OFOI Airtame; Airtame device powered via PoE.
4. The District shall supply all ancillary cables, patch cords, and adapters necessary to provide a completely functional system.

Classroom Assistive Listening Systems

1. Classrooms shall be equipped with assistive listening systems.
2. For new construction, provide an audio-out port at the AV receptacles by the teacher's desk.
3. For Elementary and Middle School upgrades, the audio-out port will be included in the Artome AV Cart provided by the District.

Auditorium Audio/Video – Middle School

1. Auditorium Audio/Video system design is to be determined on a per-project basis.
2. For schools with a stand-alone Auditorium, the space may require a dedicated network.
3. Auditorium spaces shall be designed for live performances with a full crew of stage hands, directors, audio technicians, lighting personnel, and actors.
4. Auditorium spaces shall be designed for program playback with full audio and video production and display.
5. There will typically be one control center location. These spaces are to be located in conjunction and coordination with the Architect.

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6. Audio:

- a. Microphone jacks shall be located in the proscenium walls, a flush floor pocket at center front of stage, and overhead drops from the pipe grid system. Provide not fewer than four wireless handheld mics and head-end transceiver.
- b. Provide input/output patch box on stage wall near proscenium, adjacent to onstage lighting control panel.
- c. Provide 6 channel auto-mixer system for non-technical users and small events, adjacent to lighting control panel at onstage proscenium wall.
- d. Provide portable roadcase audio mixer with 16 input channels and LCR outputs. Roadcase shall include EQ and basic effects.
- e. Loudspeaker shall be suspended above the stage proscenium opening, facing the audience, and shall provide for center array for voice, and LEFT/RIGHT stereo for music.
- f. System shall limit devices to prevent overloading loudspeakers, and to keep dB levels at highest measured point onstage and in Commons / Gym at less than 92dB.
- g. System input shall be included to allow for audio content from a video projection source.

7. Video Projection / Screen:

- a. The projector shall be located in Commons / Gym for proper alignment with top of projection screen, without need for downshifting or anti-keystoning. If the projector resides in a gymnasium, provide a protective cage that does not interfere with the lens or obstruct ball play. The projector bulb shall emit no less than 6,000 lumens, and resolution shall be HDTV (1920x1080). Inputs shall be HDMI.
- b. Projection Screen: 16:10 Aspect ratio, 160" x 100" viewable area, high contrast fabric. Case shall be designed to flush into ceiling. The unit shall be motorized and shall be furnished with one remote control station, which shall be located at stage wall adjacent to lighting and sound controls.
- c. Input panel for video source device shall have interconnection patch link to audio reinforcement system.
- d. System function shall include audio only option.

Auditorium Audio/Video – High School

- 1. High School auditorium spaces shall be designed for live performances with a full crew of stage hands, directors, audio technicians, lighting personnel, and actors.
- 2. Auditorium spaces shall be designed for program playback with full audio and video production and display with system configuration options for audio-only and video-only playback.

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3. Control center locations shall be located in conjunction and coordination with the Architect:
 - a. The main control room with all the headend control equipment shall be in the rear of the audience chamber space on a mezzanine level with a complete and unobstructed view of the stage/screen area.
 - b. A secondary control room shall be located in the center of the audience space and be used for live audio and lighting control.
 - c. A stage manager's rack will be located on one side of the proscenium at the front of the stage area ("down stage").
4. Additional locations near the auditorium shall require Audio/Video if they are part of the project. For example, the Green Room, Black Box, Choir, Band, and Dressing Rooms shall require a production intercom and display for video and audio from the control room.
5. Production intercom access shall also be required throughout the Auditorium in addition to the spaces located above:
 - a. At any area that has a production support person manually operating equipment as part of the production.
 - b. At any manual lighting locations on the lighting catwalks.
 - c. At all usher locations at the entrances to the auditorium.
 - d. On the stage at the stage manager's rack location.
 - e. In the Orchestra Pit. (Video will also be required in this location.)
 - f. In the Box office.
 - g. One on each of the walls backstage at stage level.
 - h. One at each of the rigging control areas on each side of the stage at the catwalks.
6. Performance Requirements:
 - a. Coverage: within 3 decibels (2000-4000 Hz) and 3 decibels (broadband).
 - b. Output capability: 105 decibels A-weighted.
 - c. Frequency response: 50 to 2,000 Hertz, rolling off to 16,000 Hertz
7. Auto Mixing System:
 - a. Automatic "plug and play" mode for simple events.
 - b. Six wired XLR microphone inputs.
 - c. Automatic mixing, with automatic volume controller.
 - d. Multiple locations of remote control for on/off, microphone master, and auxiliary volume.

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- e. Dedicated input jacks for auto-mix microphones.
 - f. Rack-mounted auxiliary input panel.
 - g. Utilizes same amplifiers and speaker cluster system as *production* mixing
8. Production Mixing System:
- a. Control console in mixing location that presents acoustical environment same as audience area (i.e., the “house mix” location).
 - b. A secondary mixing location may be in the control room.
 - c. Analog-style consoles are recommended for CUB use, for simple operation.
 - d. Digital-style consoles are recommended for student and school use for new construction/modernizations.
 - e. Portable rack for effects, sources, and processing.
 - f. I/O boxes for portable mixing console at rear wall.
 - g. Minimum 24 channel boards; split 24 channel half/half each side or as needed for installation.
 - h. Subfloor installation of mic. Line audio snake must be waterproof.
 - i. Mic splitter with isolation transformers at board location.
 - j. Media Docking Station that adapts to all use cases should be provided.
 - k. Professional grade, rack mountable CD player
 - l. A minimum of four monitor auxiliary sub-mixes should be provided.
 - m. System should be able to cross feed to/from gymnasium, commons, and football field.
9. Microphones:
- a. Provide eight wired XLR instrument microphones.
 - b. Provide four wired XLR speech microphones.
 - c. Provide four handheld wireless microphones.
 - d. Provide 12 over the ear wireless microphones.
 - e. Provide two lavalier wireless microphones.
 - f. Provide twelve body pack wireless microphone transmitters.
 - g. Provide 14 wireless microphone receivers.
 - h. Provide a mix of XLR cables in multiple lengths to support multiple event configurations.

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- i. Provide a mix of microphone stands for handheld (wired & wireless) as well as stands with boom arms for instrument microphones.
10. Input/output (“I/O”) boxes for microphones, portable monitors, and other devices:
- a. Stage walls, Orchestra pit, stage ceiling (ceiling-hung microphones), catwalk (for hanging microphones from battens or above audience), house mix location, control booth, sprung stage floor, SSRC ‘FP’ series floor pockets required for devices mounted flush in performance floor systems.
11. Loudspeaker Cluster(s):
- a. May be center cluster or left/right cluster.
 - b. Subwoofers for low-frequency enhancement may be used when appropriate but must be properly isolated to prevent transfer of sound energy into the structure.
 - c. Loudspeaker array should be mounted so the lowest point of the array is above the proscenium opening.
 - d. Limiter required for maximum volume to prevent damage or audio spikes.
12. Power Amplifiers:
- a. Two-channel. Anti-feedback (software or a device) with a minimum of 10 filters.
13. Digital Signal Processing (DSP):
- a. Include a DSP system to process and distribute audio signals. System to be programmable via web-based interface utilizing a drag and drop GUI.
14. Assistive Listening System:
- a. Assistive listening system shall conform to jurisdictional requirements for areas of assembly.
15. Production Intercom System:
- a. Multi-channel, supportive of multiple configurations of belt packs, speaker stations, and headset stations.
 - b. Production intercom stations using the house mix should be provided in control booths, stage manager’s panel, catwalks, stage rigging fly rail, dressing rooms, greenroom, drama classroom/black box, and orchestra pit/trap room.
16. Multimedia Presentation (Video):
- a. Interface to computer for presentations to allow computer's image to be shown on the projection screen and allow the computer's audio to be reproduced by the sound system, and interface to portable laptop computers.
 - b. Playback of DVD/Blu-Ray Movies from professional grade, rack mountable Blu-Ray/DVD player. The player shall be remotely controllable via Ethernet or RS232, and shall

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incorporate an integral image scaler.

- c. A video switcher should be provided to allow for seamless switching between multiple video sources.
- d. Widescreen video mode.
- e. Optional: 5.1 channel surround sound feed to audio.
- f. Large-screen video projection.
- g. Motorized screen (16:9) in stage rigging.
- h. Both 4:3 and 16:9 (widescreen) projection.
- i. High-output, large venue triple LCD or DLP/DMD video projector, available with long-throw lenses, remotely controllable via Ethernet or RS232.
- j. Optional video and audio connectivity between the auditorium and other areas of the school shall be determined on a per-project basis.

17. Audio/Video Integrated Control System:

- a. Programmable touchscreens or button panels as appropriate, ability to connect to devices via Ethernet, RS232, and contact closure to allow for integrated control of DVD Player, Video Switcher, Video Projector, and Recalling presets on Audio DSP.

18. Equipment shall be located in the main control room.

19. A separate space shall be required for the sound system amplification equipment. This additional location shall be fully conditioned and coordinated with the Architect.

20. Coordinate with the Architect for all room locations, all special finish and acoustic requirements, and all exposed equipment locations within the auditorium area.

21. Acceptance testing shall be performed with and signed off by the PPS OTIS Audio/Video Team.

Music and Athletics Audio/Video

- 1. Gymnasium spaces shall be designed for live audio performances – typically with 1- 5 microphones and audio reinforcement.
- 2. Gymnasium spaces shall be designed for program playback with full audio and video program sound and display.
- 3. Exterior Grandstand and Field audio systems shall include monitor speakers in the pressbox or control booth to ensure reasonable volume control is managed during each event. If no pressbox or control booth is anticipated to be staffed, ensure alternative volume monitoring equipment such as a live headset is available for District staff typically responsible for event and competition management.

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4. There may be more than one location for a projector and screen as determined on a per project basis.
 - a. Video display shall be via projector onto a projection screen. Depending on the height of the gymnasium, a projector lift may be required to meet PPS maintenance requirements. PPS OTIS Project Manager shall be consulted on this requirement.
 - b. The projector should be protected via an appropriately-rated cage.
 - c. For retrofit applications, Gymnasium AV systems may include a tabletop-style projector to be used, as needed, for teaching and special events.
5. The Gymnasium shall have one location for Audio/Video headend equipment – typically, this will be an adjacent space coordinated with the Architect.
 - a. On a per project basis, there may need to be a control location within the gymnasium at a location coordinated with the Architect.
6. The projector shall be a medium/large venue projector located in coordination with other ceiling-mounted equipment in the space.
7. The projection screen shall be a powered retractable screen.
8. The microphones shall be either via wired XLR connections or via wireless. The wired connection locations shall be coordinated with the other equipment in the space and with the Architect. The wireless connections shall be via an antenna in the space wired back to the Audio/Video headend location. The wireless microphones shall include both handheld and lavalier versions.
9. The audio speakers shall be a central cluster system located at the center of the gymnasium, angled down to cover the audience. Infill speakers may be required, depending on the acoustic volume and overall configuration of the gymnasium. Coordinate requirements for intelligibility and audio coverage with the Technology Project Manager.
10. The main equipment shall be installed in an environmentally controlled space.
11. Coordinate the design to include all special finish requirements and all exposed equipment locations within the gymnasium area. Considerations include but are not limited to acoustic performance, access, and equipment protection.
12. Acceptance testing to be performed with and signed off by the PPS OTIS Audio/Video Team.

Commons and Library/Media Center Audio/Visual

1. Commons and Library/Media Center spaces shall be designed for live audio performances typically with 1-5 microphones and audio reinforcement.
2. In new construction, Commons and Library / Media Center spaces shall be designed for program playback with full audio and video program sound and display.
3. The display shall be via projector onto a projection screen.

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4. Enable wireless broadcasting via Airtame (OFCI).
5. Airtame device shall be powered via network PoE.
6. The Commons and Library/Media Center shall each have one location for Audio/Video headend equipment – typically, this will be an adjacent space that will need to be coordinated with the Architect. For Commons areas, this space may also hold the headend equipment for the Gymnasium. There shall be a control location within the Commons and Library/Media Center spaces in a location coordinated with the Architect.
7. The headend equipment shall be located adjacent to the space and contain the equipment for all the audio and video systems. This includes audio DSP, audio amplification, main Audio/Video input output matrix, and the main Audio/Video system controller.
8. The projection screen shall be a powered retractable screen.
9. The projector shall be sized and recommended by the design team for the projection conditions.
10. The microphones shall be either via wired XLR connections or via wireless. The wired connection locations shall be coordinated with the other equipment in the space and with the Architect. The wireless connections shall be via an antenna in the space wired back to the Audio/Video headend location. The wireless microphones shall include both handheld and lavalier versions.
11. The audio speakers shall be a front of space wall mounted system. In-fill speakers may be required if the Commons or Library/Media Center space is large enough.
12. Main headend equipment is to be located in an environmentally controlled space.
13. Coordinate with the Architect for all room locations, special finish requirements, and exposed equipment locations within the Gymnasium area.
14. Acceptance testing to be performed with and signed off by OTIS Audio/Video Team.

Audio/Video Digital Signage

1. Digital signage monitors shall be commercial grade.
2. Mounting height to be 6' from the bottom of the screen or higher to prevent damage.
3. Layout and quantities shall be reviewed and approved by the PPS OTIS Project Manager.
4. PPS OTIS will furnish the digital signage platform.
5. Wall mounts are OFCI.

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27 51 13 IP PAGING

1. Install a fully operational Valcom-based IP paging system at new schools and major renovations. The system shall include software, speakers, power supplies, cabling and zone controllers. The District shall provide software and programming all hardware and cabling shall be provided and installed by the contractor. Provide end-point software licenses as required. Coordinate requirements with the District, noting the following:
 - a. Classrooms, conference rooms, work rooms, offices and other teaching spaces shall have IP-addressable talkback speakers.
 - b. Gymnasiums, auditoriums, cafeterias, commons, media center, hallways, boiler rooms, restrooms, and exterior shall have analog speakers connected to an IP-addressable zone controller.
 - c. Provide wire guards for speakers in gymnasiums.
 - d. All speakers and zone controllers shall be compatible with Informacast and Cisco IP phones and IP speakers must support two-way communication.
 - e. Speaker height not to exceed 12' AFF.
2. Exterior analog speakers shall address field(s), playground, courtyard(s), outdoor gathering areas and main entry areas and be zoned independently of interior analog speakers.
 - a. Recommended installation height 12' – 14' above adjacent grade.
3. Zone controllers shall be installed in the nearest Telecom/IT Room on the same floor. Cabling for all analog speakers shall be homerun back to the Telecom/IT Room.
4. Install white Category 6 cabling to each IP-addressable speaker and zone controller.
5. Speaker power supplies shall be on the backboard mounted in the Telecom/IT room and powered by the UPS.
6. Upon completion of project, create a matrix for zoning of analog speakers and provide to PPS OTIS Telecom for review and approval prior to installation.
7. Testing and Commissioning
 - a. Test all individual IP speakers and speaker zones and verify operational prior to acceptance testing.
 - b. Acceptance testing shall be performed with and signed off by OTIS Telecom Team.
 - c. For analog speakers, adjust volume levels to 70%.
 - d. Provide as-built drawings with speaker labeling.

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27 51 23 INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

Gym Call Box

1. Provide a Category 6 cable for a recessed wall mounted gym call box, terminated in the nearest TR.
2. Placement shall be in a non-runoff area in the gym. In locations where the gym call box cannot be placed in a non-runoff area or be fully recessed, wall padding shall be installed around it extending beyond the edges.
3. Placement shall be near emergency response equipment (i.e., AED or fire extinguisher). If no emergency equipment is installed, call box shall be placed near the main entrance to the Gym.
4. The top button of the box shall be no higher than 48" above finished floor.
5. Programming of this device is to be by the District.
6. Gym Call Box shall be the Valcom District standard red box with 2 buttons:
 - a. Top button to be labeled "Calls Office" and be routed to site's main office. Label is blue with white lettering and also includes braille.
 - b. Bottom button labeled "Calls 911" and will be routed to 911. Label is red with white lettering.
7. Contractor is to label the device per PPS Standards as an IP speaker.
8. The installation configuration shall be in accordance with code requirements ("ADA") for protruding objects.

27 51 29.17 TWO-WAY RADIO COMMUNICATION

District Two-Way Radio System

1. New and renovated schools shall include one Kenwood NXDN Digital UHF repeater.
2. System shall be compatible with the District's master radio template/existing two-way radios and UHF frequency.
3. Location shall be determined in consultation with and approved by PPS Security Services and the District's two-way radio contractor. The location shall be in a secure room with AC power and be located as close to the antenna as possible to provide the shortest coax run to limit RF loss.
4. Coordination with Security Services staff is required when using the District contractor.
5. System shall be open to enable the District contractor and Security Services to program and maintain.
6. Repeater Placement:
 - a. Centrally located to the campus.

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- b. Proximity to the antenna and AC power.
- c. Maximum possible elevation to ensure performance as well as access for maintenance, as approved by the Technology Project Manager.
- 7. Antenna Placement – see project specifications
- 8. All equipment, cabling, antennas, cabinets/enclosures, and surge protectors shall be bonded to the ground bars. Meet applicable code, as well as ANSI/TIA-607-D requirements.
- 9. Provide RF coverage map to the District Security Team.
- 10. Radio configuration and FCC License to be provided to the District.

27 53 13 CLOCKS

- 1. Clocks are wireless American Time and Signal devices connected to the network for time synchronization. Retrofits will match existing if a system is present and functioning.
- 2. Clocks will be placed in every classroom, office, commons, gymnasium, media center and other common spaces.
- 3. Clocks will be 15" diameter in commons and gymnasiums and 12-1/2" in all other areas.
- 4. Provide wire guards for clocks in gymnasiums.
- 5. The main controller shall be installed in an equipment rack in the most centrally-located IDF on the highest available floor.
 - a. Insert batteries in clocks and follow the manufacturer's detailed, written setup procedures.
 - b. Install clocks after construction, painting, and other finish work in each space is complete.
 - c. Verify that all clocks are receiving signal and displaying the correct time.
 - d. Provide conduit for the clock antenna between the main controller and the roof according to the manufacturer's written specifications.
- 6. Testing and Commissioning
 - a. Provide as-built drawings with clock labeling.

27 53 19 DISTRIBUTED ANTENNA SYSTEM / EMERGENCY RESPONDER RADIO COVERAGE

- 1. The Distributed Antenna System for emergency responder radio coverage shall comply with OSSC 915 and OFC 510.
- 2. Provide rated pathways per OSSC 915 for riser cabling.
- 3. Provide coverage testing in existing buildings or at 75% construction completion in new buildings to determine the extent of the system to be installed.
- 4. Provide shop drawings for review and approval by the District prior to commencement of work.

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5. Provide a complete system including the system, cabling, taps, antennas and connections for a full building coverage to support first responder radio and cell coverage.
6. Provide an uninterrupted power supply or connect to generator per code.
7. Represent the District to obtain required licenses for operation under FCC regulations.
8. Label all cabling at both ends, taps and antennas. Labels to be machine printed.
9. Conduct final testing and produce coverage maps for PPS.