

27 00 00 COMMUNICATIONS

**COMMUNICATIONS
SYSTEM DESIGN,
CONSTRUCTION AND
COMMISSIONING GUIDE**

FACILITY SPECIFICATION GUIDELINE



**University of Texas at Austin
INFORMATION TECHNOLOGY
SERVICES**

SECTION 27 00 00
COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Division 27 – Communications governs the infrastructure for the low-voltage information transport systems, which include voice, data, cable TV (CATV), and **[audio/video,] [mass notification,] [distributed antenna]** systems and their pathways.
- B. Description of Work:
 - 1. Furnish and install materials for the communications infrastructure systems as specified herein and as shown on the drawings. Upon completion, the systems shall be functioning systems in compliance with performance requirements specified.
 - 2. The cabling specified and shown on the drawings is for complete, performance based, workable systems. Deviations from the cabling shown due to a particular manufacturer's requirements shall be made only with the written approval of the Architect and the Owner, and at no additional cost to the Owner.
 - 3. **[This division also includes telecommunications cabling, connections, and equipment needed for the IP Video Camera Security System. Refer to Security System drawings for those locations, quantities and additional requirements.]**

1.2 RELATED DOCUMENTS

- A. Comply with the referenced codes and standards and with the Contract Documents. Where conflicts occur, the more stringent shall apply.
- B. The following codes, associations, acts and agencies, as required by law:
 - 1. Americans with Disabilities Act (ADA)
 - 2. Federal Communications Commission (FCC)
 - 3. National Electric Code (NEC)
 - 4. National Electrical Safety Code (NESC)
 - 5. National Fire Protection Association (NFPA)
 - 6. Occupational Safety and Health Administration (OSHA)
- C. The following standards:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society of Testing Material (ASTM)
 - 3. National Electrical manufacturers Association (NEMA)
 - 4. Telecommunications Industries Association (TIA)
 - 5. Electronic Industries Association (EIA)
 - 6. Institute of Electrical and Electronics Engineers (IEEE)
 - 7. Underwriters Laboratories (UL)

8. American Standards Association (ASA)

D. The following guidelines:

1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)

1.3 DEFINITIONS

- A. Advanced System Warranty – an extended telecommunications system warranty (15 years or greater) held either by the connectivity or cabling manufacturer directly with the owner for this project that guarantees product and performance of the entire cabling system for the warranty period. Refer to Warranty Requirements in Quality Assurance sub-section of this specification for additional information and requirements.
- B. Communications Room – a generic term for an equipment room or telecommunications room.
- C. Conveniently Accessible - being capable of being reached from floor or use of 8' step ladder without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.
- D. Design Engineer – As defined for sections referring to telecommunications work only, the Design Engineer shall be the design consultant employed by the Owner for the purpose of observing the work of the Communications Subcontractor(s).
- E. Entrance Room – A space in which the joining of campus and building telecommunications backbone facilities takes place.
- F. Equipment Room – An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect, as well as audio/video and security equipment.
- G. IDF – Intermediate Distribution Frame, also known as a Telecom(munications) Room or Communications Room.
- H. ITS Representative - For each project, the University of Texas at Austin will designate an official representative from ITS (Information Technology Services) Networking and Telecommunications.
- I. Lead Telecommunications Installer – acting as the project manager for the Telecommunications Subcontractor for all telecommunications work in the construction documents (T-series drawings and specification sections 27 00 00 through 27 39 99), who shall be on-site at all times while Division 27 work is being performed. This individual shall attend all construction project meetings. Lead Communications Installer and Project RCDD may be the same person, but not necessarily. Refer to other sub-sections in this specification section (27 00 00) for qualifications, requirements and responsibilities.
- J. Listed Communications Cable – A cable listed by the Underwriters Laboratory (UL) and acceptable to the local authority having jurisdiction as having met appropriate designated standards or has been tested and found suitable for installation in specific spaces. Refer to NEC Section 800 for listing types and additional requirements.
Assume Outside Plant (OSP) Cable being supplied to the building is not listed.
- K. MDF – Main Distribution Frame, also known as the Main Telecommunications Room.

- L. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system. *Assume space above suspended/accessible ceilings is a plenum.*
- M. Plenum-rated – listed by the Underwriters Laboratory as being suitable for installation into a plenum space. Communications cabling routed through plenum-rated space shall be plenum-rated and identified as Type CMP.
- N. Point of Entrance (Building Entrance) - The point within a building at which the Outside Plant (OSP) communications wire or cable emerges from an external wall, from a concrete floor slab, or from a rigid metal conduit (Type RMC) or an intermediate metal conduit (Type IMC) connected by a grounding conductor to an electrode in accordance with the NEC.
- O. Project RCDD – The Registered Communications Distribution Designer (RCDD) on staff of the Telecommunications Subcontractor responsible for ensuring all telecommunications work meets the construction documents (T-series drawings and specification sections 27 00 00 through 27 39 99) and the referenced codes, standards and guidelines. Refer to other sub-sections in this specification section (27 00 00) and other individual sections for Project RCDD qualifications, requirements and other responsibilities.
- P. Subcontractor, Audio/Video – company responsible for all audio-video work in the construction documents (AV-series drawings and specifications sections 27 40 00 through 27 51 99)
- Q. Subcontractor, Telecommunications – company responsible for all telecommunications work in the construction documents (T-series drawings and specification sections 27 00 00 through 27 39 99).
- R. Telecommunications – in general, telecommunications refers to infrastructure/equipment needed for the voice and data communications systems.
- S. Telecommunications Room - An environmentally enclosed architectural space designed to contain telecommunications equipment, cable terminations, or cross-connect cabling. The Main Telecommunications Room may also be known as the MDF, and may be co-located with the building's Entrance Room and Equipment Room. Other Telecommunications Rooms may be referred to as IDFs. Most Telecommunications Rooms will also house equipment for additional systems, such as security, cable television, and audio/video.
- T. UL – Underwriters Laboratory

1.4 QUALITY ASSURANCE

- A. Telecommunications Subcontractor Qualifications
 - 1. Company Requirements
 - a) The Telecommunications Subcontractor shall have total responsibility for the coordination and installation of the work shown and described in the telecommunications drawings and specifications. The Telecommunications Subcontractor shall be a company specializing in the design, fabrication and installation of integrated telecommunications systems.
 - b) Telecommunications Systems specified shall be engineered, assembled and installed under the direction of a pre-qualified Telecommunications

Subcontractor. Pre-qualification requirements shall include submittal by the Telecommunications Subcontractor to the Architect of the following:

- 1) List of previous projects of this scope and nature, including names and sizes of projects (to include square footage and construction cost – overall and that of the Telecommunications Subcontractor), description of work, times of completion, and names of contact persons for reference.
 - 2) Installers shall certify that they are manufacturer-authorized or trained for work to be performed.
2. Project RCDD Requirements:
- a) Project RCDD shall be a current Registered Communications Distribution Designer as awarded by BICSI from time of bid through project's substantial completion.
 - b) Project RCDD shall be a full-time employee of the Telecommunications Subcontractor.
 - 1) Ensure the RCDD's information is up-to-date on BICSI's website. UT ITS will verify the Project's RCDD status at the following website: <https://www.bicsi.org/forms/Verify/CredentialHolder/>
 - c) Submit copy of RCDD certificate with bid and pre-construction submittal package.
3. Lead Telecommunications Installer Requirements:
- a) Lead Communications Installer shall be a current member of BICSI in good standing and have completed (at a minimum) BICSI ITS Installer 2 Training (for both copper and fiber).
 - b) Submit certificate of ITS Installer 2 Training (or higher) with bid and pre-construction submittal package.
 - c) Advanced training from connectivity manufacturer may be submitted in lieu of BICSI ITS Installer 2 Training. Submit manufacturer training certificates for review by Owner as substitution request as part of Pre-Bid questions. This training must be by the same manufacturer that will hold the Advanced System Warranty.
4. General Telecommunications Installer Requirements:
- a) For all work associated with Specification Sections 270526, 270529, and 270553 through 271543, all installers are to have a minimum of BICSI ITS Installer 1 Training or equivalent training from the connectivity manufacturer.
 - b) Submit a list with bid of names of all installers and appropriate copies of certificates verifying training with pre-construction submittal package.
5. Other Installer Requirements:
- a) Refer to individual sections for additional installer requirements for other systems within Division 27.
- B. Audio/Video Subcontractor Qualifications
1. Refer to Section 27 40 00 for Audio/Video Subcontractor qualifications.

C. Warranty Requirements

1. Project Warranty

- a) Equipment and materials required for installation under these specifications shall be the current model and new (less than one [1] year from date of manufacture), unused and without blemish or defect, and are to be guaranteed to be free from defect for a minimum of one year from date of project's substantial completion.
- b) When a defect or problem is observed within the first year after substantial completion, the Owner will notify the governing subcontractor through the proper channels. The appropriate Subcontractor then has 48 hours to fix the defect or furnish and install a replacement part/system, all at no cost to the project or Owner.

2. Advanced System Warranty for Telecommunications (Copper and Fiber Systems)

- a) Beyond the initial one year project warranty, the Copper and Fiber Telecommunications Systems shall be warrantied for a minimum of 15 years by a national and reputable connectivity or cabling manufacturer.
 - 1) This warranty shall to cover any material defect, as well as the performance of the cabling system. (Example: A Category 5e cabling system is to deliver 1000BASE-T speed, or 1 "Gig" performance for the entire length of the warranty period.)
 - 2) This warranty shall cover both material and labor for the full length of the warranty period.
- b) The Telecommunications Subcontractor shall be certified by this manufacturer.
- c) The following manufacturers are conditionally approved to provide the system warranties (subject to specific project requirements):
 - 1) Copper Connectivity Manufacturers
 - (i) Ortronics
 - (ii) Panduit
 - 2) Fiber Connectivity Manufacturers
 - (i) Systemax
 - (ii) Corning
 - 3) Cabling Manufacturers
 - (i) Hitachi Cable Manchester
 - (ii) Mohawk
 - (iii) Superior Essex
 - (iv) Or approved equivalent (Refer to section 1.8, B, 1.)

1.5 COORDINATION

- A. When articles, materials, operations or methods related to execution of communications work are noted, specified, or described in the specifications or are

indicated or reasonably implied on drawings and schedules, execute work as required or appropriate to provide complete and proper function, operation and installation.

- B. The drawings utilize 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 and proper installation and operation. The Telecommunications Subcontractor shall install work complete and ready for proper operation, including related items not specifically identified, shown, indicated or specified. The work shall be installed, in accordance with the intent diagrammatically expressed on the drawings, and in conformity with the dimensions indicated on architectural drawings and on shop drawings approved by the Telecommunications and Audio/Video Engineers. When abbreviations appear on the drawings or specifications in upper or lower case letters, with or without periods, the resultant work shall be as stated above.
- C. The drawings include details for various items, which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the Telecommunications Subcontractor.
- D. The drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions.

1.6 EXISTING CONDITIONS

- A. Prior to bid, Telecommunications Subcontractor is to visit the existing building and evaluate all existing conditions. Bring to the attention of the Owner and Design Team any cause for concern or conflicts with the contract documents as soon as practically possible.

1.7 TRAINING

- A. The appropriate Telecommunications and Audio/Video Subcontractor shall be responsible for training of facility personnel in accordance with requirements of this Section and Division.
- B. Training shall take place within 2 weeks after substantial completion and shall include programs for on-site operations and maintenance of telecommunications and audio/video systems. Training shall be for not more than ten people, shall be held at the Owner's site in Austin, Texas, and shall be of sufficient duration and depth to ensure that the trained personnel can operate the installed systems and can perform usual and customary maintenance actions.

1.8 SUBMITTALS

- A. General Requirements
 - 1. Provide Submittals in accordance with Division 1.
 - 2. UT ITS Representative is to review and accept all submittals related to Division 27 work. This includes, but is not limited to, relevant:
 - a) Pre-bid questions,
 - b) Contractor and personnel qualifications with bid,
 - c) Voluntary alternates and unit pricings with bid,

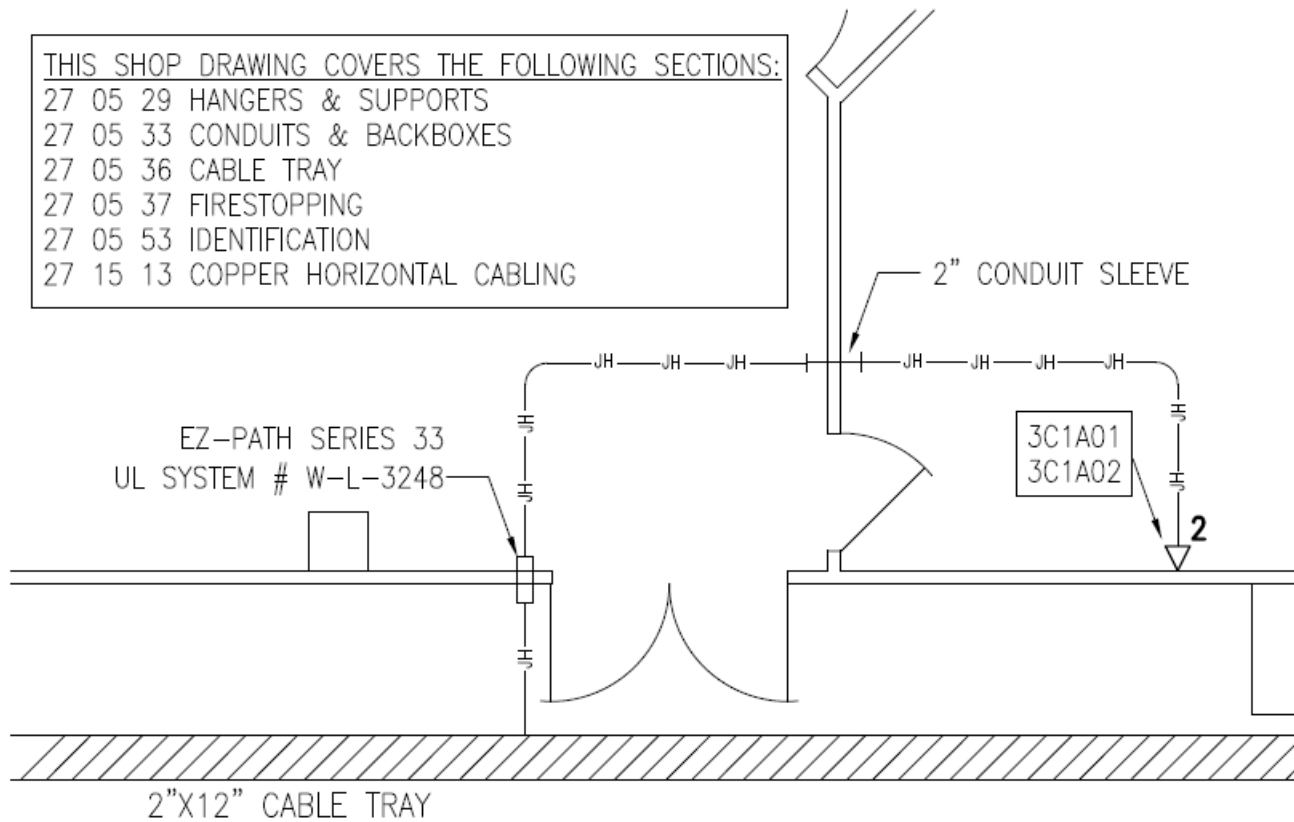
- d) Pre-construction product submittals and shop drawings,
 - e) Change order requests, requests for information (RFIs), design change directives (DCDs), and any other changes as directed by the architect/engineer.
 - f) Record drawings and warranty certificates/letters.
3. Please allow a minimum of one week (five working days) for the ITS Representative to review (once delivered to ITS).
- B. The following submittals are due at the Pre-Bid deadline for questions:
1. Requests for product substitution
 - a) All products seeking approval either as “approved equivalent” or otherwise, shall be submitted as a product substitution request prior to bid. Failure to submit product substitution request in a timely manner (before pre-bid questions are due) may preclude product from being utilized on the project. Requests made with bid or post-bid will not be considered without a significant cost savings realized to the Owner.
 - b) The burden of proof is on the contractor to provide documentation that equivalent product meets the specifications and project requirements. Include in substitution request:
 - 1) Product being replaced
 - 2) Reason for product substitution
 - 3) Full manufacturer specification sheet clearly indicating that all requirements in project documents have been met.
 - c) Failure to meet these requirements will result in the product substitution request being returned without review.
 - d) All product substitution requests are to be reviewed and approved by the Owner (ITS Representative). Not all requests will be approved, and all decisions are final, without recourse.
- C. The following submittals are due with the Bid:
1. Proof of Telecommunications Subcontractor and personnel qualifications.
 - a) Provide a typed list with the following information:
 - 1) Company name of Telecommunications Subcontractor.
 - 2) List of connectivity or cabling manufacturers that the Telecommunications Subcontractor is certified to install and provide advanced warranty for.
 - 3) List of previous projects (minimum of 3) of this scope and nature, including:
 - (i) Project name and date of completion
 - (ii) Project size (square feet of building, total construction cost, total cost of telecommunications scope)
 - (iii) Name and contact information for building owner or IT Manager.

- 4) Name and contact information for Project RCDD.
 - 5) Name and contact information for Lead Telecommunications Installer, the de facto project manager on-site at all times. (This may be the same person as the Project RCDD.)
 - b) Provide certificates or letter(s) from BICSI and manufacturers verifying by name these qualifications have been met.
 - c) Refer to Quality Assurance subsection in this specification section for additional requirements and qualifications.
 2. Proof of Audio/Video Subcontractor qualifications.
 - a) Provide a typed list with the following information:
 - 1) Company name of Audio/Video Subcontractor
 - 2) List of audio/video manufacturers Subcontractor is certified to install and program, as required by contract documents. (Example: Crestron, Electrovoice, etc.)
 - 3) List of previous projects (minimum of 3) of this scope and nature, including:
 - (i) Project name and date of completion
 - (ii) Project size (square feet of building, total construction cost, total cost of telecommunications scope)
 - (iii) Name and contact information for building owner or IT Manager.
 - 4) Name and contact information for Audio/Video Project Manager on-site at all times while audio/video equipment is being installed.
 - (i) Provide a list of previous projects for which this individual was the A/V Project Manager for.
 - (ii) Provide any certifications this individual has achieved, such as CTS-Installer, Crestron programming, etc.
 3. Voluntary alternatives (that realize substantial cost savings)
 4. Unit pricing for the following items:
 - a) Cost to add typical telecommunications work area outlet (with **[two]** cable drops) anywhere within the project/building footprint. This cost shall include electrical rough-in, cabling, faceplate, and modules at both ends for a complete and functioning outlet.
- D. The following submittals are due at the Pre-Construction Phase **[to be delivered to UT ITS Representative]**:
1. General Requirements:
 - a) Follow submission guidelines as outlined in Division 1. At a minimum, provide the requirements as outlined in this section. Where Division 1 requirements are more stringent, follow those *in addition to* the requirements in this section.

- 1) Strictly electronic submission to UT ITS Representative is acceptable. General contractor, architect, and engineering requirements may differ.
 - b) Ensure a cover page with Project Title, Telecommunication or Audio/Video Subcontractor company, and point of contact are included for all physical submittals.
 - c) Updated Personnel Qualifications
 - 1) Provide a list of names of all telecommunications installers with appropriate certificates from BICSI or the manufacturer.
 - 2) Submit Quality Assurance certifications for the installers of the submitted Firestopping Systems. Refer to Section 27 05 37 for these requirements.
2. Product Information, divided by Specification Section and in order as listed in specification. Identify the start of each specification section.
- a) Provide manufacturer's product information cutsheet or specifications sheet with the specific product number identified or filled out.
 - 1) Submitted cutsheets without specific product identified will result in the whole submittal being returned without review.
 - 2) No product substitutions will be considered post bid without a significant cost savings to the project to be realized by the owner – a minimum of \$1000, either in material or labor savings. For any product substitution requests post-bid, Telecommunications or Audio/Video Subcontractor shall submit an RFI through the proper channels with the requested documentation from the Pre-bid requirements above. Also, include realized cost savings. The project team may issue a change order (or its equivalent) for the product change at their discretion.
 - (i) One exception to this is if the specified product goes out of production and is unavailable before submitted shop drawings are approved. Telecommunications or Audio/Video Subcontractor is to submit an RFI explaining the situation and recommending an equivalent product with the same features at no cost change to the project or Owner.
 - (ii) Other exceptions may be considered. Telecommunications or Audio/Video Subcontractor is to submit an RFI explaining the situation.
 - 3) Specific product information to be included in submittal:
 - (i) Cable Trays - Include documentation from manufacturer that the cable tray system has been UL-tested to be continuously grounded.
3. Shop Drawings
- a) Generate electronic shop drawings in AutoCAD, dwg file format, version 2004, 2007, or 2009, saved to disk (CD-R or DVD+/-R) or USB Flash Drive with project name and number clearly indicated **[or uploaded to**

project website]. Shop drawings shall include Telecommunications or Audio/Video Subcontractor titleblock and included readily printable Plot/Drawing tabs with mview-window at a scale to not be less than 1/8"=1'-0" unless otherwise noted. The scale shall also be indicated on the drawings.

- 1) Acceptable electronic shop drawing sizes include: 8.5"x11", 11"x17", 22"x34", 24"x36" or 36"x48".
 - 2) It is permissible to incorporate multiple specification section requirements on a series of shop drawings, such as Hangers & Supports, Conduits & Backboxes, Cable Tray, Firestopping, Identification, and Copper Horizontal Cabling locations.
- b) Refer to individual sections for additional requirements.
- c) Grounding and Bonding Shop Drawings
- 1) Indicate fully-coordinated location and size/length of TMGB, TGBs, BCT and TBB conductors, and all splice points. (It is acceptable to incorporate grounding information on shop drawings with other Division 27 information, such as cable tray routing.)
 - 2) Provide scaled plan and elevation drawings of telecommunications rooms (not less than 1/4" = 1'-0") indicating fully-coordinated locations of TMGB and TGBs.
- d) Communications pathways
- 1) Hangers and Supports – indicate proposed routing of all cabling supported by j-hooks.
 - 2) Conduits and Backboxes – indicate proposed locations of communications outlets, conduits (including size), pullboxes (including size) and conduit sleeves (including size); should any of those locations or sizes differ from the construction drawings due to minor coordination issues, cloud the affected area and note why the change is necessary. (For major coordination issues, please submit an RFI.)
 - 3) Cable Trays - indicate size and proposed routing of all communications cable trays; should any of those locations or sizes differ from the construction drawings due to minor coordination issues, cloud the affected area and note why the change is necessary. (For major coordination issues, please submit an RFI.)
 - 4) Firestopping – indicate manufacturer, product/assembly, and UL system for all firestop penetrations required for communications cabling.
 - 5) Example:



- E. The following submittals are due during Construction (project closeout), in accordance with the submittal requirements in Section 27 00 00 Communications:
1. 3 weeks prior to Substantial Completion:
 - a) Record Drawings
 - 1) Modify reviewed and accepted AutoCAD shop drawings to include revisions based upon completion of work.
 - 2) Provide (1) printed set of record drawings to scale (not less than 1/8" = 1'-0").
 - (i) For Telecommunications T-sheets, the Project RCDD is to include their RCDD stamp on the drawings and provide a letter stating their portion of the project was installed to construction documents and referenced codes, standards and guidelines.
 - 3) This set is to include system function diagrams and details not on original construction documents.
 - b) Connection and programming schedules, as appropriate. (Microsoft Excel 2007 or cvs format)
 - c) Equipment material list, including quantities. (Microsoft Excel 2007 or cvs format)

- d) Test Results, in accordance with section 27 05 26 Grounding and Bonding for Communications Systems, 27 08 10 Optical Fiber Testing, and 27 08 20 Copper Testing.
 - e) Operation and Maintenance Manuals for all installed equipment (in accordance with Division 1)
 - 1) The manual shall be subdivided into separate specification sections with folders to identify subsystems of the integrated system.
 - 2) The manual will include Manufacturers' description literature (specification or cutsheet) for installed equipment.
 - 3) Provide the following additional information for each electronic system.
 - (i) Operations manuals for components and for system as a whole.
 - (ii) Maintenance manuals for components and for system as a whole.
 - (iii) List of spare parts (provide quantities), materials and suppliers of components. Provide name, address and telephone number for each supplier.
 - (iv) Emergency instructions for operational and maintenance requirements.
 - (v) Delivery time frame for replacement of component parts from suppliers.
 - (vi) Troubleshooting procedures for each system and for each major system component.
 - f) With the exception of the (1) printed set of record drawings, submit these files electronically either on disk (CD-R or DVD+/-R) or USB Flash Drive, with project name and number clearly indicated.
2. Within two weeks after Substantial Completion:
- a) Training for all Division 27 Systems
 - b) Warranty Certificates for the Advanced Telecommunications System Warranty for the copper and fiber systems with point of contact for any warranty claims.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.
- B. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer and part number.
- C. All products and materials shall be new and unused prior to their installation as part of this project. Refurbished items are not allowed.

PART 3 - EXECUTION**3.1 PROJECT RCDD**

- A. At a minimum, Project RCDD shall perform weekly inspections during construction to ensure Division 27 installation meets the requirements and recommendations in the referenced codes, standards, and guidelines.
1. The Project RCDD shall invite the Design Engineer and ITS Representative to these weekly inspections.
 2. Should any disparity be discovered by the Project RCDD, Design Engineer, or ITS Representative, contractor shall make necessary corrections without cost or time change to the project.

3.2 GENERAL

- A. Coordinate with all other trades prior to installation.
1. Telecommunications and Audio/Video Subcontractors shall meet with Electrical and General Contractors prior to construction to identify pathway and infrastructure space requirements.
 - a) At a minimum, the following items shall be discussed:
 - 1) Cable tray locations and clearance space above (12" if possible, with proper coordination)
 - 2) In-ceiling projection screens and other audio/video equipment.
 - b) Failure to coordinate sufficient space for telecommunications and audio/video infrastructure shall result in relocation of various systems by the contractor at no additional cost to owner.
 2. Prior to the start of work, the Telecommunications and Audio/Video Subcontractors shall carefully inspect the installed work of other trades and verify that such work is complete to the point where Division 27 work may properly commence. Start of work indicates acceptance of conditions.
 3. Coordinate location of equipment and conduit with other trades to minimize interference.
 - a) Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base building. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the Design Engineer as required by limited working space.
 - b) Holes shall be located so as not to affect structural sections such as ribs or beams.
 - c) Holes shall be laid out in advance. The Design Engineer shall be advised prior to drilling through structural sections, for determination of proper layout.
 - d) Structural Penetrations: Where conduits, wireways and other raceways pass through fire partitions, fire walls or walls and floors, provide an effective barrier against the spread of fire, smoke and gases.

- B. Follow all manufacturers' instructions and install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.
 - 1. In the event of discrepancy, immediately notify the Design Engineer through the proper channels. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.
- C. Protection of Systems and Equipment
 - 1. Asbestos Survey: Prior to the disturbance of any building materials, construction personnel must know the results of an asbestos survey.
 - 2. Lead Survey: Prior to the disturbance of any building materials, construction personnel must know the results of a lead survey.
 - 3. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.
 - 4. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on sides with securely fastened protective rigid or flexible waterproof coverings.
 - 5. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum-cleaned both inside (as appropriate) and outside before testing, operating or painting.
 - 6. As determined by the Design Engineer, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Design Engineer shall be final.
 - 7. Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.
 - 8. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer.
- D. Access to Equipment
 - 1. Equipment shall be installed in a location and manner that will allow convenient access for maintenance and inspection.
 - 2. Working spaces shall be not less than specified in the National Electrical Code for voltages specified.
 - 3. Where the Design Engineer determines that the Telecommunications Subcontractor has installed equipment not "conveniently accessible" for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the Design Engineer, at no additional cost to the Owner.
- E. Cleaning
 - 1. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by communications work.

2. Remove dust and debris from interiors and exteriors of telecommunications equipment (including electrical rough-in). Clean accessible current carrying elements prior to being energized.
- F. Completion
1. General:
 - a) Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.
 2. Results Expected:
 - a) Systems shall be complete and operational and controls shall be set and calibrated.
 - b) Testing, start-up and cleaning work shall be complete.
 - c) Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the Owner.
 3. Testing and Verification – General Requirements
 - a) Refer to individual sections for additional testing and verification requirements.
 - b) The Telecommunications Subcontractor shall verify that requirements of this specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.
 - c) Verification by Inspection: Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the specifications. Inspection may require moving or partially disassembling the item to accomplish the verification, included as part of the work at no additional cost to the Owner.
 - d) Verification by Test and Demonstration: The Telecommunications and Audio/Video Subcontractors shall verify by formal demonstrations or tests that the requirements of this Specification have been met. The Communications Subcontractor shall demonstrate that the communications systems components and subsystems meet specification requirements in the "as-installed" operating environment during the "System Operation Test". Even though no formal environmental testing is required, the communications Subcontractor shall measure and record temperature, humidity and other environmental parameters and the environmental conditions, which were encountered during the "System Operation Test".
 - e) Perform commissioning and pretest prior to enclosure of walls.
 - f) Perform system operation tests after full enclosure of walls.
 - g) System Operation Tests Conducted Upon Completion of Work: Upon completion of the Telecommunications and Audio/Video Subcontractor's Work, subject the system to functional and operational tests. When required, corrections determined by initial test results, have been

completed, fully retest the system. The Owner shall be notified in writing not less than seven days in advance of date of proposed final testing and inspection. The advance notice shall include certification that the installation is complete and operable and that the Telecommunications and Audio/Video Subcontractor has satisfactorily performed the final tests specified herein. The acceptance testing and final inspection shall be accomplished in the presence of the Owner and the Design Engineer. At least 10 days prior to scheduled system completion, the Telecommunications and Audio/Video Subcontractors shall submit, for approval by Owner and DESIGN ENGINEER, a test plan to completely test the telecommunications and audio/video systems. The Telecommunications and Audio/Video Subcontractors shall include in test plan, for acceptance by the Owner and Design Engineer, a complete and detailed final acceptance test check-off list ("punch list"). The list shall be a complete representation of specified functions and conditions, including contingency, priority and abnormal modes of operation. The arrangement of the list shall be such as to provide an orderly method of tabulating checks of system features, response and operation. The punch list shall include a designated space adjacent to each test procedure where the Design Engineer can mark his initials to indicate compliance with each test procedure. The Owner and Design Engineer may add items to this check-off list prior to Subcontractors' commencement of System Operation Tests. At the time of final acceptance testing, required tests shall be repeated and defects corrected until the system is found to be acceptable to the Owner and the Design Engineer. The Telecommunications Subcontractor shall maintain a log of test activities and results. Both electronic and printed copies of this log including copies of the signed-off punch list shall be submitted to the Owner within seven days of the testing.

4. Commissioning
 - a) Commissioning of the communications systems (telecommunications and audio/video) is to be completed by the Design Engineer for each system.
 - b) There shall be three phases of commissioning:
 - 1) Rough-in inspection
 - 2) Above-ceiling inspection (after cables are placed)
 - 3) Final inspection
 - c) Once electrical rough-in and pathways have been installed, but prior to walls and ceilings being installed, contractor shall request of the design team, in writing, for the official rough-in inspection to take place. The Design Engineer shall then schedule a time to be on-site to conduct this inspection; the Design Engineer shall also invite the ITS Representative to attend this inspection. If the ITS Representative is unavailable at that time, they may request another ITS employee attend in their place.
 - 1) At a minimum, the Design Engineer shall check the following items:

- (i) Accurate location and height above finished floor for all outlet boxes.
 - (ii) Accurate dimensions (particularly depth) of all outlet boxes and diameter of in-wall conduit serving outlet boxes.
 - (iii) Cable tray size, location, and clearance.
 - (iv) Location and size of all other communications conduits or pathways.
 - (v) That power receptacles within the communications rooms meet the design requirements.
- 2) The Design Engineer is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate communications subcontractor and all items are to be addressed. This report is not necessarily all-inclusive; should issues be discovered later in the project, the appropriate communications subcontractor is still responsible for corrections/repairs.
- d) Once all communication cabling has been installed and properly supported and walls have been painted, but prior to the installation of ceiling tiles/material, contractor shall request of the design team, in writing, for the official above-ceiling inspection. The Design Engineer shall then schedule a time to be on-site to conduct this inspection; the Design Engineer shall also invite the ITS Representative to attend this inspection. If the ITS Representative is unavailable at that time, they may request another ITS employee attend in their place.
- 1) At a minimum, the Design Engineer shall check the following items:
 - (i) That all items from the previous inspection have been corrected.
 - (ii) That communications cabling is routed correctly and adequately supported.
 - (iii) That communications cabling is not painted or over-sprayed.
 - (iv) That the installed communications cabling matches what was specified/submitted.
 - (v) That there are no kinks, splices, or other damage to the installed communications cabling.
 - 2) The Design Engineer is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate communications subcontractor and all items are to be addressed. This report is not necessarily all-inclusive; should issues be discovered later in the project, the

appropriate communications subcontractor is still responsible for corrections/repairs.

- e) Once all communications work has been completed, contractor shall request of the design team, in writing, for the official final inspection. *This request shall be made **3 weeks before substantial completion**.* The Design Engineer shall then schedule a time to be on-site to conduct this inspection; the Design Engineer shall also invite the ITS Representative to attend this inspection. If the ITS Representative is unavailable at that time, they may request another ITS employee attend in their place.
 - 1) At a minimum, the Design Engineer shall check the following items:
 - (i) That all items from the previous inspections have been corrected.
 - (ii) That all faceplates are installed, with the correct modules, quantity of modules, and approved labeling scheme.
 - (iii) That all equipment and cabling within communications rooms is installed per the contract documents, including all patch panels and wall blocks (with specified spare capacity), horizontal and backbone cabling labeling, and telecommunications grounding.
 - (iv) And all other items necessary to guarantee contract documents are met and complete and functioning communications systems are installed.
 - 2) The Design Engineer is then to issue a written report to the Architect identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate communications subcontractor and all items are to be addressed prior to substantial completion. This report is not necessarily all-inclusive; should issues be discovered within one year after substantial completion, the appropriate communications subcontractor is still responsible for corrections/repairs.

END OF SECTION

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