

SECTION 270001

GENERAL REQUIREMENTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 DEFINITIONS

- A. Acceptance Testing Authorities (ATA) - The individuals and/or business entities that participate in Acceptance Testing and report to the Owner when work appears to be complete. These parties represent the interest of the Owner.
- B. Authority Having Jurisdiction (AHJ) - The governmental agency or sub-agency having authority over the construction process and having the ultimate authority to enforce, uphold and rule on codes and safety compliance at the project site.
- C. Contractor – The entity(s) contractually responsible for performing work of this Division.
- D. Wherever the words “Site”, “Project Site”, or “Premises” appears in these specifications or related drawings, it shall be interpreted to mean all real estate, buildings and structures where work will be performed and where products will be installed and reside.
- E. Commissioning Authority – An agent of the Owner, often independent of the design team, responsible for ensuring compliance with the Owner’s project intent.
- F. Contractor of Record – The Contractor entering into a contract for all or part of the work of this division directly with the Owner, directly with the Construction Manager or directly with a General Contractor.
- G. Designer – The Consultant(s) representing the Owner and directly responsible for specification of work within this Division including their related drawings. The Designer may or may not be affiliated with the architectural or an engineering firm of record for this Project. The Designer is a member of the project Design Team.
- H. Furnish – To supply product or labor (context dependant) including all associated shipping, storage, travel, lodging, miscellaneous and warranty expenses.
- I. High Voltage – For the sake of this division, greater than 70.7VAC RMS; greater than or equal to 100VAC P-P; greater than 70.7VDC
- J. Install – To supply all labor, tools and incidental materials necessary to handle, store, mount, terminate, program, configure and adjust a product in order to fulfill the requirements of this project.
- K. Low Voltage – For the sake of this division, less than or equal to 70.7VAC RMS; less than 100VAC P-P; less than or equal to 70.7VDC
- L. Medium Voltage – For the sake of this division, greater than 70.7VAC RMS; greater than or equal to 100VAC P-P; greater than 70.7VDC.

- M. Nominal Operating Level: The standard signal voltage/power reference which a manufacturer has designed its product's inputs and outputs to operate at in order to achieve specified performance.
- N. Provide – To furnish and install, inclusive of accessories, modules, and ancillary items necessary to render the respective product and system fully operational and usable to the Owner for its intended purpose.
- O. Substantial Completion
1. The point in this project where all work of this Division that occurs at the project site has been completed. For work to be substantially complete, all of the following must be valid:
 - a. All products have been delivered and installed at the project site, and;
 - b. All portable and loose equipment has been delivered, and;
 - c. All systems have been installed, adjusted and are usable by the owner for their intended purpose, and;
 - d. All products, including cables, have been labeled in accordance with these specifications and related drawings, and;
 - e. All systems are performing in accordance the design intent of these specifications, drawings and reference standards, and;
 - f. All systems have been demonstrated as complete and working to the
 - g. Designer, and;
 - h. All systems have been demonstrated as complete and working to Owner, and;
 - i. The Contractor has successfully completed Acceptance Testing of all work of all sections.
 - j. The Contractor has complied with all additional requirements of the
 - k. Contract.
- P. Work – The supply of products, materials, labor, incidentals and services necessary to fulfill the complete requirements of this project.
- Q. Acronyms and Abbreviations
1. ADA - Americans with Disabilities Act
 2. AM – Amplitude Modulation
 3. ANSI – American National Standards Institute
 4. ASME - American Society of Mechanical Engineers
 5. ASTM – American Society of Testing Materials
 6. ATM – Asynchronous Transfer Mode
 7. AWG – American Wire Gauge
 8. BGP – Border (Boundary) Gateway Protocol
 9. BICSI - Building Industry Consulting Services International
 10. BIT – Binary digit
 11. BOM – Bill of Material
 12. Bps – Bits per second
 13. BRI – Basic Rate Interface
 14. CAD – Computer Aided Design
 15. CAN – Campus Area Network
 16. CATV – Community Antenna Television
 17. CCITT – Consultative Committee for International Telegraphy and Telephony
 18. CCTV – Closed Circuit Television
 19. CDDI – Copper Distributed Data Interface
 20. CLEC – Competitive Local Exchange Carrier
 21. CPE – Customer Premises Equipment
 22. CPU – Central Processing Unit
 23. CSA – Canadian Standards Associations

24. CSMA/CA – Carrier-Sense Multiple Access with Collision Avoidance
25. CSMA/CD – Carrier-Sense Multiple Access/Collision Detection
26. CSU – Channel Service Unit
27. db - Decibel
28. Device ID – A system specific label assigned to a product to uniquely identify it within a given a system.
29. DSL – Digital Subscriber Line
30. DSU – Data Service Unit/Digital Service Unit
31. DTE – Data Terminal Equipment
32. EF – Entrance Facility
33. EGP – Exterior Gateway Protocol
34. EIA – Electronics Industries Association
35. EMI – Electromagnetic Interface
36. ER – Equipment Room
37. ETSI – European Telecommunications Standards Institute
38. FCC – Federal Communications Commission
39. FDDI – Fiber Data Distributed Interface
40. GAN – Global Area Network
41. GB – Giga Byte
42. Gb/s (Gbps) – Gigabits per second
43. GHz – Gigahertz
44. IDF – Intermediate Distribution Frame (Replaced by TR)
45. IEEE – Institute of Electrical and Electronics Engineers
46. IP – Internet Protocol
47. IPX – Internet Packet Exchange
48. ISDN – Integrated Services Digital Network
49. ISO – International Organization for Standardization
50. ISP – Internet Service Provider
51. LAN – Local Area Network
52. LANE – LAN Emulation
53. LASER – Light Amplification by Stimulated Emission of Radiation
54. LAT – Local Area Transport
55. LATA – Local Access and Transport Area
56. LEC – Local Exchange Carrier
57. LED – Light Emitting Diode
58. MAC – Media Access Control
59. MAN – Metropolitan Area Network
60. MB – Mega Bytes
61. Mb/s (Mbps) – Megabits per second
62. MDF – Main Distribution Frame (Replace by ER)
63. MHz – Megahertz
64. MODEM – Modulator/Demodulator
65. ms – millisecond
66. MTBF – Mean Time Between Failures
67. MPLS – Multi Protocol Label Switching
68. OC – Optical Carrier
69. OFCI – Owner Furnished Contractor Installed
70. OFE – Owner Furnished Equipment
71. OFOI – Owner Furnished Owner Installed
72. OSI – Open Systems Interconnection
73. PAN – Personal Area Network
74. pps – Packets Per Second
75. PRI – Primary Rate Interface
76. PSTN – Public Switched Telephone Network
77. QoS – Quality of Service

- 78. RAID – Random Array of Inexpensive Disks
- 79. RAM – Random Access Memory
- 80. RBOC – Regional Bell Operating Company
- 81. RF – Radio Frequency
- 82. RFC – Request For Comment
- 83. RFI – Request For Information/ Radio Frequency Interference
- 84. RFP – Request For Proposal
- 85. RFQ – Request For Quotation
- 86. RIP – Routing Information Protocol
- 87. RMON – Remote Monitor
- 88. ROM – Read Only Memory
- 89. SMTP – Simple Mail Transfer Protocol
- 90. SNA – Systems Network Architecture
- 91. SNMP – Simple Network Management Protocol
- 92. SONET – Synchronous Optical Network
- 93. TB – Tera Byte
- 94. TCP – Transmission Control Protocol
- 95. TCP/IP – Transmission Control Protocol/Internet Protocol
- 96. TIA – Telecommunications Industries Association
- 97. TR – Telecommunications Room
- 98. VoIP – Voice over Internet Protocol
- 99. WAN – Wide Area Network

1.2 QUALITY ASSURANCE

- A. The Contractor shall have a business history of at least (5) years performing Work of similar type as that specified in these project documents. In addition, the Contractor shall also be able to demonstrate through valid references and other Designer required support information that it has successfully completed no less than (6) projects of similar or greater contract value, with like system types, and including similar scope of work within the last 24 calendar months. This applies to each section of work individually.
- B. Contractor shall be a “factory-authorized” reseller (distributor, dealer, integration partner and/or channel partner) for at least 70% of the product value to be supplied.
- C. Contractor shall have substantial business operations located within a (300)-mile radius of the project site with full-time employee staff actively engaged in the supply, installation and service of systems and equipment of the type and scope herein specified.
- D. Contractor shall have full-time employee service staff based within a (50)-mile radius of the project site.
- E. Contractor shall supply any additional information requested by the Designer deemed appropriate by the Designer to validate the Contractor’s qualifications and its ability to perform and warranty the specified work within the time frame allotted and of the quality expected.
- F. Contractor shall provide the services of locally licensed and authorized electrician(s) to perform that portion of the work of this division that is required by the applicable codes and/or the AHJ to be performed by licensed electrician(s).
- G. Superintendent/Project Manager
 - 1. The Contractor shall furnish the services of an experienced superintendent/Project Manager who shall be constantly in charge of the work, together

with a qualified Foreman and technical specialists to properly install, connect, adjust, start, operate and test the work involved.

2. The superintendent's/Project Manager's qualifications shall be subject to the review and acceptance by the Designer and Owner. Unless the Designer and Owner grants prior special permission, the same Superintendent/Project Manager shall be utilized throughout the duration of the project and shall remain responsible for the complete scope of the Contract.

H. Subcontractors

1. If the Contractor, as a singular entity, does not meet 100% of the quality assurance requirements for all specification sections, the Contractor shall enlist the services of qualified subcontractors to perform the work of those section(s) for which Contractor is not fully qualified. This includes but is not limited to the supply of the products for the section but also the supply of the project engineering services, preparation of shop drawings and section submittals, technical installation labor, training, warranty, post installation support and service.
2. The Contractor shall ensure that each Subcontractor supplies the services of a project manager to represent the interest of the Subcontractor at all project meetings in which the Contractor is also required to participate. This requirement is mandatory as an aid towards ensuring that the special needs and timing of subcontracted work are fully represented to the project team.
3. The Designer and Owner reserve the right to disqualify the use of any subcontractor that does not meet the quality assurance requirements set forth in these specifications. Should a subcontractor be disqualified, the Contractor shall supply the services of a different subcontractor that complies with the published quality assurance requirements. The Contractor is solely responsible for costs incurred as a result. It is therefore incumbent upon the Contractor to pre-qualify subcontractor choice(s) prior to submitting pricing for work.
4. For the purposes of achieving quality assurance compliance, an equipment vendor that is not performing the technical installation labor associated with work of a section shall not be considered a subcontractor

I. Trainer Qualifications

1. Individual(s) conducting training shall be fully knowledgeable of the product, system and technology on which they will be training. These individuals shall be factory trained, factory certified and/or otherwise approved by the Designer as having sufficient experience and knowledge in the area of interest to conduct training.

1.3 SUBMITTALS

- A. Refer to Section 26 00 15 "Submittals".

1.4 WARRANTY

- A. Unless otherwise noted, all materials and workmanship furnished shall be covered by the Contractor for a minimum period of (1) year from date of Acceptance Testing Completion or Substantial Completion (whichever is later) for related work.
 1. Supplied products with manufacturer's warranties of less than the warranty term shall be extended by the Contractor for the full specified warranty term.
 2. Supplied products featuring a standard manufacturer's warranty whose term extends beyond the Contract Warranty term shall be shall be facilitated by the Contractor for the full duration and conditions of the manufacturer's warranty.

- B. The Warranty supplied shall be a full "System Warranty" that covers all supplied products, onsite and off-site labor and related personnel transportation and product shipping expenses.
 - 1. During this period the Contractor will remedy (at no cost to the Owner) any problem with the system, or any of its related components that is the result of defective materials, equipment settings, workmanship, or loss of programming.
- C. Individual sections of this Division may feature more stringent requirements than those set forth in this section. The most stringent of these requirements shall apply.
- D. All warranty work shall be performed at the Contractor's expense and to the satisfaction of the Owner and Designer.
- E. Response Requirements
 - 1. During the Warranty Period, the Contractor shall:
 - a. Respond by phone within four (4) business hours of notice by the Owner of a problem, and;
 - b. Supply qualified personnel onsite within (1) business day or (72) contiguous hours (which ever comes first) to begin remediation of the problem, if the problem cannot be remediated over the phone in less time, and;
 - c. Supply "on-call" emergency response service labor (at the request and authorization of the Owner) at a hourly rate that does not exceed the Contractor's published emergency service rates, nor two-times the Contractor's standard hourly rate, whichever is lower.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials, apparatus and equipment shall bear the Underwriter's Laboratory, Inc. label (or other nationally recognized testing laboratory label) where regularly supplied, and as additionally required by Code.
- B. All products furnished shall be new, full weight and of the best quality. All similar materials shall be of the same type and from the same manufacturer.
- C. In the event that a specified product is discontinued by the manufacturer and is no longer available for purchase, the Contractor shall provide replacement product of equal or greater value, performance and function as that of the Basis of Design product. The replacement product shall be from the same manufacturer as that of the Basis of Design equipment unless written permission has been granted by the Designer. The Contractor is solely responsible for researching and submitting proposed replacement product. The final decision as to whether a Contractor proposed replacement is acceptable lies solely with the Designer
- D. Substitute products will only be considered provided that the Contractor has strictly adhered to the guidelines set forth by Division 1 Specifications.

PART 3 - EXECUTION

3.1 WORK AND WORKMANSHIP

- A. Provide all required labor, materials, equipment and Contractor's services necessary for complete installation of systems required to comply with the requirements of authorities having jurisdiction, as indicated on Drawings, and as specified.
- B. Work shall be functional and complete in every detail, including any and all items required to complete the system, regardless of whether all items have been fully enumerated or shown on the Drawings.
- C. Special attention shall be given to access to working and controlling parts. Adjustable parts shall be within easy reach. Removable parts shall have space for removal.
- D. Contractor and Subcontractors shall be fully knowledgeable of the details of all Work to be performed by other trades and shall take necessary steps to integrate and coordinate Work of This Division with that of other Divisions and other trades.
- E. Wherever tables or schedules show quantities, they shall not be interpreted to represent the total contract quantity requirement, but instead a portion of the contract requirement. The Contractor shall be responsible for the higher quantity communicated by the drawings, within the specifications and on the schedules/tables. Seek clarification from the Designer should a discrepancy between them be found.
- F. The Designer and Owner's Representative have the full power to condemn or reject any Work, materials or equipment not in accordance with these Specifications and Construction Drawings or the manufacturer's specifications or drawings reviewed by the Designer or Owner.
- G. Work or equipment that is rejected shall be removed and replaced to the satisfaction of the Owner at the Contractor's expense. Work or equipment that is rejected shall be so stated in writing by the Owner or Designer.
- H. Such decisions that the Owner or Designer may make with respect to questions concerning the quality, fitness of materials, equipment, and workmanship shall be binding upon the parties thereto.
- I. Work shall fully comply with these specifications and related Drawings and all manufacturers recommended installation guidelines.
- J. All Work shall be performed with the best practices of the trade for performance, functionality, safety, endurance, and aesthetics.
- K. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the schedule.
- L. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible. Consult the Designer for direction.
- M. Set all equipment to accurate line and grade, level all equipment and align all equipment components.
- N. Supply scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.

- O. Equipment shall not be hidden or covered up prior to inspection by the Owner's representative. Work that is determined unsatisfactory shall be corrected immediately.
- P. Work shall be installed level and plumb, parallel and perpendicular to prevailing building lines, except as expressly detailed otherwise or required for proper form, function or Designer intended operation.
- Q. Install equipment and materials in strict accordance with the manufacturer's written instructions. Bring conflicts between the manufacturer's written instructions and these project documents to the attention of the Designer for review and direction.
- R. Upon completion of installation of equipment and communication circuitry, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with re-testing.

3.2 TESTING

A. General

- 1. Upon complete physical installation of products, the Contractor shall align, balance, and adjust equipment to make it usable to the Owner for its intended purpose, and to ensure compliance with all related drawings, specifications and references.
- 2. The Contractor shall fully test each system, and each component thereof, and correct all deficiencies prior to scheduling acceptance testing.
- 3. Replace malfunctioning or damaged products with new product, following immediately with retesting until satisfactory performance and specification compliant conditions are achieved.

B. Operational Testing

- 1. Perform operational testing of all supplied products, individually and collectively, to verify conformance with these project documents, and as required ensuring compliance with the product manufacturer's published specifications and as additionally necessary for the system to meet the intended purpose.
- 2. Perform operational testing of Owner furnished equipment to the extent necessary to verify overall system functionality and specification compliance. Report any compliance problems that are directly the result of Owner Furnished Equipment.
- 3. Although each system requires additional supplemental testing to confirm compliance, the following testing shall be conducted as they apply to the supplied systems products.
 - a. Verify all functions of all supplied equipment as applicable to the design, functionality and intended use of the system.
 - b. Test each system inputs and output.
 - c. Test each remote control.
 - d. Test each source device
 - e. Setup and test portable equipment.

C. Performance Testing

- 1. Perform all measurements and testing necessary to demonstrate performance compliance.

3.3 ACCEPTANCE TESTING

- A. Acceptance Testing is conducted by the Designer and/or the Owner's designated Commissioning Authority and/or the Owner.
- B. Acceptance testing occurs following the submittal and review of required Pre-Acceptance Submittal(s).
- C. Acceptance testing may include, but may not necessarily be limited to:
 - 1. Visual and mechanical inspections of Contractor's workmanship
 - 2. Inventory of equipment
 - 3. Random system and/or component measurements to verify compliance with specifications and to check of the accuracy of the Pre-Acceptance Submittal and as-built drawings
 - 4. Inspection of system components, sub-systems, software, component functionality, etc...
 - 5. Other tests and/or inspections as determined necessary by the Designer
 - 6. Functional tests of system
 - 7. Performance measurements of components or groups of components
- D. The Contractor shall be onsite in advance of the scheduled acceptance testing time to get prepared for and stage for testing. Contractor shall schedule and coordinate acceptance testing with all parties. Contractor shall coordinate and ensuring free access into all areas of work.
- E. The Contractor shall have qualified technical representation onsite to work with the Designer during Acceptance Testing. The representative(s) shall be fully familiar with aspects of the work being evaluated.
- F. Prior to the start of Acceptance Testing the Contractor shall have turned over a copy of the most up-to-date as-built documentation.
- G. The Contactor shall furnish and shall have present at the project site test equipment, cables, tools and personnel necessary to test, verify and demonstrate any product, operation, and workmanship deemed necessary by the Designer.
- H. The Contractor shall be prepared to demonstrate the presence of supplied products, cabling and installation methods. The Contractor shall be prepared to demonstrate the operation of all systems (and each requested component thereof) and shall be prepared to make electronic, physical or software related adjustments to the system or any of its components to the satisfaction of the Designer.
- I. Corrective actions may not be undertaken by the Contractor during Acceptance Testing that in any way impedes Acceptance Testing progress or negatively alters the day's schedule.
- J. Acceptance Testing shall not pass if any of the following conditions are true.
 - 1. Inspections do not substantially match the Pre-Acceptance Submittal.
 - 2. Inspections do not match the criterion of these specifications.
 - 3. The Contractor's workmanship does not appear to be of professional quality.
 - 4. The Contractor has failed to follow established installation requirements.
 - 5. As-built drawings have not been presented to the Designer prior to the commencement of Acceptance Testing.
 - 6. As-built drawings are found to be incomplete or inaccurate.
 - 7. More than one cable is found to be missing a required label.
 - 8. More then one cable is found to be inaccurately recorded on the as-built drawings.

9. Installed equipment does not match the equipment specified and/or previously authorized for use by the Designer.
 10. More than one unit of equipment, cable, connector, circuit, etc... fails to pass a test performed on it.
 11. There are substantive workmanship issues judged by the Designer to be negative and are of material importance to the long-term usability, safety, professional appearance, or service and maintainability of the Contractor's work.
 12. There is any material deviation from the intent of these specifications.
- K. Contractor is entitled to no more than (2) acceptance testing visits per system. One primary visit and one follow-up (secondary) visit. The Contractor is responsible for reimbursement of Designer fees associated with each additional visit that is the result of the Contractor's failure to be complete; the Contractor's failure to comply with the requirements of the contract documents; or the Contractor's failure to be fully prepared for acceptance testing at the date and time scheduled. The cost for subsequent acceptance testing visits shall be \$1500 per person, per day, plus travel and other expenses.
1. An Acceptance Testing report (i.e. punch list) will be supplied by the Designer following each official Acceptance Testing visit enumerating issues found during the visit.
- L. Should the Designer conclude that the Contractor has inaccurately represented the level of completion, the Designer reserves the right to abort the balance of the days' scheduled acceptance testing and the Contractor shall be docked one acceptance testing visit for each system not evaluated.

3.4 TRAINING

- A. Training shall be supplied for each section of this Division and for each unique system provided.
- B. The Owner shall have the right to use total allocated training for a period of (365) calendar days following final completion of onsite work, solely at its discretion.
- C. Training shall be supplied as expressly identified within individual sections. Where training requirements are not otherwise expressly identified, the Contractor shall supply a minimum of (2) hours per unique system, per section. The Contractor shall presume that at least (2) discrete trips to the project site shall be required per unique system to conduct training.
- D. Training dates and times shall be coordinated with the Owner's designated training representative(s).
- E. Training shall cover the following:
 1. Normal system use and operation
 2. Procedures and schedules involved in troubleshooting and performing routine preventative maintenance.
 3. Other facets as identified in individual sections
- F. Agenda and relevant training handouts shall be prepared and distributed to attendees at each training session.
- G. A sign-in sheet shall be created and used for each training session. The sheet shall:
 1. The section and system(s) being trained upon.
 2. The date and starting time of the session.
 3. The signatures of all attendees.

4. The ending time of the session, along with a separate owner signature certifying the ending time.
 5. Have attached to it a copy of the training outline/agenda.
- H. Recording of Sessions
1. When a related section requires recording of supplied training sessions they shall be recorded.
 2. Recordings shall be supplied on DVD video format media playable in standard consumer grade reproduction appliance. Recordings do not need to be professionally edited but shall feature intelligible audio and a clear image of the subject trainer and any supplemental visual content material to the training.
 3. Recordings shall be turned over and signed for by an Owner's training representative at the end of each session. A copy of a signed delivery receipt shall be included as part of the Contractor record documentation.
 4. Contractor shall require each attendee to sign-in at the start of each training session. The sign-in form shall summarize the training conducted, specification section and system being trained on, as well as the starting time and duration of training. Following training, a representative of the Owner shall sign the form, acknowledging the same. Contractor shall retain the original copy of these forms and turn over a photo copy of the form to the Owner's representative as evidence of training. Training conducted without this official record of training shall not be considered as part of the Contractor's training obligation.
- I. In order for all training sessions to count towards the Contractor's training obligation, each of the following shall be met.
1. Training occurs after Training Submittal review.
 2. Training session outlines/agenda are distributed at each session.
 3. Quality Assurance requirements for trainer have been met.
 4. Training occurs after the system / section is fully complete and working (usually following final Acceptance Testing). Training in advance of this requires Designer approval.
 5. Contractor fully complies with sign-in sheet requirements for every session.
 6. Contractor maintains a master training log.

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SECTION 270502

BASIC MATERIALS AND METHODS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. All work performed shall be performed in accordance with all Codes applicable at the project site. The authority having jurisdiction shall have the final say as to whether code compliance has been achieved.
- B. Wherever the contractor believes, or the authority having jurisdiction advises, that work required by these contract documents is in conflict with applicable codes, the Contractor shall immediately advise and seek the direction of the Designer.

1.2 TOOLS

- A. Tools shall be used only for the purpose for which they are designed.
- B. Specialty tools shall be used for assembly, installation, termination, and removal of products as recommended by the product manufacturer.
- C. The designer reserves the right to require removal and replacement of any product installed using incorrect tools.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate installation of pathways before installation of pathways, including when pathways installation is not work of This Contractor.
- B. Review pre-existing pathways prior to installation of work and report to the Designer any discrepancies between specified pre-existing pathway conditions and actual existing pathway conditions.
- C. Coordinate with all other Contractors and the Owner, as applicable and necessary to ensure clean, professional looking and operating systems.
- D. Participate in coordination efforts through the preparation of shop drawings and details prior to fabrication or installation of any products. Coordinate actual clearance requirements of installed products.

- E. Begin coordinate immediately upon award of contract. Coordinate work with all other trades and adjust equipment locations accordingly. Refer to coordination drawings prepared by other trades; generate and supply the same for use by other trades.
- F. It is generally intended that all apparatus be located symmetrical with architectural elements and shall be installed at the heights and locations shown on the drawings. If a device height or location is in question it shall be the responsibility of the Contractor to immediately seek clarification of the Designer.
- G. The Contractor shall fully inform himself regarding all peculiarities and limitations of space available for installation of all work and materials furnished and installed under the contract. He shall exercise due and particular caution to determine that all parts of his work are made quickly and easily accessible. Although the locations of equipment and conduit may be shown on the drawings in certain positions, the architectural details and conditions existing at the job site shall guide the Contractor, coordinating his work with that of others. Provide all necessary offsets to provide a neat workmanlike arrangement.
- H. Plans are generally diagrammatic and indicate the design intent, required sizes, points of termination and, in some cases, suggested routes of raceways, etc. However, it is not intended that plan drawings indicate fully coordinated routing and placement, all necessary offsets, etc...
- I. Contractor shall refer to all drawings, including enlarged plans, elevations, sections, and details for additional information that may include dimensions and greater resolution and notes that serve to refine the intent and further assist and guide the Contractor.
- J. The Contractor shall work in harmony with all other contractors and subcontractors performing work at the project site, so as not to cause any delays in pouring concrete, building masonry walls, etc. This Contractor shall consult ALL project drawings, including those predominately used by other trades before installing his work so as to ensure that his work will not interfere with or be adversely affected by work of other trades. This Contractor shall take all necessary steps to ensure a coordinated installation of his work.
- K. This Contractor shall attend all regularly scheduled project meetings as well as any special meetings called to coordinate and/or resolve special issues that arise during the course of the project.
- L. Conflicts in equipment and materials shall be corrected prior to installation. Should there be a conflict with drawings of other trades, this Contractor shall work with the trades to correct the conflict while coordinating the project (prior to installation). If the conflict cannot be resolved, refer the matter to the owner's representative for a final decision as to method or material. This Contractor shall refer to drawings of all other trades for details, dimensions and locations of other work and route their work so as not to conflict with any other branch. Any work installed or equipment placed in position by this Contractor creating a conflict shall be readjusted to the satisfaction of the owner's representative at the expense of this Contractor.

3.2 INSTALLATION

- A. General
 1. Work installed in finished areas shall be concealed. Work installed in unfinished areas may be exposed at the discretion of the Owner's representative and approved in writing.
 2. Sequence, coordinate, and integrate installations of communications materials and equipment with the work of other trades for efficient flow of the Work.

3. Install systems, materials, and equipment to conform with reviewed submittal data, including coordination drawings, to greatest extent possible.
4. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and architectural/structural components.
5. Install equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.
6. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
7. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
8. Verify all dimensions by field measurements. Take measurements and be responsible for exact size and locations of all openings required for the installation of work. Figured dimensions are reasonably accurate and should govern in setting out work. Where detailed method of installation is not indicated or where variations exist between described work and approved practice, direction of the owner's representative on job shall be followed.
9. The symbols used to indicate the purpose of various outlets is identified in the
10. Legend.
11. The conductors terminating at each wired outlet shall be left not less than 8" long at their outlet fittings to facilitate installment and servicing of devices.
12. If during construction it becomes apparent that certain minor changes in layout will affect a neater job or better arrangement, such alterations shall be made as part of the contract. Designer's review shall be obtained before making such changes.
13. Workmanship throughout shall conform to the standards of best practice. Marks, dents or finish scratches will not be permitted on any exposed materials, fixtures or fittings. Inside of panels and equipment boxes shall be left clean.
14. All termination types shall correctly match cable and device termination point.
15. As an illustration if "spade lug" type of termination is appropriate then the spade lug cable entry size should match the cable used. The spade lug shall also have the correct stud size to match the terminal to which it will be connected. Terminations shall be completed with tools designed and sized for the specific application and connector.
16. Use caution not to exceed the manufacture allowed bending radius for cables and not to compromise the integrity of the cables during installation by pulling cable management devices too tightly, damaging cables, etc. Raceway/Cabling bending radii shall be minimum as directed by cable manufacturer. Use pulling compound or lubricant, where necessary, but ensure that the type of compound is compatible with and will not deteriorate the conductor or cable insulation.
17. Neatly dress all cable work and provide vertical and horizontal cable management (or other approved method) for properly dressing all work at racks, control panels, backboards etc. See detail(s) and other drawings for additional information.
18. Low-voltage cables shall be kept as far from electrical cables and equipment as possible. Avoid running low-voltage cables parallel to medium and high- voltage cables. When parallel runs cannot be avoided, keep low-voltage cables at least 24 inches away and cross cables at 90 degrees to minimize the risk of interference.
19. Avoid running low-voltage cables any closer than 24 inches to any ballast type lighting fixture or other high RF energy producing device.
20. All cables shall be supported/anchored at maximum 4 foot intervals and within
21. 12" of box or outlet. All cables shall be neatly bundled and secured to discrete cable supports at four-foot intervals.
22. Furnish color-coded cable jackets to identify runs of different systems.
23. Neatly route cables parallel and perpendicular to building architectural lines.
24. Neatly comb out multiple cable bundled runs to remove tangling and crossing of cables within the bundles.

25. All cable assemblies, etc. shall be run as straight as possible and symmetrical (perpendicular to or parallel with) with architectural items and in a consistent elevation. Work installed diagonal to building members shall not be permitted.
- B. Cable Separation
1. Cables for each system shall be installed separately and isolated from cables from other systems.
 2. Cables carrying signals of different types and different nominal operating levels shall be kept separated to reduce the risk of undesirable interference and cross-talk between cables.
 - a. As a general rule, for each 25dBV difference in nominal operating level between cables, Contractor shall provide at least 6 inches of separation. Example 1: cables with a 75dBV level difference between them shall be separated by 18 inches or greater. Example 2: Cables with a 13dBV difference between them shall be separated by 3 inches or greater.
 - b. Contractor shall provide additional separation to prevent and to remedy any crosstalk that adversely affects the performance and usability of the system, or that exceeds specific crosstalk performance guidelines defined elsewhere in these specifications.
 3. In common areas where cables from multiple systems are run in general proximity to one another, cables from each system shall be labeled to identify the system the cables serve.
- C. Cable Splices
1. Splices shall not be permitted in any cable except where expressly specified and/or approved by the Designer.
 2. In cases where splices are specified and/or otherwise approved, splices shall be made within UL listed junction or device boxes. Open air connections shall not be permitted.
- D. Cable Terminations
1. Where field installed cables connect to manufactured products via pig-tails or connectorized cable assemblies, all terminations shall be made within the product enclosure or within a UL approved junction or device box. Open air connections shall not be permitted. Exposed and open air splices are not acceptable.
- E. Strain Relief Permanently installed cables shall be properly secured with an approved device. Strain relief shall be applied typically within 6-inches from the point of entry into a product enclosure, junction box, pull box, or device box. When properly applied the strain relief device shall not damage the cable being secured and shall not permit movement of the cable in any way that may adversely affect the long term integrity of nearby connections.
- F. Identification
1. General
 - a. All identification shall be in English except where otherwise noted.
 - b. Where identification is applied to surfaces that require a finish, install identification after the surface finish is applied.
 - c. Labeling products, color, sizes, nomenclature and the installed location of the identification product are all subject to the Designer's review and approval.
 2. Cables
 - a. Every installed cable shall be uniquely labeled at each end of the cable.
 - b. Cables shall be labeled using permanent self-laminating type labels containing computer generated permanent type-written text.
 - c. Nomenclature shall be bold-type and clearly readable by a person with average sight, and typical lighting conditions within the area of installation.

- d. Labels shall be applied approximately 6 cable-inches from the point of termination.
 - e. Cables installed and intended for future use shall be clearly identified as such and the label shall clearly indicate the location of the opposite end of the cable.
 - f. Every cable installed shall be recorded in the project record documents.
3. Boxes
- a. Junction boxes and pull boxes shall be labeled on their interior and on their exterior covers with the identity of the system(s) the box serves along with the function of the box. Interior markings shall be made using permanent marker. Permanent marker may also be used on the cover of boxes installed in concealed areas (above accessible ceilings for example). Exposed boxes shall be labeled with engraved plastic cables. Labels shall closely match the color of the box.
 - b. Device boxes, when first installed, shall be identified on their interior with a permanent marker to identify the system(s) the box servers and to identify the device the box will contain.
4. Equipment Racks, Cabinets, Enclosures
- a. Engraved plastic labels shall be generated and applied to all equipment racks, cabinets, equipment enclosures, etc...
 - b. The nomenclature, color, size, installed location, and type of all labels are subject to the Designer's review and approval.
5. System Equipment
- a. Each piece of active and passive system equipment shall be uniquely identified using labels and nomenclature acceptable to the Designer.
 - b. Front panel controls of equipment shall be labeled with nomenclature meaningful to the end user based on the intended use of the equipment in the system. Examples include, but are not limited to:
 - 1) Label router/matrix control panels with system specific input/output names.
 - 2) Label patch panels with meaningful input/output destination names
 - 3) Label mixer input and output controls to identify the signal source and destination.
 - c. Professionally prepared, installed and readily visible "cheat sheets" may be acceptable under select circumstances with the approval of the designer.
 - d. The nomenclature, color, size, installed location, and type of all labels are subject to the Designer's review and approval.
- G. Medium and High Voltage Cabling (> 71 Volts)
- 1. Cabling that will carry voltages higher than 71 Volts AC or DC shall be installed and terminated only by persons licensed to perform such work within the area of jurisdiction.
- H. Plates and Panels
- 1. Device plates/panels shall be installed flush against the surface over which the plate/panel is mounted (e.g. there shall be no visible gap between the backside of a plate/panel and the wall, ceiling or floor; there shall be no visible gap between the backside of plate/panel and a surface mount box to which the plate/panel mounts). Advanced craftsmanship and construction techniques shall be employed where necessary to achieve this.
 - a. The same shall apply to other wall and ceiling mounted products.
 - 2. Cover plates shall match finish and color of other wiring devices in this project. Refer to Section 26 27 26 "Wiring Devices" for requirements.
- I. Device Boxes, Pull-Boxes, Junction Boxes
- 1. Boxes installed in walls and ceilings shall be installed so that the box does not stand proud (protrude out beyond) of the finished surface. Boxes shall be installed such that when the mounted devices and cover plates are installed that the backside of the cover plate rests flush with the finished surface of the wall or ceiling. Advanced

craftsmanship and construction techniques shall be employed where necessary to achieve this.

3.3 GROUNDING

- A. All equipment shall be properly grounded for safety and to ensure satisfactory performance of systems and equipment.

3.4 CUTTING, PATCHING AND SEALING

A. General

1. The Contractor shall perform all cutting as required for the admission of work.
2. Unless directed otherwise in field, provide all related patching and painting to match surrounding methods, materials and colors. Any damage done by this Contractor to the building during the progress of this Contractor's work shall be made good at this Contractor's expense. Perform cutting, fitting, and patching and materials as required to:
 - a. Uncover Work to provide for installation of ill-timed Work.
 - b. Remove and replace defective Work.
 - c. Remove and replace Work not conforming to requirements of these Contract Documents.
 - d. Remove samples of installed Work as specified for testing.
 - e. Install equipment and materials in existing structures.
3. Upon written instructions from the owner's representative, uncover and restore work to provide for observation of concealed work by owner's representative or by inspection authority having jurisdiction.
4. During cutting and patching operations, protect adjacent installations (structure, finishes, furnishings, etc.). Where applicable, provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to system components and components of other trades.
5. Patch surfaces and building components using new materials matching existing materials and using experienced Installers. Refer to Division 1 for definition of experienced "Installer" or determine qualifications as directed in field by owner's representative.
6. Patching through fire rated walls and enclosures shall not diminish the rating of that wall or enclosure. All materials used for patching shall be installed to meet or exceed the smoke and fire rating of the respective surface being patched.
7. Neatly cut and drill all openings in walls and floors required for the installation.
8. Secure approval of Owner's Representative before cutting and drilling in existing facilities. Neatly patch all openings cut.
9. Cutting and patching shall be held to a minimum by arranging with other
10. Contractors for all sleeves and openings before construction is started.
11. Provide factory-assembled watertight wall and floor seals, of types and sizes required; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
12. Pipe sleeves shall be fabricated from Schedule 40 rigid, heavy wall, full weight galvanized steel pipe; remove burrs. Use sleeves which are two standard sizes larger than conduit passing through respective sleeve.
13. Provide sleeve seals for piping which penetrates foundation walls below grade, exterior walls or roofs, caulk between sleeve and pipe with non-toxic, UL- classified caulking material to ensure watertight seal. Elsewhere modular provide mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill

annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

14. Install standard Schedule 40 black steel pipe sleeves two sizes larger than pipes passing through floors, bearing walls, fire walls and masonry construction. Sleeves through walls shall be cut flush with both faces. Sleeves through floor shall extend one inch above floor top elevation. Pipes penetrating roof shall use a pipe curb assembly equal to Pate Co. Furnish and set all forms required in masonry walls or foundation to accommodate pipes.

B. Grout

1. Provide non-shrink, nonmetallic grout, pre-mixed, factory-packaged, non-staining, non-corrosive, and non-gaseous grout, recommended for interior and exterior applications.

C. General Joint Sealer Application

1. Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
2. Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.
3. Clean all affected surfaces, joints, etc. immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
4. Apply sealant primer to substrates as recommended by manufacturer. Protect adjacent areas from spillage and migration of sealant, using masking tape. Remove tape immediately after tooling without disturbing seal.
5. Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
6. Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
7. Colors for exposed seals shall be as selected by the Owner's representative from manufacturer's standard colors.

3.5 FIRESTOPPING

- A. Cables and penetrations through building walls, floor and ceilings shall be fire-stopped in accordance with Code, these specifications and related drawings.

END OF SECTION 270502

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SECTION 270526

GROUNDING AND BONDING FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide the labor, tools, equipment, and materials necessary to furnish and install telecommunications grounding system in accordance with the plans and as specified herein. Provide all accessories as necessary for a complete system.
- B. Provide communications system-grounding conductor at point of service entrance and connect to Telecommunications Main Grounding Busbar (TMGB). Bond together the communications system grounding.
- C. This section includes the following:
 - 1. Telecommunications Main Grounding Busbar (TMGB)
 - 2. Telecommunications Grounding Busbar (TGB)
 - 3. Telecommunications Bonding Backbone (TBB)
 - 4. Telecommunications Bonding Conductor (TBC)

1.2 SUBMITTALS

- A. Product data for TMBG, TGB, and TBB.
- B. Ground resistance testing results certified by the testing organization.
- C. Schematic diagram of the telecommunications grounding system.

1.3 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled for their intended usage.
- B. All equipment shall comply with the latest National Electric Code.
- C. All equipment shall comply with the latest TIA/EIA-607, and BICSI standards.

PART 2 - PRODUCTS

2.1 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

- A. Provide Telecommunications Main Grounding Busbar (TMGB) in MDF Room.
- B. The TMGB shall have minimum dimensions of ¼-inch thick x 4-inch wide and 12-inch in length. The length may need to be adjusted longer to meet the application requirements with

consideration of future growth. The busbar shall be UL Listed as grounding and bonding equipment.

- C. The TMGB shall be a predrilled solid copper busbar provided with standard NEMA bolt hole sizing and spacing for the type of connectors to be used. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 15 two-hole grounding lugs with 5/8" hole centers and 3 two-hole lugs with 1" hole centers. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" standoff from the wall.

2.2 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB)

- A. Provide Telecommunications Grounding Busbar (TGB) at IDF and all Communications Equipment Racks.
- B. The TGB shall have minimum dimensions of ¼-inch thick x 2-inch wide and 10-inch in length with 7 attachment points (one row). The length may need to be adjusted longer to meet the application requirements with consideration of future growth. The busbar shall be UL Listed as grounding and bonding equipment.
- C. The TGB shall be a predrilled copper busbar provided with standard NEMA bolt hole sizing and spacing for the type of connectors to be used. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 4 two-hole grounding lugs with 5/8" hole centers and 3 two-hole lugs with 1" hole centers. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" standoff from the wall.

2.3 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

- A. Provide Telecommunications Bonding Backbone (TBB) between all TGBs and the TMGB.
- B. All TBB Connections to be made with double-bolted, Compression style, Grounding Lugs.
- C. The TBB shall be a minimum of #1/0 AWG insulated copper bonding conductor.

2.4 TELECOMMUNICATIONS BONDING CONDUCTOR (TBC)

- A. Provide conductors used to bond components to the TMGB and the TGBs as follows:
 - 1. Avoid unnecessary connections or splices in TBCs. When necessary, use an approved connection and position it in an accessible location.
 - 2. Typical connections are made by using: bolts or crimps (connectors, clamps, or lugs).
Where possible, use irreversible compression-type connections and two-hole lugs.
Always use listed hardware that has been laboratory tested.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. As a minimum, Bond TMGB to following:

1. Building Steel (minimum #1/0 AWG insulated copper bonding conductor). Attach Bonding Conductors to Building Steel using listed exothermic welding process.
 2. Main Electrical Service Ground (minimum #1/0 AWG insulated copper bonding conductor).
 3. Local Service Panel Ground.
 4. Telecommunications Bonding Backbone (TBB) that connects TMGB to other TGBs (minimum #1/0 AWG insulated copper bonding conductor).
 5. Associated Telecommunications Cable Tray(s).
 6. Telecommunications Conduit(s) Entering TR.
- B. As a minimum, Bond TGB to following:
1. Building Steel (minimum #1/0 AWG insulated copper bonding conductor). Attach Bonding Conductors to Building Steel using listed exothermic welding process.
 2. Local Service Panel Ground.
 3. Telecommunications Bonding Backbone (TBB) that connects TGB to other TGBs and TMGB (minimum #1/0 AWG insulated copper bonding conductor).
 4. Associated Telecommunications Cable Tray(s).
 5. Telecommunications Conduit(s) Entering TR (continuous minimum #6 AWG bare copper bonding conductor connecting all cable tray sections).
- C. As a minimum, the Technology Contractor shall bond the following devices to the associated TMGB and TGBs using a minimum #6 AWG insulated copper bonding conductor using 2-hole compression style lugs:
1. Equipment Racks and Cabinets
 2. Cable Ladder and Tray
 3. Surge Protectors
 4. Telecommunications Devices
 5. Coupled Bonding Conductors (CBCs)
 6. Backbone Cable Shields
 7. Telecommunication and Fiber Cable Shields
- D. General:
1. Route ground conductors to provide the shortest, most direct path from point to point. Telecommunications ground must be bonded to the lightning protection system ground.
 2. Bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place bonding conductors in ferrous metallic conduit that exceeds 3 feet in length, the conductors shall be bonded to each end of the conduit with a conductor sized as a #6 AWG, minimum (this makes the conduit a parallel path with the cable).
 3. A continuous ground path shall be provided in all telecommunications raceways. Grounded cable trays shall be considered continuous ground path.
 4. At each Telecommunication Room (TR) all equipment and raceways shall be bonded to the TGB.
 5. Any grounding or bonding conductor that is run through a metallic conduit shall be bonded to the conduit.
 6. Provide dedicated Telecommunications Bonding Backbone (TBB) to interconnect the TRs and related equipment.
- E. Telecommunications Entrance Facility (TEF) Telecommunications Main Grounding Busbar (TMGB):
1. The Telecommunications Main Grounding Busbar (TMGB) serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TMGB also serves as the central attachment point for

telecommunications bonding backbones (TBB) and equipment, and is located such that it is accessible to telecommunications personnel.

2. The TEF is the desirable location for the TMGB. This TMGB may serve as the TGB for collocated equipment in the TEF. The TMGB shall be bonded to electrical service equipment ground. This bond at the TMGB shall use a double bolted, compression style grounding lug. The bond at the electrical service equipment ground shall use an exothermically welded connection.
3. Where an electrical panelboard is located in the same room or space as the TMGB, the ground or enclosure of that electrical panelboard shall be bonded to the TMGB. Locate the TMGB as close to the electrical panelboard as practical to maintain clearances required by applicable electrical codes.
4. Locate the TMGB near the TBB cabling and associated terminations. The connections of the bonding conductors for telecommunications, and the TBBs to the TMGB shall utilize listed two-hole compression lugs.
5. Telecommunications primary protector grounding conductor shall be bonded to the TMGB. A minimum of 1 foot separation shall be maintained between this insulated conductor and any DC power cables, switchboard cables, or high frequency cables, even when placed in metal raceway.
6. All metallic raceways for telecommunications cabling located within Equipment Room (ER) shall be bonded to the TMGB. However for metallic raceways containing grounding conductors where the raceway is bonded to the ground conductor, no additional bonding to the TMGB is required.
7. In buildings where the backbone telecommunications cabling incorporates a shield or metallic member, this shield or metallic member shall be bonded to the TMGB where the cables are terminated or where pairs are broken out.
8. In a metal frame (structural steel) building, where the steel framework is readily accessible within or external to the mdf; each TMGB shall be bonded to the vertical steel metal frame.

F. Telecommunications Room (TR) Telecommunications Grounding Busbar (TGB):

1. The TGB is the grounding connection point for telecommunications systems and equipment in the location served by that TR or ER. Each TR and ER shall contain a TGB. Multiple TGBs may be installed within the same TR or ER to aid in minimizing bonding conductor lengths and terminating space. In all cases, multiple TGBs within the same ER shall be bonded together with a conductor the same size as the TBB.
2. The TGB shall be located near the TBB cabling and associated terminations.
3. The bonding conductor between a TBB and TGB shall be continuous and routed in the shortest possible straight-line path. The bonding conductor shall be the same size as the TBB.
4. All metallic raceways for telecommunications cabling located within TR shall be bonded to the TGB. However for metallic raceways containing grounding conductors where the raceway is bonded to the ground conductor, no additional bonding to the TGB is required.
5. In buildings where the backbone telecommunications cabling incorporates a shield or metallic member, this shield or metallic member shall be bonded to the TGB where the cables are terminated or where pairs are broken out.
6. In a metal frame (structural steel) building, where the steel framework is readily accessible; each TGB shall be bonded to the vertical steel metal frame. When practicable because of shorter distances and other considerations, and where horizontal steel members are permanently electrically bonded to vertical column members, TGBs may be bonded to these horizontal members in lieu of the vertical column members.

G. Telecommunications Bonding Backbone (TBB):

1. A TBB is a conductor that interconnects all TGBs with the TMGB. A TBB's basic function is to reduce or equalize potential differences between telecommunications systems

bonded to it. A TBB is not intended to serve as the only conductor providing a ground fault current return path.

2. A TBB shall be designed with consideration given to the type of building construction, the telecommunications requirements, and the configuration of the telecommunications pathways and spaces. Specifically, the design of a TBB shall:
 - a. Be consistent with the design of the telecommunications backbone cabling system.
 - b. Address routing to minimize the lengths of the TBB.
3. All TBB Connections to be made with double-bolted, Compression style, Grounding Lugs.
4. TBB conductors shall be installed without splices. Where splices are required, they shall be kept to the minimum quantity necessary, shall be accessible and located in telecommunications spaces. Joined segments of a TBB shall be connected using irreversible compression-type connectors or exothermic welding. All joints shall be adequately supported and protected from damage.

H. Telecommunications Bonding Conductors (TBC):

1. Bonding conductor sizing. The following applies to the Telecommunications Bonding Conductor (TBC):
 - a. Bonding Conductor Length (ft) / Bonding Conductor Size (AWG)
 - 1) <13 / #6
 - 2) 14-20 / #4
 - 3) 21-26 / #3
 - 4) 27-33 / #2
 - 5) 34-41 / #1
 - 6) 42-52 / #1/0
 - 7) 53-66 / #2/0
 - 8) >66 / #3/0

3.2 FIELD QUALITY CONTROL

- A. Testing Telecommunications Grounding and Bonding Infrastructure:
 1. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Measure ground resistance from longest grounding path to TMGB or TGB in TR or ER. Resistance shall not exceed 0.1 ohms

END OF SECTION 260526

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SECTION 270528

PATHWAYS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Complete and working pathway systems for communications and related system cabling, including pathways designated as spare(s) and/or reserved for future use
 2. Section includes but is not necessarily limited to:
 - a. Conduit, fittings and supports
 - b. Surface raceway, fittings and supports
 - c. Discrete cable supports, fittings and supports
 - d. Cable tray, fittings and supports
 - e. Wall, floor, ceiling and roof penetrations
 - f. Miscellaneous pathway accessories

1.2 DEFINITIONS

- A. Primary Pathways – Those pathways typically located in corridors, dedicated vertical cable chases and used to enclose and/or support large quantities of compatible signal cables from one or more systems to the general area where system devices are located. Cables carried by a primary pathway transfer to secondary pathways.
- B. Secondary Pathways - Those pathways typically extending from a primary pathway to the space near the system device to be served. A secondary pathway typically accommodates 16 or less cables of compatible signals, from a single system.

1.3 SYSTEM DESCRIPTION

- A. General
1. The pathway systems for communication shall consist of all products necessary to support, protect, enclose, manage and secure cables used for communications and related systems. The pathway system for each system may vary based up the requirements of these specifications and information on the drawings.
 2. The total pathway system shall include code-compliant penetrations through walls, floors, ceilings, roofs, etc... as necessary for the routing of cables between their intended starting and ending points.
- B. Pathway System(s) for Telecommunications (Voice/Data/Network) Cabling
1. The pathway system for the Telecommunications cabling system shall be a hybrid pathway system consisting of a mixture of cable tray, conduit, discrete cable supports, conduit sleeves, and device boxes, pull boxes and junction boxes.
 2. The pathway system shall be assembled from UL listed components.
 3. The pathway system shall be NFPA 70 and the "National Electrical Code" compliant.
 4. The pathway system shall be built so that no pathway segment shall exceed a

6. 40% cable fill. Larger pathway segments (conduits, cable tray, discrete cable supports etc...) shall be provided where indicated on the drawings.
7. The pathway system shall include all products necessary to render the system usable for its intended purpose
8. The minimum conduit size permissible for use in this system shall be 1".

C. Pathway System(s) for other Communications Systems

1. General
 - a. Unless otherwise noted on the drawings, the pathway system for each of the following systems shall be a hybrid pathway system consisting of a mixture of cable tray, conduit, discrete cable supports, conduit sleeves, and device boxes, pull boxes and junction boxes.
 - b. The pathway system shall be assembled from UL listed components.
 - c. Conduit sizes used for the system shall support a cable fill percentage not exceeding 40%. Larger pathway segments (conduits, cable tray, discrete cable supports etc...) shall be provided where indicated on the drawings.
 - d. Each system shall include all products necessary to render the system usable for its intended purpose
2. Building Intercommunication Systems
 - a. Minimum conduit size for this system is 3/4".
3. Paging Systems
 - a. Minimum conduit size for this system shall be 3/4".
4. Audio/Visual Systems
 - a. Minimum conduit size is 3/4".
5. Sound Reinforcement Systems
 - a. Minimum conduit size is 3/4".
6. Pathways for other work of Division 27
 - a. Minimum conduit size is 3/4".

1.4 SUBMITTALS

A. Product Data

1. Surface Raceway
2. Cable Tray
3. Floor Boxes
4. Device Boxes
5. Box Eliminators
6. Cable Spillways
7. Discrete Cable Supports

B. Shop Drawings

1. Floor plans depicting the intended location of the following:
 - a. Primary pathways
 - b. Secondary pathways
 - c. Planned penetrations through ceilings, floors, walls and the roof.
2. Riser diagrams of each closed conduit systems used by communication systems.

C. Closeout Submittals

1. Floor plans depicting the as-installed location of the following:
 - a. Primary pathways
 - b. Secondary cabling pathways
 - c. Locations of all penetrations and conduit sleeves
 - d. Fire-rated penetration locations, along with rating value.
2. Penetration Certification Documentation

- a. Certification paperwork for all penetrations through fire-rated building surfaces and cavities.

1.5 QUALITY ASSURANCE

- A. All products shall be UL-type listed for the location and application in which it is used.
 1. All onsite personnel shall be manufacturer trained on the anchoring system being utilized.
 2. Building penetrations shall be performed by person(s) properly trained on the installation of specific rated assembly being installed.
 3. Installation material and practices shall fully comply with NFPA 70, "National Electrical Code" and ANSI/TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and Spaces.

PART 2 - PRODUCTS

2.1 RACEWAYS

- A. Conduit
 1. Rigid steel conduit:
 - a. Threaded rigid steel conduit shall be manufactured from mild steel, zinc galvanized both inside and outside including threads. It shall be constructed in accordance with ANSI C80.1, Federal Specification WW- C-581;
 2. Intermediate metallic conduit:
 - a. Threaded intermediate metallic conduit shall be manufactured from mild steel, zinc galvanized both inside and outside including threads. It shall be constructed in accordance with ANSI C80.6, Federal Specification WW- C-581;
 3. Electric metallic tubing:
 - a. Electric metallic tubing shall be manufactured from mild steel, zinc galvanized both inside and outside. It shall be constructed in accordance with ANSI C80.2, Federal Specification WW-C-563;
 4. Flexible metallic conduit:
 - a. Flexible metallic conduit with neoprene jacket shall be spirally wound steel, strip zinc galvanized both inside and outside, integral ground conductor.
 5. Non-metallic raceways
 - a. Polyvinylchloride (PVC):
 - 1) PVC conduit shall be virgin C300 type, Schedule 40 or 80 (90° C).
 - 2) Constructed in accordance with NEMA TC2 and Federal Specifications W-C-1094A.
- B. Discrete Cable Supports (J-Hooks)
 1. General
 - a. Discrete cable supports with round surfaces (i.e. bridal rings) are not acceptable for use.
 2. Primary Pathways
 - a. J-Hook style support.
 - b. Plenum rated construction.
 - c. Steel construction, galvanized finish
 - d. Complies with UL, cUL, NEC, and ANSI/TIA/EIA requirements for structured cabling systems.
 - e. Basis of Design:

- 1) 50 UTP Category 6 cable capacity: Erico CABLECAT32xx
 - 2) 185 UTP Category 6 cable capacity: Erico CABLECAT34xx
 - f. Additional approved manufacturers: B-Line, Panduit
 - g. See manufacturer's installation guidelines for additional quantity and sizing guidelines.
3. Secondary pathways
- a. Plenum rated.
 - b. J-hooks style support
 - c. Steel construction, galvanized finish
 - d. Complies with UL, cUL, NEC, and ANSI/TIA/EIA requirements for structured cabling systems.
 - e. Basis of Design:
 - 1) 10 UTP Category 6 cable capacity: Erico CABLECAT12xx
 - 2) 32 UTP Category 6 cable capacity: Erico CABLECAT21xx
 - f. Additional approved manufacturer(s): B-Line, Panduit
 - g. See manufacturer's installation guidelines for additional quantity and sizing guidelines.

2.2 FITTINGS

- A. Rigid steel or intermediate metallic conduit:
1. Fittings shall be threaded zinc galvanized steel.
 2. At least one bushing shall be grounding type
 - a. Equipped with a ground lug
 - b. Provide on each conduit or sleeve where surface extends below ceiling line.
- B. Electric metallic tubing:
1. Fittings shall be compression type.
 2. At least one bushing shall be grounding type
 - a. Equipped with a ground lug
 - b. Provide on each conduit or sleeve where surface extends below ceiling line.
- C. Flexible metallic conduit:
1. Fittings shall be suitable for the specific application.
 2. Use oil-tight fittings with neoprene jacketed flexible metallic conduit.
- D. Non-metallic conduit:
1. Fittings shall be of the same type and manufacturer as the raceway, connected in accordance with manufacturer's written instructions.
- E. Expansion:
1. Expansion fittings shall be of a type suitable for the particular condition and shall be complete with bonding jumper.

2.3 BOXES

- A. Wall/Ceiling Outlet Style Device Boxes
1. General:
 - a. Stamped steel, code gauge, galvanized, minimum 2 ½ inches deep. Provide deeper boxes where indicated on the drawings.
 - b. Corrosion protection suitable for the atmosphere in which they are installed.

- c. Non-gangable sheet-steel box construction
 - d. Conduit knockouts of the size and quantity and box locations required.
 - e. Threaded device mounting screw holes.
 - f. Rated for installation in the space where the box will be installed
 2. Boxes Used in Masonry or Tile Walls
 - a. Galvanized steel construction
 - b. "Masonry" style box construction
 - c. Available in standard gang sizes from 1 to 6
 - d. Various depth sizes available from 2.5 to 3.5 inches
 - e. Conduit knockouts to suit the application
 3. Boxes used in Gypsum Board Walls
 - a. Galvanized steel construction
 - b. "Masonry" style box construction
 - c. Available in standard gang sizes from 1 to 6
 - d. Various depth sizes available from 2.5 to 3.5 inches
 - e. Conduit knockouts to suit the application
 4. Approved Manufacturers: Adalet, Appleton Electric, Bell Electric, Bowers, Eagle Electric, Mfg Co., Inc., Midland-Ross Corp., OZ/Gedney., Pass and Seymour, Inc., RACO, Hubbel, Thomas & Betts Co., Thepitt.
- B. Exterior Surface Mount Outlet Style Boxes
 1. Hinged cover, sized to accommodate the devices being mounted to the box.
 2. Cast Aluminum construction
 3. Available in standard gang sizes from 1 to 3
 4. Threaded conduit hubs
 5. Approved Manufacturers: Adalet, Appleton Electric, Bell Electric, Bowers, Eagle Electric, Mfg Co., Inc., Midland-Ross Corp., OZ/Gedney., Pass and Seymour, Inc., RACO, Hubbel, Thomas & Betts Co., Thepitt.
- C. Surface Raceway Device Boxes
 1. Designed to work with the surface raceway system to which they attach
 2. Factory finished to matching the associated raceway.
 3. Available in standard gang sizes of 1 to 3 gangs.
 4. Sized to suit the devices they are intended to accommodate.
 5. Available in a variety of box depths, including custom manufactured box depths up to 3-1/2 inches.
- D. Junction and Pull boxes:
 1. Conduit System Junction and Pull Boxes
 - a. Screw cover type enclosure, except where otherwise noted.
 - b. Screw covers installed in unfinished spaces, above ceilings, in utility rooms shall be provided with covers of the same finish and material construction as the box itself.
 - c. Boxes installed flush in wall shall be provided with oversize cover plates painted to match the surrounding building surface.
 - d. Boxes shall be NEMA rated for the atmospheric condition in which the box is installed.
 - e. Boxes in exterior or moist locations shall meet NEMA 3R (at minimum)
 2. Surface Raceway Junction and Pull Boxes
 - a. As manufactured by the surface raceway manufacture and designed to work with the surface raceway system installed

2.4 PENETRATIONS

- A. Sleeves Through Floors and Walls
1. All penetrations through floors or walls shall require a UL listed device for the purpose of penetrating the construction.
 - a. Concrete, block, brick, and gypsum drywall construction providing a fire rating of greater than one hour for walls and floors will require a UL rated sleeve assembly installed to manufacturer's requirements allowing the penetration(s) to not degrade the designed fire rating of the wall or floor.
 - 1) Basis of Design: as manufactured by Unique Fire Stop Products (USFP). Utilize USFP's Threaded Penetrator system for all fire- rated penetrations.
 - b. All other penetrations and gypsum drywall constructed walls providing a fire rating of one hour or less will require a UL rated sleeve assembly installed to manufacturer's requirements allowing the penetration(s) to not degrade the designed fire rating of the wall or floor.
 - 1) Basis of Design: as manufactured by Unique Fire Stop Products (USFP). Utilize USFP's Smooth Penetrator system for all fire-rated penetrations.
 - c. All penetrations found to be improperly sleeved after the installation of cabling will be sleeved and firestopped to restore the proper aesthetics and required fire rating to the obstruction.
 - 1) Basis of Design: as manufactured by Unique Fire Stop Products (USFP). Utilize USFP's split-sleeve system for all fire rated penetrations.
 2. Penetrations into fire rated walls with gypsum board construction.
 - a. All penetrations required in gypsum board walls for installation of horizontal cabling, where conduit is not stubbed into the ceiling cavity for this purpose, will require a sleeved penetration through the drywall membrane or the wall cap.
 - 1) Each penetration will require a UL listed sleeve assembly installed by an installer trained on proper installation of the sleeving device.
 - 2) Basis of Design: as manufactured by Unique Fire Stop Products (USFP). Utilize USFP's Membrane Penetrator or Cap Penetrator system for all fire rated penetrations.
 3. Basis of Design: Unique Fire Stop Products.
 4. Additionally Approved: Field fabricated systems (inspected and approved by the code authority having local jurisdiction)

2.5 ACCESSORIES

- A. Pull Strings
1. Pull strings shall be nylon type as manufactured by Arnco or approved equal.
 2. Additional Approved Manufacturers: Greenlee, Condux
- B. Fiber Optic Inner Duct
1. NEMA TC 5, UL listed, corrugated, specifically designed for optical fiber cable pathways.
 - a. Color : Orange
 - b. 1-inch minimum inside diameter
 - c. 600 pounds minimum pulling strength
 - d. Factory installed pull rope
 - e. Rated for the environment in which it is installed.
 - f. Riser Rated Environments:
 - 1) Basis of Design: Carlon DF4X1C-xxxx
 - g. Plenum Rated Environments:
 - 1) Carlon CF4X1C-xxxx for installation in Plenum environments.

- h. Additional Approved Manufacturers: Arnco, Endot, Opti-Com, Pyramid
- C. Cable Spillways
- 1. On 4-Inch Sleeves
 - a. Cable Management Corp. Model CM-1004 Cable Spillway.
 - b. Additional Approved Manufacturers: B-Line, Chatsworth
 - 2. On 2-Inch Sleeves
 - a. Cable Management Corp. Model CM-1002 Cable Spillway on two-inch sleeves.
 - b. Additional Approved Manufacturers: B-Line, Chatsworth
- D. Supports
- 1. General
 - a. Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.
 - b. Products used outdoors shall be hot-dip galvanized.
 - 2. Material Types
 - a. Concrete and Masonry Anchors:
 - 1) Basis of Design: As manufactured Hilti, or approved equal.
 - b. Raceway Supports:
 - 1) Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
 - c. Fasteners:
 - 1) Types, materials, and construction features as follows:
 - a) Expansion anchors: Carbon steel wedge or sleeve type
 - b) Toggle bolts: All steel springhead type
 - c) Powder-driven threaded studs: Heat-treated steel, designed specifically for the intended service
 - d. Conduit Sealing Bushings:
 - 1) Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
 - e. Cable supports for vertical conduit:
 - 1) Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits.
 - 2) Furnish with plugs with the number and size of conductor gripping holes as required to suit each individual application.
 - 3) Body construction: Malleable-iron casting with hot-dip galvanized finish.
 - f. Threaded Rod Stock (All-Thread Rod)
 - 1) Available in 1/4", 3/8", 1/2", and 5/8" sizes.
 - 2) Rod lengths over 6' will require a "Rod Stiffener" installation for 1/2" and 5/8" rods.
 - a) A section of U-Channel stock is placed around the rod and stiffener clamp assemblies used to clamp to rod.
 - b) Place clamps a minimum of 6" from the top and bottom of the rod and every 18" in between.
 - c) Basis of Design: B-Line SC228
Additional approved manufacturer(s):
Unistrut Diversified Products
GS Metals Corp.
Haydon, Corp.
Kin-Line Inc.

- g. Slotted Met
 - 1) 16-gauge steel channels, with 9/16 inch diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.
 - 2) Basis of Design: Unistrut Diversified Products
 - 3) Additional Approved Manufacturers: Allied Tube & Conduit, American Electric, B-Line Systems, Inc., Cinch Clamp Co., Inc., GS Metals Corp., Haydon Corp., Kin-Line Inc.
- E. Bushing, Knockout Closures and Locknuts
 - 1. Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate the layout and installation of raceway and boxes with the work of this and other Divisions; work of other trades; and with existing construction elements to ensure adequate headroom, working clearances, and to allow for post installation access.

3.2 INSTALLATION

- A. General
 - 1. Size all new pathways so as to ensure maximum fill ratios will not be exceeded when the systems cabling they serve is installed. Where drawings indicate the use of larger conduit sizes, install the larger sizes as indicated.
 - 2. Install above-grade raceways, and cable tray parallel to and/or perpendicular to building elements.
 - 3. Install pathways level, except where elevations changes are required for installation.
- B. Raceways
 - 1. Except as otherwise noted and/or detailed on the drawings, install the following types of raceways as defined below
 - a. Rigid Galvanized Steel (GRC):
 - 1) Above grade, outside the building envelope, in exposed areas.
 - 2) Above grade, inside the building envelope, in high moisture areas.
 - b. Electric Metallic Tubing (EMT):
 - 1) Within the building envelope.
 - c. Polyvinylchloride (PVC):
 - 1) Below grade (except where otherwise noted on the drawings).
 - d. Flexible Metal Conduit (FMC):
 - 1) Flexible metal conduit shall only be used between a secondary pathway and a device location and shall only be used where it is expressly indicated on the drawings.
 - 2) Maximum length of any FMC path shall not exceed 6 meters.
 - 2. Conduit

- a. Install all conduit terminations with locknuts and bushings. Provide conduits 1 ½ inches and larger with insulating bushings and locknuts inside and outside the enclosure.
 - 1) At least one bushing per conduit shall be grounding type, equipped with a grounding lug.
 - 2) Ground conduit system required by code and in accordance with the grounding and bonding specifications and related drawings.
- b. Support conduits by pipe straps or trapeze hangers. Space supports not more than 8 feet on center. Secure supports by means of toggle bolts, inserts or expansion bolts.
- c. Space wall brackets supporting conduits not more than 4 feet 6 inches on center. Secure supports by means of toggle bolts, inserts or expansion bolts.
- d. Support raceway components directly from structural building systems, not from ceiling suspensions systems. Provide supplemental supports for junction or pull boxes.
- e. Conceal conduit raceways under floors, in walls, above ceilings and in furred spaces within finishes building areas.
- f. Support single conduits 1 ½ inches and larger by means of rod and cast ring hangers. Support multiple runs in similar manner or use common trapeze hanger.
- g. Provide two-hole sheet metal pipe straps for all surface mounted conduit supports on walls up to a height of 8 feet above the finished floor.
- h. Pinch type hangers similar to minerallac type shall only be used at heights greater than 8 feet.
- i. Protect conduits during construction with temporary plugs or caps.
- j. Securely cap all conduits until wire or cable is installed. Do not install conduit in concrete slab.
- k. Provide expansion fittings where raceway crosses the building expansion joints. (O.X. Type AX, EX, EXDS, TX, EXE, or approved equal).
- l. Conduit Routing
 - 1) If specific routing information appears on the drawings, route and maintain conduits as shown. Should interference or conflict arise, the Contractor shall inform the Designer before proceeding with the Work.
 - 2) If specific routing information does not appear on the Drawings, Contractor shall determine the best route for the conduit in accordance with code and other specified guidelines.
- m. Conduit bends
 - 1) Bends shall be made so that the conduit will not be flattened or kinked and the internal diameter of the conduit will not be reduced.
 - 2) The radius of the curve of the inner edge of any bend shall not be less than as indicated by the National Electrical Code and ANSI/TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and Spaces.
 - 3) In no case shall any conduit be bent or shall any fabricated elbow be applied to less than the allowable bending radius as specified by the cable manufacturer of the installed conductor.
 - 4) When necessary to make field bends, use tools designed for conduit bending.
 - a) Heating of metallic conduit to facilitate bending is not permitted.
 - 5) Constructing an outside entrance to a building from buried conduit to penetrate above the ceiling line will allow an exception for a 4" LB fitting at one end to allow placement of the conduit flat to the building outside wall.
- n. The Contractor shall not cut, burn, or drill any structural member to mount electrical equipment or to facilitate tray or conduit installations without having previously received approval, in writing, from the Architect/Engineer/Consultant.

- o. Install above-ceiling conduits a minimum of 7 inches above ceiling tiles so as to permit ceiling tile removal
 - p. Install conduits at least 6 inches from insulated pipes, steam lines or any other hot pipes they pass. Where the lines are not insulated, the clearances shall be increased until the temperature of the conduit, with no live conductors enclosed, does not rise above the ambient temperature of the installation area.
 - q. Conceal all raceways except where otherwise indicated.
 - r. Install flashing and counter flashing or pitch pockets for waterproofing of all raceways, outlets, fittings, etc. that penetrate the roof.
 - s. Install sleeves in forms for new concrete walls, floor slabs, and partitions for passage of raceways.
 - 1) Seal sleeves in an approved manner that pass through fire rated walls, floors, and ceilings, following raceway installation.
 - t. Waterproof all sleeved raceways in areas prone to high moisture and condensation.
3. Surface Raceway
- a. Install surface raceway in areas indicated on drawings.
 - b. Coordinate installation with casework prior to the installation of casework and raceway.
 - c. Install raceway, accessories and device boxes plumb and level.
 - d. Anchor raceways to walls with the anchors designed for the wall construction encountered.
 - e. Secure raceway at intervals of not more than 2 feet, and not less than 6 inches from the ends of each raceway.
 - f. Install raceway per the manufacturer's written recommendation, including necessary entrance, ending and bend fittings.
 - g. Furnish and install all of the manufacturer's recommended fittings and accessories.
 - h. Where surface raceway is provided for a secondary pathway from the outlet to the ceiling space, extend surface raceway into the ceiling space not less than 4 inches.
4. Pull Boxes
- a. Install all pull boxes as indicated on the drawings.
 - b. Install pull boxes every 180 degrees of conduit bends
 - c. Install pull boxes within the building every 100 feet of conduit.
 - d. Install pull boxes for underground conduits at intervals not more than 600 feet of conduit. Install more frequently as required by Code.
 - e. Install pull boxes in areas that will be accessible after installation.
 - 1) Accessible areas include above accessible ceiling, snap-in ceilings, and behind access doors.
 - f. Support and size boxes in accordance with the N.E.C.
 - g. Land conduits on the box so conduit entry will permit the longest radius for conductors contained therein.
 - h. Provide junction and pull boxes such that conduits enter and exit across from each other on opposite sides of the junction box.
 - i. Do not use pull boxes in lieu of conduit bends.
- C. Pull Stings
- 1. Install a usable pull string in every pathway prior to the installation of cables.
 - 2. This string shall be used to aid in the installation of system cables.
 - 3. Install a usable pull string each pathway during the installation of cable(s) within the pathway. This string be tied off and shall remain available for future use.
- D. Inner Duct

1. Install appropriately sized inner duct in all pathways that will be used to enclose and support fiber optic cables.
 - a. Inner duct is not required in those pathways containing exclusively Armored-type fiber optic cables.
 2. Plenum rated inner duct shall be used in pathways that are not 100% conduit.
- E. Spillways
1. Install cable spillways where cabling exits a conduit sleeve, cable tray, etc. where cable(s) will be unsupported for more than six inches.
- F. Telecommunications / Power Poles
1. Mount straight and anchor to building structure above the ceiling line.
 2. Provide mounting hardware, entrance end fitting, and ceiling trim plate.
 3. Coordination and Positioning
 - a. Coordinate positioning with other trades to assure maximum accessibility.
 - 1) Tray shall be mounted securely along the wall at a minimum of 6" (lower tier) above the ceiling line.
 - 2) Where two 12" trays connect to a two tier unit, the upper tray may continue at 12" (upper tier) above the accessible ceiling.
 - 3) Where tray cannot be wall mounted, (transversing hallways, etc.) mount span securely to wall at each end and provide 1/2" threaded rod supports, anchored into the concrete deck above, every 4' at minimum.
 - 4) Minimum access should be 12 inches clear above the tray (each tier) and 12 inches clear beside the tray to facilitate moves, adds and changes for telecommunications cabling.
- G. Discreet Cable Supports (J-Hooks)
1. Discrete cable supports shall be installed to support cables in areas that are readily accessible after installation (example: above accessible suspended ceiling).
 2. Enclosed raceways systems shall be used in lieu of discrete cable supports where cables must pass through inaccessible areas.
 3. Install separate supports for cables from every system, and install separate supports for incompatible cables from the same system. Array supports vertically using the appropriate spacing.
 4. Attach supports directly to vertical building surfaces, or from overhead structural members using threaded rod and other approved attachment methods.
 5. Install supports plumb and square.
 6. Mount bottom of supports approximately 12" above suspended ceilings.
 7. Cable supports shall be installed at intervals not exceeding 5' feet.
 8. Adjacent supports shall be installed at the same elevation except where necessary for coordination with other trades and pathways of other systems.
 9. Install supports so that they do not interfere with the ability to remove ceiling tiles.
 10. Support with threaded rod and U-channel supports systems.
 11. Discrete Support Sizing and Quantity
 - a. Do not exceed 75% of the permissible fill capacity of any support provided.
 - b. Install multiple supports as required to handle the total quantity, size and type of cables served.
 - c. After installation of cables, 25% of rated permissible fill capacity shall be reserved of future use.
 12. Discrete Support Usage and Quantity
 - a. Use separate supports for cables from difference systems
 - b. Use separate supports to carry cables of incompatible signals from the same system.

H. Device Boxes

1. New-work and old-work device boxes shall be installed flush with or slightly recessed below the finished surface (but no more than code allow, nor more than .078-inches (2mm)). Old work boxes require advanced craftsmanship and construction techniques to achieve this.
2. Installed height of boxes shall generally be as indicated on the drawings. Installed heights shall be adjusted in the field to ensure a clean appearance that results from coordinating with existing installed box heights and new boxes being installed to serve non-communications systems. Where the specified box height and existing condition boxes differ by more than 2-inches, seek the direction of the Designer prior to installation.
3. Device boxes and their associated cover plates shall not span different types of wall finishes either vertically or horizontally. Horizontal and vertical position of boxes shall be adjusted at time of installation to ensure that this condition does not exist after installation.
4. Boxes in masonry shall be installed so that the specified over plates will cover the mortar joints and cut openings completely.
5. Device boxes shall be installed so that they are securely and rigidly attached to the building by any of the following methods:
 - a. Double bar installation for metal stud walls. Bar hanger punch, mounting clips, and retainer clips shall be used in strict accordance with manufacturer's instructions. Factory pre-punched stud holes shall not be used to support the bar hangers.
 - b. Steel stud installed behind box for support without "caddy-type" mounting clips for metal stud wall construction.
 - c. "Caddy-type" screw gun bracket installed behind box for support. Installation shall be per manufacturer's instructions.
6. Devices boxes shall not rely on the raceway as their primary means of support. Boxes shall be attached to surrounding building structure.
7. Device boxes shall be installed plumb and level, held to within all of the following limits:
 - a. Maximum one-tenth (1/10) of one degree from plumb and from level, and;
 - b. Maximum difference from level of .078-inches (2mm) at one end of the box relative to the other end of the box, and;
 - c. Maximum difference from plumb of .078-inches (2mm) at the top of the box relative to the bottom of the box;
8. Boxes shall be shimmed as necessary to insure level and plumb installation.
9. Install gaskets on all boxes installed outside and in wet or damp locations (tunnels, crawlspaces, pits, etc.).
10. Device boxes shall be protected from plaster.
11. Floor boxes shall be installed flush and true with the finished floor.
12. Boxes shall be cleaned of debris after installation.
13. Boxes shall be cleaned of debris thoroughly prior to installation of cover plates;
14. Install blank cover plates on each unused device box.

I. Penetrations

1. Sleeves Through Floors and Walls
 - a. Install conduit sleeves where indicated on the drawings and wherever cables or raceways will pass through floors, walls, ceilings, and any concrete or masonry structure, except where tunnels, chases or shafts are provided in the project site construction.
 - 1) Sleeves through poured-in-place concrete surfaces shall be set in place prior to the concrete pour and shall be of a design that seals against the passage of water between the sleeves and concrete floor.
 - b. Install cable protecting bushings on the each end of each sleeve.

- c. Extend all through-the-wall sleeves a minimum of 2 inches beyond the wall surface, longer as required, to allow installation of conduit bushings.
 - d. Extend through-the-floor sleeves 4 to 6 inches above finished floors, except where otherwise noted on the drawings.
 - e. Voids between the sleeve and the building surface shall be neatly finished and filled with approved fire stop material.
 2. Labeling
 - a. Install penetration certification next to each penetration through fire-rated surfaces.
- J. Supports
 1. Fabricated Supporting Devices
 - a. Conform to the manufacturer's recommendations for selection and installation of supports.
 - b. The strength of each support shall be adequate to carry present and planned future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs. provide additional strength until there is a minimum of 200 lbs. safety allowance in the strength of each support.
 - c. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - d. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 - e. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners shall be used in lieu of hangers for 1 ½ inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only.
 - f. For hanger rods with spring steel fasteners, use ¼ inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
 - g. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings shall be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
 - h. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
 2. Miscellaneous supports
 - a. Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, pull boxes, junction boxes, and other devices.
 - b. Support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
 3. Fastening:
 - a. Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to; conduits, raceways, cables, cable traps, busways, cabinets, panel boards, transformers, boxes, disconnect switches, and control components in accordance with the following:
 - 1) Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, machine screws, welded threaded studs,

or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts shall be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.

- 2) Holes cut to depth of more than 1 ½ inch in reinforced concrete beams or to depth of more than ¾ inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 - 3) Ensure that the load applied to any fasteners does not exceed 25 percent of the proof test load. Use vibration-and shock-resistant fasteners for attachments to concrete slabs.
- b. Raceway supports: Hanger spacing shall be as required for proper and adequate support of the raceway, but in no case shall be less than one hanger per 5 feet of raceway length.

K. Ground and Bonding

1. Ground and bond raceway systems in accordance with the NEC and ANSI/TIA/EIA 607. See Related Drawings and Specifications for additional information.

3.3 TRAINING

- A. Review the pathway system(s) with the Owner's facility management personnel, and other owner designated personnel responsible for ongoing maintenance of systems installed within the pathways.
- B. Review all key pathway paths and expansion capabilities

END OF SECTION 270528

SECTION 270553

IDENTIFICATION FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Labeling of Communications Systems, Equipment and Rooms
 - 2. System includes but is not limited to:
 - a. Communications product identification labels
 - b. Communications room labels
 - c. Communications Key Drawings

1.2 REFERENCES

- A. ANSI/TIA/EIA-606 – The Administrative Standard for the Telecommunications Infrastructure of Commercial Building.
- B. "TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL" published by the Building Industry Consulting Services International (BICSI).

1.3 SYSTEM DESCRIPTION

- A. Identification of Communications shall consist of professionally created and applied labeling products for the following types of Communications products.
 - 1. Cabling
 - 2. Equipment racks
 - 3. Equipment enclosures
 - 4. Patch panels
 - 5. Device plates
 - 6. Communications equipment room(s)
 - 7. Communications cabling, including horizontal and backbone cabling
 - 8. Communications cabling cross-connects
 - 9. Communications backboards
- B. The labeling schema used for structured cabling shall be an ANSI/TIA/EIA-606 compliant system - The Administrative Standard for the Telecommunications Infrastructure of Commercial Building Identification System. See Related Drawings for graphical representation.
- C. Each communications room shall be equipped with a set of unique Key Drawings that shall identify the installed location of communications devices served out of and interconnected to the communications room. The drawings shall include identifiers that uniquely associated field devices with specific termination products within the Communications room.

1.4 SUBMITTALS

- A. General
 - 1. Product Data and Shop Drawing submittals for work of this section shall be SUBMITTED TOGETHER, complete, as a single submittal.
- B. Product Data
 - 1. Manufacture datasheets for all products.
- C. Shop Drawings
 - 1. Labeling system diagram, detailed.
 - 2. Communications room wall elevation drawings indicated the size, title and location of all Key Drawings.
- D. Communications Room Key Drawings
 - 1. (2) full size copies of the Communications Room Key Drawings
 - a. These drawings should be submitted for review by the Designer with or prior to the pre-acceptance submittal.
- E. Closeout Submittals
 - 1. A diagram of the labeling schema used on the Project.
 - 2. Copies of Communications Room Key Drawings

PART 2 - PRODUCTS

2.1 GENERAL

- A. All products used for labeling and identification of communications systems shall be reviewed and approved by the Designer prior to installation.

2.2 MANUFACTURERS

- A. Products equal to the Basis of Design products from the following manufacturers may be used on this project:
 - 1. Panduit
 - 2. Hellerman/Tyton
 - 3. Brother
 - 4. Thomas and Betts

2.3 LABELS

- A. Cable Labels
 - 1. Cable labels shall permanent, self laminating type.
 - 2. Labels shall have a white background for text, and bold black nomenclature.
 - 3. Provide alphanumeric, clearly typewritten labels at all designated points as follows:
 - a. Horizontal Cables
 - 1) 4 pair UTP cables
 - a) Basis of Design: Brady PTL-31-642
 - 2) 4 pair STP cables
 - a) Basis of Design: Brady PTL-21-642
 - 3) Coaxial cables
 - a) Basis of Design: Brady PTL-31-642

- b. Backbone cables
 - 1) 100 pair Copper cables
 - a) Basis of Design: Brady PTL-34-642
 - 2) Fiber Optic Cables
 - a) Basis of Design: Brady PTL-21-642
 - 3) Cable Bundles
 - a) Basis of Design: Brady PTL-12-109

- B. Miscellaneous Product Labels
 - 1. Telecommunications outlet port
 - a. Basis of Design: Panduit PLL-46-Y2-1
 - 2. Telecommunications outlet faceplate
 - a. Basis of Design: Panduit JLEFPS-1
 - 3. Patch panel ports
 - a. Basis of Design: Panduit JLCPL-1
 - 4. Patch Panels
 - a. Basis of Design: Brady PTL-20-422
 - 5. 110 style blocks
 - a. Basis of Design: Panduit DSL-110
 - b. Use with Panduit P110LH
 - 6. Communications Backboards
 - a. Basis of Design: Brady PTL-37-422
 - 7. Racks and Cabinets
 - a. Basis of Design: Brady PTL-42-422

2.4 KEY DRAWINGS

- 1. Key drawings shall be professional produced by the Contractor.
- 2. Drawings shall be produced to include floor plans drawing to scale, typically at 1/8-inch = 1-foot, unless otherwise approved by the Designer.
- 3. Key drawing size shall be in direct proportion to the size of the space represented, but in not case larger than 24-inches by 36-inches.
- 4. Drawings shall be prepared on a 20lb bond paper substrate.
- 5. The key drawing information shall be produced in color. The color scheme shall be as follows.
 - a. Paper background: White
 - b. Floor plan layout: Light gray / faded black
 - c. The colors of all drawing system associated with each system shall be unique.
- 6. Key Drawing Protective Overlay
 - a. 1/8" Clear Plastic
 - b. Size: 2-inches wider and 2-inches taller than the key drawings it protects.
 - c. Pre-drilled with mounting screw clearance holes
 - 1) Mounting holes shall be place 1/2-inch from the overlay edge and 1/2-inch from the drawing the overlay protects.
 - 2) Mounting holes shall exist in each corner of the overlay
 - 3) Mounting holes shall exist along the vertical and horizontal edges, uniformly spaced no more than 18-inches on center.
- 7. Key drawings shall be prepared for each system and for each Communications room.
- 8. All key drawings shall have the same quality appearance. Colors, font type and properties shall be consistent and shall appear as though they were all prepared by the same professional organization.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Labels

1. General

- a. Apply all labels so that they are installed parallel to the dominant visual lines of the product being labeled.
- b. Labels shall be clearly legible and appropriately sized for the application.

2. Cable Labels

a. Horizontal structured cabling:

- 1) Cabling to ER/TR from outlets and devices
 - a) ER/TR # - Patch Panel #/Port # - Outlet Room Number.
 - b) Example: ER01-211-B22 where Equipment Room is identified as ER01, the cable travels to room 211 and the cable is landed on patch panel B position 22 (of 48) in the ER.
 - c) Locate label on cable jacket between 3 and 6 inches of each end of the cable.
- 2) Cabling between horizontal outlets/devices
 - a) Label local input cables.
 - b) Locate label on cable jacket between 3 and 6 inches of each end of the cable.
 - c) Label each cable as to its signal type, purpose, and destination. Add a numeric suffix to uniquely identify multiple cables of duplicate signal type, purpose or destination.

3. Miscellaneous Product Labels

a. Telecommunications outlet ports and faceplates:

- 1) ER/TR# - Outlet Room Number – Patch panel #/ Jack #.
- 2) Example: ER01-211 faceplate number and B22 through B25 jack numbers for a 4 port faceplate where Equipment Room is identified as ER01, the cable is landed on patch panel B position 22 through 25 (of 48) in the ER and travels to room 211.
- 3) Locate the faceplate label, excluding the jack designation at the top of the faceplate. Locate the individual jack designation numbers immediately above each jack on the faceplate.

b. Patch panels and patch panel ports:

- 1) Label each patch panel A-Z, top-to-bottom
 - a) Locate label on the front upper left corner of all patch panels
- 2) Locate on the front of all patch panels, directly above or below (as indicated by the manufacturer) each jack position (1 through 48) in the patch panel; place the room number corresponding to the room number used on the faceplate for each port.
- 3) Labeling shall be in numerical order and correspond to the telecommunications outlet faceplate schema.

c. Backbone cabling:

- 1) Service designation – ER#/TR#.
- 2) Service designation – CB = Copper Backbone, FB = Fiber
- 3) Backbone, VB = Video Backbone. Example: CB – ER01/TR02.
- 4) Locate label on cable jacket within 6 inches of each end of the cable and at key pull points along pathway.

d. Cross-connect blocks, 110 style

- 1) Locate on the front of all blocks directly above or below (as indicated by the manufacturer) each position in the block.
- 2) Labeling shall be in numerical order and correspond to the telecommunications outlet faceplate scheme or opposite end labeling dependant on use.

- 3) Label the upper left corner of each block designating the service of that particular block. Do not terminate mixed services on the same block.
 - e. Cross-connect blocks, 66 style
 - 1) Locate on the front of all blocks directly above or below (as indicated by the manufacturer) each position in the block.
 - 2) Labeling shall be in numerical order and correspond to the telecommunications outlet faceplate scheme or opposite end labeling dependant on use.
 - 3) Label the upper left corner of each block designating the service of that particular block. Do not terminate mixed services on the same block.
 - f. Communications Backboards (TBB)
 - 1) Backboard # with the prefix TBB, followed by the numeric backboard number in the room, followed by the suffix identifying the room in which the backboard is located. Example: TBB-01- ER-xxx.
 - 2) Label each 4'x8' sheet and each partial sheet, in numerical order left-to-right as facing the front of the backboards.
 - g. Equipment Racks
 - 1) Device ID. Example: ER01.02.
 - 2) Label each cabinet/rack in numerical order left-to-right as facing front of cabinet/rack bays.
 - h. Telephone Patch Cables
 - 1) Labeled with the same unique identifier at both ends of the assembly.
- B. Key Drawings
1. Install Key drawings within each Communications room.
 2. Create and install separate drawings, for each system. Voice and data systems may occupy the same key drawing.
 3. Install key drawings where they will be readily accessible, visible and legible by Owner personnel.
 - a. Normally, drawings shall be installed so that the top edge of the drawing(s) is at 72-inches above finished floor. If this height is not achievable the Contractor shall make recommendations to and seek the direction of the Designer.
 4. Separate Key Drawings shall be prepared for each system, including but not limited to:
 - a. Voice (Telephone) and Data (Network) communication systems RF Broadband Video Distribution Systems (CATV/SMATV/MATV)
 - b. Security Systems (Video Surveillance, Access Control, Intrusion Detection, etc...)
 - c. Other systems as specified in this Division.

3.2 TRAINING

- A. Conduct a walk through of the project site and demonstrate the presence and location of all key labeling elements used.
- B. Demonstrate the accuracy of these Key drawings to the Owner by having the Owner randomly select devices on the key drawings followed by this Contractor showing the physical location and coordinated labeling of the actual field devices.
- C. Furnish handouts to all owner personnel attending training that clearly depicts the labeling schema used on the project.

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END OF SECTION 270553

SECTION 271116

COMMUNICATION CABINETS, RACKS, FRAMES AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Supply and installation of equipment racks, cabinets, frames, enclosures and related accessories.

1.2 DEFINITIONS

- A. Where the term "Equipment Rack", or "Rack", in either it's singular or plural form, as utilized within this specification(s) and on the drawings is intended to generically refer to products designed for and normally used to house and/or mount 19", 23" and 25" E.I.A. standard "rack mounted" equipment. These "Racks" come in multiple forms, sizes, styles and finishes including but not limited to the following:
1. Cabinet Types
 2. Open Frame/Relay Types
 3. In-Wall Types
 4. Wall Mounted Types
 5. Swinging Types
 6. Portable and Roll around Types
 7. ATA Types
 8. Miscellaneous specialty types

1.3 SUBMITTALS

- A. General
1. Product Data and Shop Drawing submittals for work of this section shall be SUBMITTED TOGETHER, complete, as a single submittal.
- B. Product Data
1. Complete Bill of Materials (BOM) List
 - a. The BOM shall be organized (i.e. "sub-grouped") by Device ID.
 - b. Under each Device ID the Contractor shall enumerate the quantity, brand and model of every product to be supplied associated with each Device ID.
 - c. The manufacturer's name (Brand) and full model number shall be used. (Distributor and Contractor assigned names and model numbers are unacceptable).
 - d. Adjacent to the Device ID the Contractor shall clearly indicate the following:
 - 1) The Rack Type (as identified within these specifications)
 - 2) The room name and number in which the rack is to be located.
 - 3) The system(s) that the rack supports
 2. Manufacturer Product Datasheet for each product.

- a. Product datasheets shall be manufacturer originals, or first generation printed versions of manufacturer's official electronic product sheets.
- b. Manufacture model shall be highlighted on each sheet.
- c. Datasheets shall be organized to match the order and organization of this section

C. Shop Drawings

1. $\frac{1}{2}$ " = 1'0" enlarged plans of each space that houses one or more equipment rack(s) and related accessory products. Seek the direction of the Designer if a scale other than this is necessary to make the plan(s) fit on the specified sizes of paper.
 - a. Drawings shall be reproduced on 11" x 17" paper,
 - 1) Drawings shall be reinforced, folded and bound into the rear of the submittal binder.
 - 2) Each drawing shall reflect a single room.
 - b. Drawings shall clearly reflect the unique Device ID assigned to the rack.
2. Full Scale drawings of the labels that will be affixed to each equipment racks.

D. Quality Assurance / Control Submittals

1. RCDD Certification for the staff member responsible for this project.
2. Resume of the last 10 projects of the RCDD responsible for this project
3. BICSI Technician's certificate for each lead Technician(s) on the project

E. Closeout Submittals

1. Communication Room enlarged Floorplan Layouts, drawing to scale, depicting device sizes and locations..
2. A diagram of the labeling scheme used on the Project.

1.4 DELIVERY, STORAGE AND HANDLING

- A. This contractor shall coordinate the delivery location and timing of delivery of product to the project site and/or other contractor's pre-assembly site(s) as necessary to meet the needs of contractors utilizing product supplied under this section.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. General

1. All racks shall be UL Listed for the location and manner in which the product will be installed and used.
2. All products furnished of a given type under this section shall be manufactured by a single manufacturer; shall bear the same brand name; shall be of the same finish color and texture; and shall be from the same product model series, unless otherwise noted.
3. Accessories furnished for use with an equipment rack shall be from the same manufacture as the rack, except where unless otherwise specified and/or indicated on the drawings
4. All equipment racks and their accessories shall be furnished black in color unless otherwise expressly identified herein or noted on the drawings.
5. All racks located adjacent to one another shall be matching in size, color, fit and finish texture, and shall be manufactured by the same manufacturer except where otherwise expressly required by the Designer.

6. All racks located within eye-sight of one another shall be matching in color, finish texture, and as manufactured by the same manufacture except where otherwise expressly required by the Designer.

B. Substitute Racks

1. Substitute equipment racks may not exceed the physical dimensions of the specified equipment racks, nor may they be less than ½ inches less in any external dimension without the model specific pre-bid written approval of the Designer.

C. Rack Side Panels

1. Where equipment racks require accessory side panels, and where these racks are detailed on the drawings to be “ganged” together, only one set of side panels is required to be furnished for each model of rack in the gang.

2.2 EQUIPMENT RACKS

A. Floor Type

1. Description
 - a. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - b. Material: Extruded aluminum.
 - c. Four-post: minimum 1000lbs load rating.
 - d. Overall height: as shown on drawings.
 - e. Depth: minimum 23 inches.
 - f. Rack units: as shown on drawings.
 - g. Finish: Manufacturer's standard, baked-polyester powder coat.
 - a) Color: Black.
 - h. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug and power distribution units (PDU).
 - i. Base shall have a minimum of four mounting holes for permanent attachment to floor.
 - j. Top shall have provisions for attaching to cable tray or ceiling.
 - a) Self-leveling
 - k. Approved Manufacturer: Panduit.
 - l. Additional approved manufacturer(s): Great Lakes, Chatsworth, Hubbell.

2.3 RACK ACCESSORIES

A. Storage Drawer

1. Accessory key lock.
2. Sizes and quantity as indicated and/or scaled from drawings.

B. Filler Panels

1. General
 - a. Provide quantity of filler panels as required to filling all unused spaces of every supplied equipment rack not occupied by a supplied product specified in another section or as shown on the Detail Drawings.
 - b. Except where shown on the drawings, all furnished filler panels shall not exceed 2-rack units (3.5 inches) in height.
 - c. Provide appropriate mixture of vent-type and blank-type filler panels as required to ensure proper air-flow and equipment cooling.
2. Vent-Type

- a. 16-Gauge steel construction
 - b. Vertical vent slot orientation
 - c. Textured powder coat finish
 - d. Flanged upper and lower edges for rigidity.
3. Blank-Type
 - a. 16-Gauge steel construction
 - b. Textured powder coat finish
 - c. Flanged upper and lower edges for rigidity.
- C. Rack Mount Shelves – (for use in Voice/Data/Network Racks only)
1. Basis of Design: Homaco ESV-19-4B
 2. Sizes and quantity as indicated and/or scaled from drawings.
- D. Rack Mounted Shelves – Custom (used for Audio, Video and Security Systems Equipment)
1. 16-Gauge steel construction
 2. Textured powder coat finish
 3. Form-fitted front panel sized to exactly match the products hosted on the shelf
 4. Custom sized in standard EIA Rack unit heights to match the equipment hosted on the shelf.
 5. Quantity: Furnish quantity and size of custom shelves required to accommodate all equipment to be mounted that is neither supplied with nor available from the product manufacturer with a rack mount accessory kit.
- E. Rack Mounting Screws
1. Truss-type screw head
 2. Black finish
 3. Matching size and color nylon protective washer
 4. For Racks with #10-32 threaded rack rails
 - a. #10-32 thread
 - 1) Furnish (3) Phillips-drive screw/per rack space/per supplied rack.
 - 2) Furnish (1) Square-post security drive screw/per rack space/per supplied rack.
 5. For Racks with #12-24 threaded rack rails
 - a. #12-24 thread
 - 1) Furnish (4) Phillips-drive screw/per rack space/per supplied rack.

2.4 LABELS

- A. Equipment Racks
1. Label shall be white polyester.
 2. Label shall have temperature range of -40 to 248 degrees F
 3. Label shall have superior adhesion and utilize thermal transfer
 4. Label shall utilize $\frac{3}{4}$ " black font
 - a. Basis of Design: Brady PTL-100-483

PART 3 - EXECUTION

3.1 COORIDINATION

- A. This Contractor shall coordinate closely with all Contractors/sub-contractors/vendors supplying work within supplied product. This coordination shall include review of equipment rack configurations to ensure that they appropriately complement the systems being supplied;
- B. This Contractor shall coordinate the delivery of product and its installation to meet the workflow of contractors, sub-contractors and this project as a whole.

3.2 INSTALLATION

- A. Equipment Racks
 - 1. General
 - a. Secure all fixed position, non-portable equipment racks using removable threaded fasteners to prevent equipment racks from movement and tipping over.
 - b. Bond all equipment racks to the Telecommunications System Ground.
 - c. Properly secure racks to the floor allowing a minimum of 36-inches of clearance from the rear of the rack to the rear wall except where otherwise expressly dimensioned on drawings.
 - d. Install rack doors and panels.
 - 2. Cabinet Types
 - a. Install bushings or grommets to protect cables where exiting or entering the rack. Clean, prep and paint visible conduits using oil-based paint that exactly matches color of equipment rack.
 - 3. Open Frame/Relay Types
 - a. Install bushings or grommets to protect cables where exiting or entering the rack. Clean, prep and paint visible conduits using oil-based paint that exactly matches color of equipment rack.
 - 4. Swinging Cabinet Types
 - a. Furnish and install minimum of two (2) 3-inch conduits stubs from top of cabinet back pan to cable tray, ladder rack and/or accessible ceiling above for cabling. Provide additional quantities and sizes as indicated on drawings. Install insulated throat bushings to protect cables. Clean, prep and paint visible conduits using oil-based paint that exactly matches color of equipment rack.
 - 5. Wall Mounted Types
 - a. Furnish and install minimum of two (2) 3-inch conduits stubs from top of cabinet to cable tray, ladder rack and/or accessible ceiling above for cabling. Provide additional quantities and sizes as indicated on drawings. Install insulated throat bushings to protect cables. Clean, prep and paint visible conduits using oil-based paint that exactly matches color of equipment rack.
 - 6. Portable Types; Racks with Casters
 - a. Install insulated throat bushings to protect cables entering rack and other cable penetrations.
- B. In-Ceiling Zone Cabling Enclosures
 - 1. In-ceiling consolidation points shall be designed to fit in 2'x2' drop-ceiling grid.
 - 2. Enclosure shall be supported from building structure above lay-in ceiling grid and be installed to manufacturer's instructions.
 - 3. Enclosure shall be capable of mounting at least 9 RU of equipment/panels.
 - 4. Basis of Design: Panduit CICZC2X2 with CICZCBRKT
 - a. Additional approved manufacturers: American Access Technologies, Chatsworth Products
- C. Rack Accessories
 - 1. Grounding Bus Bar
 - a. Install grounding bus bars in each equipment rack

2. Filler Panels
 - a. Install the required size and type of filler panels in equipment racks.
 - b. The size, location and ratio of blank-to-vent filler panels shall be as required to assure proper ventilation of equipment.
 - c. Mount the filler panels within the rack using approved mounting hardware, ensuring that all unused spaces within the equipment rack are covered.
3. Rack Lights
 - a. Supply and mount service lights in the rear of all equipment racks.
 - b. Where non-magnetic racks are supplied, supply and install Designer approved substitute fixture attachment hardware.
4. Rack Drawers
 - a. Furnish and install rack drawers as indicated on the drawings.
5. Ventilation Products
 - a. Furnish and install ventilation products as specified and indicated on the drawings. Test operation of all ventilation products and adjust as appropriate
6. Cable Management Products

3.3 LABELING

- A. Label all equipment racks in accordance with Division 27 – “Identification for Communications”

END OF SECTION 271116

SECTION 271123

COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Supply and installation of complete and working cable management system(s) for use within communications rooms. Work includes, but is not necessarily limited to:
 - a. Specialty cable management and support products used to dress, support, store and organize cables mounted to walls and ceilings.
 - b. Horizontal and vertically oriented ladder rack used for support and management of cables.
 - c. Horizontal and vertical cable management used within equipment racks.

1.2 SYSTEM DESCRIPTION

- A. The cable management and ladder rack system shall accommodate the support and orderly routing and management of communications and related cabling with communication rooms.
- B. The system shall consist of horizontal ladder rack used for support of cables that need to traverse horizontally overhead within the room.
- C. The system shall consist of vertical ladder rack for support and dressing of cables that must traverse vertically from cable entry/exit points near the floor upwards towards the ceiling and/or to entry/exit points near the ceiling of the room.
- D. The system shall consist of horizontal and vertical cable management products used to support and dress cables that land on products mounted to the walls and/or ceilings.
- E. The system shall consist of horizontal and vertical cable management products used for management of communication cable products within an equipment rack

1.3 SUBMITTAL

- A. General
1. Product data and shop drawing submittals for work of this section shall be submitted together as a single submittal.
- B. Product Data
1. Bill of materials list
 2. Manufacture datasheets for all products and accessories
- C. Shop Drawings
1. Communication room enlarged floor plan(s) depicting all of the following:
 - a. Sizes and locations of all ladder rack

- b. Sizes and locations of other cable management products
- c. Drawings shall be on 11x17 paper.
- 2. Communication room(s) wall elevations depicting all of the following:
 - a. Sizes and locations of all ladder rack
 - b. Sizes and locations of other cable management products
 - c. Drawings shall be on 11x17 paper.
- D. Closeout Submittal
 - 1. Datasheets for all products used.
 - 2. Bill of materials list of products used in each communications room.
 - 3. Scaled and accurate as-built shop drawings.

PART 2 - PRODUCTS

2.1 COMPONENTS

- A. Ladder Rack
 - 1. Horizontally mounted
 - a. Constructed of 1 ½ inch by 3/8 inch ASTM A513 compliant tubular steel
 - b. Black in color.
 - c. Dimensions shall be 12 to 24 inches wide (as indicated on the drawings) with 9 to 12 inch spacing between cable support rungs.
 - d. Horizontally installed ladder rack shall have 7-inch high posts spaced every two feet on center.
 - e. Basis of Design: Chatsworth 10250-712
 - f. Additional Approved Manufacturers: Homaco, PFT, B-Line/Saunders
 - 2. Vertically mounted
 - a. Constructed of 1 ½ inch by 3/8 inch ASTM A513 compliant tubular steel
 - b. White in color. (Matching white backboard)
 - c. Ladder rack dimensions shall be 12 to 24 inches wide (as indicated on the drawings) with 9 to 12 inch spacing between cable support rungs.
 - d. Basis of Design: Chatsworth 10250-212
 - e. Additional Approved Manufacturers: Homaco, PFT, B-Line/Saunders
 - 3. Spillways, Waterfalls, Cable Drop-outs
 - a. Basis of Design shall be Chatsworth 12100-xxx.
 - b. Additional approved manufacturers: Cooper/B-Line, Hoffman, Homaco, Middle Atlantic
- B. Voice/Data Rack Cable Management
 - 1. TYPE A (All Cable Management panels shall be of this type unless specifically noted as another type on the detail drawings.
 - a. Cable Management panels shall provide station cable routing on the rear and both horizontal and vertical metal slotted rings, and plastic wire holding clips on the front.
 - b. Basis of Design:
 - 1) 2 Rack Space units:

WIRE MGMT PANEL	WM-A(2RU)		
	Basis of Design	Additional Approved Product	Additional Approved Product
Manufacturer:	HOMACO	MIDDLE ATLANTIC	HUBBELL
H/W Inches:	3.5/19"	3.5/19"	3.5/19"

Panel	HFM-19-2	HCM-2DR	HC219GC36
Vert.Cable Mgmt Rings:	INCL	(2) D-RING	(2) HC23VR2
Front Cord Rings:	INCL	INCL	INCL
Rear Cable Channel		INCL	INCL

2) 1 Rack Space units:

WIRE MGMT PANEL	WM-A(1RU)		
	Basis of Design	Additional Approved Product	Additional Approved Product
Manufacturer:	HOMACO	MIDDLE ATLANTIC	HUBBELL
H/W Inches:	1.75/19"	1.75/19"	1.75/19"
Panel	HFM-19-1SR	HCM-1DR	HC119GC36
Vert.Cable Mgmt Rings:	INCL	(2) D-RING	(2) HC23VR2
Front Cord Rings:	INCL	INCL	INCL
Rear Cable Channel	INCL	INCL	INCL

2. TYPE B (Shall be used when mounting in a Cabling Cabinet with Vertical Management installed)
 - a. Cable Management panels shall provide station cable routing on the rear and horizontal metal slotted rings, and plastic wire holding clips on the front.
 - b. Basis of Design:
 - 1) 2 Rack Space units:

WIRE MGMT PANEL	WM-B(2RU)		
	Standard of Quality	Additional Approved Product	Additional Approved Product
Manufacturer:	HOMACO	MIDDLE ATLANTIC	HUBBELL
H/W Inches:	3.5/19"	3.5/19"	3.5/19"
Panel	HFM-19-2SRC	HCM-2DR	HC219GC36
Vert.Cable Mgmt Rings:	NONE	NONE	NONE
Front Cord Rings:	INCL	INCL	INCL
Rear Cable Channel	INCL	INCL	INCL

2) 1 Rack Space units:

WIRE MGMT PANEL	WM-B(1RU)		
	Standard of Quality	Additional Approved Product	Additional Approved Product
Manufacturer:	HOMACO	MIDDLE ATLANTIC	HUBBELL
H/W Inches:	1.75/19"	1.75/19"	1.75/19"
Panel	HFM-19-1SRC	HCM-1DR	HC119GC36
Vert.Cable Mgmt Rings:	NONE	NONE	NONE
Front Cord Rings:	INCL	INCL	INCL
Rear Cable Channel	INCL	INCL	INCL

- C. Non-Voice/Data Rack Cable Management
 - 1. Horizontal Cable Lacing Bars
 - 2. Steel construction
 - 3. Baked on enamel finish
 - a. Coordinate exact model(s) supplied with system supplier. Furnish LBR-1A when supplied rack is provided for future use.
 - 4. Additional Approved Manufacturers: Atlas-Sound, Lowell Manufacturing
 - 5. Quantity: Furnish (1) lacing bar for each 5-1/4" of vertical rack mounting space for each supplied equipment rack.

- D. Vertical Cable Lacing Bars
 - 1. Steel construction
 - 2. Baked on enamel finish
 - 3. 2-inch wide
 - 4. Perforated design for easy mounting to rails within equipment racks and for securing cable tie wraps.
 - 5. Basis of Design: Middle Atlantic LACE Series.
 - a. Coordinate exact models supplied with system supplier. Furnish LACE-P, sized to suit, when supplied rack is designated for future use.
 - 6. Quantity: Furnish minimum (4) lacing bar for each equipment rack supplied.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Ladder Rack
 - 1. Within Communication Rooms
 - a. Within ER, TR, IDF, MDF communication rooms, ladder rack shall be installed to facilitate Cable Management within the space.
 - b. Where related drawings indicate specific routing, size and location of ladder rack, install ladder rack as indicated in these drawings.
 - c. Where related drawings do not expressly depict ladder rack in communication rooms, supply and install ladder rack as follows:
 - 1) 12" horizontal ladder rack, minimum size, installed around the entire perimeter of the room. Install rack 12" below finished ceiling, but not less than 86" above finish floor. Install at a height that does not interfere with doors, windows and other equipment within the room.
 - 2) 12" horizontal ladder rack, minimum size, installed directly above and parallel to floor mounted equipment racks below. Ladder rack shall intersect and join the perimeter ladder rack.
 - 3) 12" vertical ladder rack, minimum size, installed on the wall at every floor and/or ceiling cable penetrations. Cable tray shall extend from the penetration to the perimeter cable tray.
 - 4) Furnish larger ladder rack sizes, as required, to accommodate all cables within the room.
 - 5) See "Horizontally Mounted" and "Vertically Mounted" installation guidelines for additional information.
 - 2. Horizontally Mounted
 - a. Install ladder rack using manufacturer recommended hardware and accessories including, but not limited to: splice extension clamps; horizontal tee splice kits; corner support kits; adjustable vertical bend kits; adjustable vertical splice kits; runway support kits designed for ceiling

- b. support from all threaded rod; runway drop-out at equipment racks; runway end caps; etc.
 - c. Install waterfall fittings in every location where cable is intended to exit the ladder rack downward, at the end of a run as well as between the rungs.
 - d. Support with threaded rod and U-channel supports systems.
 - e. Ladder rack shall be installed approximately 96" A.F.F, near the top of the backboards, unless otherwise noted on the drawings.
 - f. Rack mounted with a side along a backboard, may mount with wall brackets; utilize threaded rod and manufacturer's bracket kits for suspension of all remaining ladder rack sections.
 - g. Install as a complete system in accordance with manufacturer's written installation instructions as indicated on the Drawings and to ensure electrical continuity of the system and adequate support for the cabling. Provide all manufacturer's recommended fittings and accessories.
 - h. Provide support for the ladder rack at a minimum of 4' 6" on center and at all splices, tees, elbows, bends, intersections, and transitions.
 - 1) Support with threaded rod and U-channel supports systems
 - a) 12" width – 1/2" ATR; 24" width – 5/8" ATR
 - 2) Rod lengths over 6' will require a "Rod Stiffener" installation.
 - a) A section of U-Channel stock is placed around the rod and stiffener clamp assemblies used to clamp to rod
 - b) Place clamps a minimum of 6" from the top and bottom of the rod and every 18" in between.
 - i. Install the ladder rack system free of all sharp edges, burrs or projections that could harm cables or humans.
 - j. Provide side posts at 2' on center to both sides of the rack lengths.
 - k. Provide end caps as specified.
 - l. Install "waterfall" type protection for cable exit downward between rungs. l. Paint fittings as required to maintain aesthetic integrity of the installation. m. The ladder rack shall be ceiling supported with wall bracing at rack ends.
3. Vertically Mounted
- a. Ladder rack rails shall mount flush against the backboard with rungs out.
 - b. Mount flat to backboard with wall mount clamps.
 - c. Rack mounted with one end on the floor and extending to intersecting cable tray/ladder rack used for horizontal cable delivery.
 - d. Install as a complete system in accordance with manufacturer's written installation instructions as indicated on the Drawings and to ensure electrical continuity of the system and adequate support for the cabling. Provide all manufacturer's recommended fittings and accessories.
 - e. Provide support for the ladder rack at a minimum of 3' on center up the entire length.
 - f. Install system free of all sharp edges, burrs or projections.
 - g. Ground and bond the system in accordance with the NEC and ANSI/TIA/EIA 607.
 - h. Provide end caps on all exposed ladder rack ends.
 - i. Trim out rectangular slot of appropriate size in ceilings, where applicable, to enable cable passage to above ceiling lines.
 - j. Paint fittings to maintain aesthetic integrity of the installation.
4. Spillways, Waterfalls, Cable Drop-outs
- a. Shall mount securely to ladder rack rails and shall maintain minimum bend radius on all cables entering or exiting the ladder rack.
 - b. Install cabling exits a conduit sleeve, cable tray, or ladder rack and the cable(s) will be unsupported for more than six inches.

B. Rack Mount Cable Management

1. All cable management panels shall be securely attached with recommended screws.
2. Install panels in positions indicated on related drawings.
3. Perform final coordination with other specification systems prior to installation.

END OF SECTION 271123

SECTION 271126

COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Supply and installation of uninterruptible power supplies for communications equipment.
 2. Supply and installation of AC power distribution products for communications equipment.

1.2 SYSTEM DESCRIPTION / DESCRIPTION OF WORK

- A. Equipment racks, cabinets, frames and enclosures shall be provided with
- B. Uninterruptible Power Supplies (UPS) as indicated on the drawings.
- C. UPS shall be installed in all other locations as identified in this section and on the drawings.
- D. UPS shall supply power to equipment with the associated rack, cabinet, frame or enclosure in the event of any input power loss to the UPS.
- E. Power distribution systems shall be provided within all equipment racks, cabinets, frames and enclosures and shall be sufficient to deliver to all equipment contained within them.
- F. Power distribution products shall be provided on all communication backboards as indicated on the drawings and as additionally required to distribute power to all products mounted to the communications backboards.
- G. 20% minimum, unused spare AC power receptacles shall be provided in all equipment racks, cabinets, frames and enclosures. This spare capacity shall remain for owner use after all specified and pre-designated future systems are installed.

1.3 SUBMITTALS

- A. Product Data
1. Manufacture datasheets for all system equipment
 2. Complete BOM list
 - a. BOM shall include the following information for each product:
 - 1) Contractor's quantity estimates.
 - 2) Manufacturer name.
 - 3) Manufacturer model number (as it appears on manufacturer's product data sheet).
 - 4) Manufacturer product description.
 - 5) Paragraph number of this section where the product is specified.
- B. Shop Drawings
1. Power Distribution Block Diagrams(s)

COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

- a. Drawings shall depict the specific power products and the exact AC power distribution configuration for each rack.
 - b. Separate power distribution diagrams shall be prepared and submitted for each rack, cabinet enclosure shall be presented on a separate drawing.
 - 1) Where identical power distribution arrangements are being planned to be supplied for multiple racks a typical shall be supplied that clearly identifies every rack (by Device ID) that will be using that specific power distribution plan.
- C. Quality Assurance
- 1. RCDD Certification for the staff member responsible for this project.
 - 2. Resume of the last 10 projects of the RCDD responsible for this project
 - 3. BICSI Technician's certificate for each lead Technician(s) on the project
- D. Closeout Submittal
- 1. Power Distribution Block Diagram(s)
 - a. Drawings shall depict the specific power products and the exact AC power distribution configuration for each rack

1.4 DELIVERY, STORAGE AND HANDLING

- A. Products of this section shall be furnished in timely manner to coordinate with work of other sections.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All AC power products furnished shall be UL Listed for the location and manner in which the product will be installed and used.
- B. All products furnished of a given type under this section shall be manufactured by a single manufacturer; shall bear the same brand name; shall be of the same finish color and texture; and shall be from the same product model series unless otherwise noted and/or approved by the Designer.

2.2 UNINTERRUPTIBLE POWER SUPPLIES (UPS)

- A. General
 - 1. Unless otherwise noted on the drawings, all UPS units shall be manufacturer designed for rack mounting and shall be furnished with all mounting hardware.
- B. 2kVA Size
 - 1. True on-line double conversion.
 - 2. Furnished with power management software.
 - 3. 120VAC input and output.
 - 4. 19" EIA rack mounting hardware
 - 5. NEMA 5-20 plug
 - 6. Four (4) NEMA 5-20 receptacles
 - 7. Basis of Design: Liebert GXT3 Series

8. Additional approved manufacturer(s): APC

C. 3kVA Size

1. True on-line double conversion.
2. Furnish with power management software.
3. 208VAC input and output.
4. 19" EIA rack mounting hardware
5. NEMA L6-30 plug
6. 4 NEMA 5-15R Receptacles
7. One NEMA L5-30R Receptacle
8. Basis of Design: Liebert GXT3 Series
9. Additional approved manufacturer(s): APC

2.3 POWER DISTRIBUTION

A. General

1. Furnish receptacles of the amperage rating matching the power feed(s) to the rack.

B. Within Voice/Data Equipment Racks

1. 15A Vertical multi-outlet power strips (Use with 3KVA RM UPS)
 - a. 120VAC input
 - b. NEMA 5-15R receptacles (14 – 24 outlets)
 - c. 45 - 72 inch length
 - d. 9 foot power cord with Nema5-15P plug
 - e. Basis of Design: Middle Atlantic PD-1415C-NS and PB-5A brackets.
 - f. Additional approved manufacturers:
 - 1) Great Lakes Case & Cabinet #7215
 - 2) Hoffman # AP722415
2. 20A Vertical multi-outlet power strips (Use with 2KVA RM UPS or Floor Model and Power Distribution Panel within room.)
 - a. 120VAC input
 - b. NEMA 5-20R receptacles (14 - 24 outlets)
 - c. 49 - 72 inch length
 - d. 9 foot power cord with NEMA 5-20P plug
 - e. Basis of Design: Middle Atlantic PD-1220C-NS and PB-5A brackets.
 - f. Additional approved manufacturers:
 - 1) Great Lakes Case & Cabinet #7215-20AR
 - 2) Hoffman # AP722420

C. Within Sound Reinforcement and Audio-Video Systems equipment racks

1. General
 - a. Each rack shall be furnished with a complete and working AC power distribution system.
 - b. System shall consist of a remotely controllable power sequencer and AC power outlets controlled by this sequencer.
 - c. Refer to both Communication Technology and Electrical series drawings to determine the presence of isolated-ground circuits feeding the equipment rack(s). Provide isolated ground versions of power distribution products as required to match power supplied.
 - d. Where rack is designated for future use and where no system is specified for the rack, furnish (2) discrete vertical receptacle strips, each strip containing at least one (1) AC receptacle for every 5-1/4" inches of rack mounting space within the equipment rack.
2. Integrated Power Sequencing System

- a. Equipment racks with fewer than 12 products requiring AC power, and less than 12 amperes of continuous current draw shall be provided with an integrated power sequencing system plus supplemental power strips. This system shall consist of.
 - 1) Rack mounted power sequencer with integral AC receptacles
 - 2) Supplemental Vertical AC power strips.
 - b. Rack Mounted Power Sequencer
 - 1) Rack Mounted
 - 2) Front panel power switch
 - 3) Low-voltage remote control input
 - 4) Low-voltage status output port
 - 5) 120VAC Input
 - 6) (6) Nema5-15R Duplex Receptacles
 - 7) Nema5-15P Input plug
 - 8) 15 amp current rating
 - 9) Basis of Design: Middle Atlantic PDS-615R
 - c. Vertical Power Strips
 - 1) Furnish quantity of individual strips containing the quantity of receptacles required (plus 20% spares) to fit within the supplied equipment rack(s).
 - 2) Basis of Design: Middle-Atlantic PD-Series
3. Modular Power Sequencing System
- a. Equipment racks with greater than 12 products requiring AC power or a continuous current draw of 12 amperes or more shall be furnished with a complete and working modular power sequencing system consisting of:
 - 1) Power Sequence controller
 - 2) 6-circuit capable, 6-duplex outlet modular power distribution strips.
 - 3) Supplemental vertical power strips adequate AC receptacles to accommodate all equipment in the equipment rack (plus 20% spare capacity).
 - b. Power Sequence Controller
 - 1) Six (6) low voltage control outputs
 - 2) External remote control inputs
 - 3) Status output ports
 - 4) 19" EIA rack mountable
 - 5) 1 Rack unit high
 - 6) Front panel power switch and status LEDs
 - 7) Basis of Design: Middle-Atlantic USC-6R Universal Sequence Controller
 - 8) Controller
 - 9) Additional approved manufacturers: Brand/Model specific pre-approval required.
 - c. Modular Vertical Raceway System
 - 1) Raceway
 - a) 3-Module Modular Raceway
 - (A) Overall Length: 32 inches
 - (B) Basis of Design: Middle-Atlantic MPR-3
 - b) 6-Module Modular Raceway
 - (A) Overall Length: 56 inches
 - (B) Basis of Design: Middle-Atlantic MPR-6
 - c) 9-Module Modular Raceway
 - (A) Overall Length: 80 inches
 - (B) Basis of Design: Middle-Atlantic MPR-9
 - 2) Power Modules
 - a) 20Amp – 120volt – Remote Controllable
 - (A) Nema5-20R Duplex Receptacle

- (B) Basis of Design: Middle-Atlantic RM-20
 - b) 20Amp – 120volt – Remote Controllable – Isolated Ground
 - (A) Nema5-20R(IG) Duplex Receptacle
 - (B) Basis of Design: Middle-Atlantic RM-20IG
 - c) 15Amp – 120volt – Remote Controllable
 - (A) Nema5-15R Duplex Receptacle
 - (B) Basis of Design: Middle-Atlantic RM-15
 - d) 15Amp – 120volt – Remote Controllable – Isolated Ground
 - (A) Nema5-15R(IG) Duplex Receptacle
 - (B) Basis of Design: Middle-Atlantic RM-15IG
 - e) Blank Modules
 - (A) Basis of Design: Middle-Atlantic MPR-BL
 - 3) Jumper Cables
 - a) Receptacle to receptacle power jumpers
 - b) 12, 24 and 72 inch length available
 - c) Connectorized at both ends to mate with receptacles
 - d) Basis of Design: Middle-Atlantic J series
 - e) Tail Cables
 - f) Basis of Design: Middle-Atlantic T series
 - 4. Vertical Power Strips
 - a. Basis of Design: Middle-Atlantic PD-Series
 - b. Furnish quantity of individual strips containing the quantity of receptacles required (plus spares) to fit within the supplied equipment rack(s).
- D. Within Public Address, Intercom, and Security System(s) Equipment Racks
 - 1. General
 - a. Each rack shall be furnished with a complete and working internal power distribution system consisting of enough AC receptacles to accommodate all equipment to be housed within the equipment rack, plus a 20 percent spare outlet capacity.
 - b. Refer to both Communication Technology and Electrical drawings to determine the presence of isolated-ground circuits feeding the equipment rack(s).
Furnish isolated ground versions of power distribution products to match incoming power feed(s).
 - c. Where rack is designated for future use and where no system is specified for the rack, furnish (2) discrete vertical receptacle strips, each strip containing at least one (1) AC receptacle for every 5-1/4" inches of rack mounting space within the associated equipment rack.
 - 2. Vertical Rack Power Strips
 - a. Full Rack Length
 - b. 120VAC operating voltage
 - c. 20-Amp and 15-Amp capacity versions
 - d. Standard and Isolated Ground versions
 - e. Basis of Design: Middle Atlantic PD Series
 - f. Additional Approved Manufacturers: Wiremold, Hammond
 - g. Manufacturing, Tripplite
 - 3. Rack Mount Receptacle Strips
 - a. 20 Amp – Non-Isolated Ground Version
 - 1) 19" EIA Rack Mountable
 - 2) 1-3/4" High
 - 3) 20Amp Nema5-20P Plug
 - 4) 6' AC Power Cord
 - 5) Integral 20Amp Circuit Breaker
 - 6) Front Panel AC power switch
 - 7) No front panel receptacles

- 8) Minimum of 6 rear-mounted Nema5-20R receptacles
 - 9) Basis of Design: Hammond Manufacturing 1589H6F1BKRR
 - b. 15Amp – Non-Isolated Ground Version
 - 1) 19" EIA Rack Mountable
 - 2) 1-3/4" High
 - 3) 15Amp Nema5-15P Plug
 - 4) Receptacles rotated 90 degrees (i.e. perpendicular) to length receptacle strip
 - 5) 6' AC Power Cord
 - 6) Integral 15Amp Circuit Breaker
 - 7) Front Panel AC power switch
 - 8) No front panel receptacles
 - 9) Minimum of 6 rear-mounted Nema5-15R receptacles
 - 10) Basis of Design: Hammond Manufacturing 1583H6A1BKRA
- E. Within all Other Equipment Racks
1. Unless otherwise specified herein and/or shown and/or noted on the related drawings each supplied rack shall be provided, minimally, with the following:
 - a. One (2) 15-Amp 120VAC Single-circuit vertical power receptacle strips.
 - b. Receptacle strip shall contain at least (1) Nema5-15R AC power outlet for each 3-1/2" of vertical rack mounting space. For example: A 44-rack unit cabinet shall have at least 22 total AC outlets.
 - c. One (1) 20Amp 120VAC Single-circuit horizontal AC rack-mount AC power receptacle strip. Receptacle strip shall contain (6) Nema5-20R AC power outlets.

PART 3 - EXECUTION

3.1 COORDINATION

- A. This Contractor shall coordinate with all other Contractors and sub-contractor(s) supplying and installing equipment racks, cabinets, frames and enclosures as well as the contractors providing

3.2 INSTALLATION

- A. General
 1. Secure all fixed position equipment racks using removable threaded fasteners to prevent equipment racks from movement and tipping over.
- B. Uninterruptible Power Supplies and Power Distribution
 1. General
 - a. Coordinate directly with each system/equipment supplier/contractor/sub-contractor prior to installation of UPS, sequential controllers and receptacle strips to coordinate the installed location of these products. Location of these products shall complement the location of all connected products.
 2. Uninterruptible Power Supplies (UPS)
 - a. Plug UPS into un-switched AC power source.
 - b. Rack-mount both the power supply(s) and their accessory batteries as applicable.
 3. Telecommunication Racks

- a. Mount receptacle strips vertically in the rear of a cabinet or on rear of open frame relay racks.
- b. When UPS products are present, connect receptacle strips into outlets located on the UPS.

3.3 POWER DISTRIBUTION DEVICES:

- A. Provide specified plug-in outlet centers in each equipment rack or backboard.
 1. Plug-in outlet centers shall be securely mounted to the equipment rack utilizing
 2. Manufacturer's recommended hardware.
 3. Position to allow the Owner adequate access and avoid functionality conflicts with rack features (i.e. adjustable rails).

END OF SECTION 271126

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SECTION 271323

COMMUNICATIONS FIBER OPTIC BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Supply and installation of a complete and working Fiber Optic Backbone Cabling Systems for
 1. Multi-Purpose Fiber Optic Backbone
 - a. Including Data connectivity provisions for Data Network and Other Systems (i.e. Video Surveillance, Access Control, Control Data, Intrusion Detection, etc.).
 2. System includes but is not limited to:
 - a. Backbone cabling.
 - b. Connectors
 - c. Patch panels

1.2 REFERENCES

- A. ANSI/TIA/EIA-568-B – Commercial Building Telecommunications Cabling Standard.
- B. ANSI/TIA/EIA-569-A – Commercial Building Standard for Telecommunications Pathways and Spaces.
- C. ANSI/TIA/EIA-606 – The Administrative Standard for the Telecommunications Infrastructure of Commercial Building.
- D. ANSI/TIA/EIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications.
- E. ANSI/TIA/EIA 568 B.1 (SP-4425) General Cabling Systems Requirements
- F. ANSI/TIA/EIA 568 B.3 (PN-3894) Optical Fiber Cabling Systems.
- G. “TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL” published by the Building Industry Consulting Services International (BICSI).

1.3 SYSTEM DESCRIPTION / DESCRIPTION OF WORK

- A. The system shall be a multi-strand Fiber Optic backbone cabling system
 1. Provide, test, and label all cables and terminations devices as described below and as shown on the plans.
 2. The system shall be an ANSI/TIA/EIA 568-B compliant Fiber Optic backbone cabling system.
 3. See related Drawings for specific Project requirements.
 4. The system shall consist of total connectivity for a complete and permanent installed communications link.
 5. Refer to Backbone Diagram for types, quantities of cables.
 6. Refer to detail drawings for terminations standards and positioning of termination devices.

7. Refer to floor plans for termination locations.
8. All cables shall be continuous without splices and shall be of proper construction for the designated use.
9. All system cables shall be UL/NEC rated for the location, manner and site conditions in which the cables are installed. This includes, but is not limited to:
 - a. Use of the cable rated for the application
 - b. Not exceeding fill capacities of raceways
 - c. All cable used shall be in compliance with Local, State, and Federal laws (at minimum the NFPA published "National Electric Code") as to acceptability for placement in the designed pathway. This includes, but is not limited to, cable fill capacities of raceways and plenum vs. non-plenum construction. The Contractor shall provide and install the appropriate cable for the appropriate conditions.
 - d. Fiber Optic Backbone (Multi-purpose)

1.4 QUALITY ASSURANCE

- A. The Prime Contractor or his subcontractor responsible for this Section shall have a Registered Communications Distribution Designer (RCDD) on staff that will be ultimately responsible for this Project. The RCDD must have sufficient experience in this type project as to be able to lend adequate technical support to the field forces during installation, the warranty period, and any extended warranty periods or maintenance contracts. If in the opinion of the Owner, the RCDD does not possess adequate qualifications to support the Project, the Owner reserves the right to require the Contractor to assign an RCDD who, in the Owner's opinion, possesses the necessary skills and experience required of this Project.
- B. The lead technician(s) on the Project shall carry a current BICSI Technician Certificate or have five years of experience in projects of similar scope.
- C. The lead technician(s) on the Project shall have a thorough understanding of the following:
 1. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 568B Commercial Building Telecommunications Cabling Standard.
 2. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and spaces.
 3. American National Standards Institute/Telecommunications Industry Association – ANSI/TIA/EIA 606 The Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings.
 4. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 607 Commercial Building Grounding and Bonding Requirements for Telecommunications.
- D. All Work shall fully comply with these specifications and related Drawings and all manufacturers recommended installation practices.

1.5 SUBMITTALS

- A. General
 1. Product Data and Shop Drawing submittals for work of this section shall be SUBMITTED TOGETHER, complete, as a single submittal. Product Data and Shop Drawings are not to be submitted separately.

2. Samples shall be submitted with or immediately following submission of Product Data submittals.

B. Product Data

1. Manufacture datasheets for all system equipment
2. Manufacture datasheets for all cable
3. Manufacture datasheets for all connectors
4. Complete BOM list
 - a. BOM shall include the following information for each product:
 - 1) Contractor's quantity estimates
 - 2) Manufacturer name
 - 3) Manufacturer model number (as it appears on manufacturer's product data sheet)
 - 4) Manufacturer product description
 - 5) Paragraph in this section where product is specified.

C. Shop Drawings

1. Plan Drawing(s)
 - a. Depicting the location of all drops and major equipment locations at the project site, coordinate with work of related sections.
2. System Riser Diagram(s).
 - a. Depicting the interconnecting cabling between system equipment located at different locations at the project site.
3. System block wiring diagram, detailed.

D. Quality Assurance / Control Submittals

1. RCDD Certification for the staff member responsible for this project.
2. Resume of the last 10 projects of the RCDD responsible for this project
3. BICSI Technician's certificate for each lead Technician(s) on the project

E. Closeout Submittal

1. Backbone diagram indicating all backbone cables and the connectivity provided; i.e. show cable types and the to-and-from locations for each.
2. Equipment Room/Telecommunications Room rack/cabinet layouts (to scale) showing rack space used by each installed component.
3. A diagram of the labeling scheme used on the Project.
4. Cable manufacturer's certification of quality and performance.
5. Extended Warranty Certificate.

1.6 WARRANTY

- A. Additional requirements: All cabling and connectivity products manufacturers, including patch cords, shall have in place an agreement recognizing each other for complete execution of warranty as specified. All performance and applications warranties shall be channel rated.
1. The cable manufacturer and the connectivity products manufacturer shall have a partnership agreement established in order to provide the required warranty.
 2. Required warranty:

PART 2 - PRODUCTS

2.1 PRODUCT STANDARDS

A. General

1. This section is designed to provide the Contractor with a minimum Basis of Design and functionality for the products used for telecommunications infrastructure.
2. This standard will be considered in force for the original response as well as for any additions or changes to this Project. Due to this, there may be items listed in the Products section that are not required under the scope of this contract.
3. Products required by the Drawings but not enumerated will be evaluated as a performance specification based on the information provided on the Drawings.

2.2 CABLES

A. General

1. All cables on this Project shall be color-coded. Refer to Division 27 Section "Identification for Communications".
2. OFNP and OFNR references below are as required by the NEC published by the National Fire Protection Association.
3.
 - a. Cables not specifically identified otherwise, shall be provided with CMP classification.
 - b. Exceptions:
 - 1) Requirements for Outside Plant Rated cables.
 - 2) Cables run in continuous conduit.
 - 3) Proper cable classification is ultimately determined by building construction; reductions in classification for cables, not clarified or altered by addendum to the specifications, will require a deduct in price through a change order.
4. All references below for pathways, conduits, etc. are as defined by Division 27 Section "Pathways for Communications".

B. Fiber Optic Cables:

1. General
 - a. Where Multimode and Singlemode fiber optic cable requirements share the same start point, the same end point, and the same pathway, hybrid cables may be used to combine the Multimode and Singlemode strands under a common jacket.
 - b. All indoor fiber optic cable shall be of interlocking armored construction.
 - 1) Any fiber optic cable not of interlocking armored construction shall be installed in a properly rated (plenum) inner-duct as specified in related Division 27 Section "Pathways for Communications".
2. Optical Requirements:
 - a. All Multimode fiber optic cable is required to have the following optical characteristics:
 - 1) Optimized multi-mode fiber cable shall be 50/125 micron diameter with dual window of 850/1300 nm with industry standard color coding.
 - 2) Cable shall meet or exceed ISO/IEC 11801 OM4 Grade 6 optical characteristics.
 - 3) Optical characteristics shall include minimum Modal Bandwidth of
 - 4) 4700 MHz/km (EMB) at 850nm and 500 MHz/km at 1300nm allowing guaranteed GigaBit Ethernet distances of 1000 m at 850 nm and 550 m at 1300 nm with guaranteed 10 Gigabit Ethernet distances of 550 m at 850nm and 300 m at 1300 nm.
 - 5) Maximum attenuation – (dB/km) 3.5 at 850 nm and 1.5 at 1300 nm.
 - b. All Singlemode fiber optic cable is required to have the following optical characteristics:

- 1) Singlemode fiber cable shall be 8.3/125 micron diameter with dual window of 1310/1550 nm with industry standard color coding. Cable shall meet TIA/EIA 492-CAAA.
 - a) Maximum attenuation – (dB/km) .7 @ 1310 nm and .7 @ 1550 nm.
3. Construction
 - a. Cable shall be of all-dielectric construction unless specifically noted otherwise.
 - b. All fiber optic cable will be properly constructed for the environmental conditions and to meet all applicable codes.
 - c. The following basic construction types are recognized on this Project:
 - 1) Tight buffer armored premise distribution cable
 - 2) Plenum (OFNP) rated construction unless otherwise specifically noted.
 - 3) Used in indoor pathways primarily as backbone cable.
 - 4) Fiber counts can range from 4 to 72 strands
 - 5) Hybrid SM/MM strand mix is acceptable.
 - 6) This cable construction will never be used in an outdoor or harsh environment.
 - 7) Multimode Basis of Design shall be as manufactured by
 - 8) General Cable BL024IPNU-ILP(A) (MM 24 STRAND)
 - 9) Singlemode Basis of Design shall be as manufactured by General Cable AP006IPNU-ILPA (SM 6 STRAND) (Confirm Color and Strand Count)
 - 10) Additional approved manufacturers: Berk-Tek, Mohawk, Corning.

2.3 TERMINATION HARDWARE

A. General

1. Suggested layout of termination hardware is indicated on the Drawings. Coordinate layout of termination hardware with the Owner's Representative or Consultant/Architect/Engineer before installation.
2. The manufacturer of the cable and the manufacturer of the connectivity products shall have a partnership agreement established in order to provide the required warranty. See Warranty requirements above and in related Section 27 00 01.00.
3. All devices shall be UL listed as required by the NEC published by the National Fire Protection Association.

B. Equipment/Telecommunications Room Cabinet/Rack

1. The following basic termination devices are available and recognized for this Project.
 - a. Fiber Optic Patch Panel 24 port
 - 1) Panel shall be black steel with smoked Plexiglas door
 - 2) Rear tray capacity for optional splice trays
 - 3) Slack management spools included
 - 4) Drawers slide out for easy front access
 - 5) Accepts standard 6-pack assemblies; 4 units (FAP or FMP)
 - 6) Mountable in 1 rack space (1.75") EIA standard 19" rack/cabinet rails.
 - 7) Must use F/O Coupler Packs; see below
 - 8) Basis of Design shall be Panduit FMD1
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - b. Fiber Optic Patch Panel 48 port
 - 1) Panel shall be black steel with smoked Plexiglas door
 - 2) Rear tray capacity for optional splice trays
 - 3) Slack management spools included
 - 4) Drawers slide out for easy front access
 - 5) Accepts standard 6-pack assemblies; 8 units (FAP or FMP)
 - 6) Mountable in 2 rack spaces (3.50") EIA standard 19" rack/cabinet rails.

- 7) Must use F/O Coupler Packs; see below
 - 8) Basis of Design shall be Panduit FMD2
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - c. Fiber Optic Coupler Packs - Multimode
 - 1) Panel shall be black steel individual couplers installed
 - 2) Mounts in 24 or 48 port Fiber Optic patch panel
 - 3) 6 duplex LC adapters with phosphor bronze sleeves (MM)
 - 4) Color code MM couplers Aqua
 - 5) Basis of Design shall be Panduit FAP6WAQDSC
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - d. Fiber Optic Coupler Packs - Singlemode
 - 1) Panel shall be black steel individual couplers installed
 - 2) Mounts in 24 or 48 port Fiber Optic patch panel
 - 3) 6 simplex LC adapters with ceramic sleeves (SM)
 - 4) Color code SM couplers Blue; utilize industry standard color coding
 - 5) Basis of Design shall be Panduit FAP6WBUSCZ
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
- C. Wall-mounted Termination
- 1. The following basic termination devices are available and recognized for this Project.
 - a. Wall Mounted Fiber Optic Patch Panel 24 port
 - 1) Panel shall be black steel with dual doors and locks
 - 2) Tray capacity for optional splice trays
 - 3) Slack management spools included
 - 4) Accepts standard 6-pack assemblies; 4 units (FAP or FMP)
 - 5) Wall Mountable; 13" x 16" x 5"
 - 6) Must use F/O Coupler Packs; see below
 - 7) Basis of Design shall be Panduit FWME4
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - b. Fiber Optic Coupler Packs - Multimode
 - 1) Panel shall be black steel individual couplers installed
 - 2) Mounts in 24 or 48 port Fiber Optic patch panel
 - 3) 6 duplex LC adapters with phosphor bronze sleeves (MM)
 - 4) Provide adapter plate with couplers to match specified fiber performance. Utilize industry standard color coding.
 - 5) Basis of Design shall be Panduit
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - c. Fiber Optic Coupler Packs - Singlemode
 - 1) Panel shall be black steel individual couplers installed
 - 2) Mounts in 24 or 48 port Fiber Optic patch panel
 - 3) 6 simplex LC adapters with ceramic sleeves (SM)
 - 4) Provide adapter plate with couplers to match specified fiber performance.
 - a) Color code SM couplers Blue; utilize industry standard color coding
 - 5) Basis of Design shall be Panduit
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
- D. Discrete Cable Connectors
- 1. The following basic termination devices are available and recognized on this Project:

- a. LC Connector Multi-mode
 - 1) Provide connector to match specified fiber performance; utilize industry standard color coding.
 - 2) Each connector shall use a U/V or adhesive/epoxy to firmly adhere the glass strand to the connector.
 - 3) The connector ferrule shall be ceramic.
 - 4) The connector must provide 0.10dB typical attenuation or less
 - 5) Provide duplex LC clip, as required
Standard of quality shall be Panduit. Additional approved manufacturers: 3M, Leviton, Ortronics, or Hubbell.
- b. LC Connector Single-mode
 - 1) Provide connector to match specified fiber performance; utilize industry standard color coding.
 - 2) Each connector will use a U/V or adhesive/epoxy to firmly adhere the glass strand to the connector.
 - 3) The connector ferrule shall be ceramic.
 - 4) The connector must provide 0.15dB typical attenuation or less
 - 5) Provide duplex LC clip, as required
 - 6) Standard of quality shall be Panduit. Additional approved manufacturers: 3M, Leviton, Ortronics, or Hubbell
- c. Fiber Optic Break-out (fan-out)/(furcation) kit.
 - 1) Shall be used for all fiber optic cable terminations
 - 2) Shall include buffer tubing and heat shrink tubing for each strand to have an 18" length from break-out.
 - 3) Basis of Design shall be Corning cable Systems FAN-BT25-xx
 - 4) (Indoor) or FAN-OD25-xx (Outdoor)
 - a) Additional approved manufacturer(s): Hubbell, Leviton, Ortronics Panduit

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. This section is designed to provide a Basis of Design and functionality for the installation of technology systems infrastructure. Not all procedures will be necessary for the installation of this Project; however, this standard shall be considered in force for the original response as well as for any additions or changes to this Project.

3.2 INSTALLATION

- A. Coordination
 - 1. Review and coordinate proper pathways prior to installation.
 - 2. Reference the TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL (TDMM) published by the Building Industry Consulting Services International (BICSI) for cable installation practices. This Specification may take exception to optional statements within the TDMM. Treat any conflict per this Specification under discrepancies or Conflicts.
- B. General
 - 1. Cable routing shall follow building structure lines and shall be installed with adequate length to reach to any location within the equipment racks with at least 5 feet of service loop at each end.

2. At point of final terminations, excess cable and the service loop shall be stored and dressed neatly.
 - a. At the station end of the cable the service loop shall be stored above the ceiling line at an accessible point and supported with an approved device designed for that purpose.
 - b. Within a communications room the service loop shall be dressed and stored within the ladder rack.
 3. Provide strain relief at all connection points. Strain relief techniques shall be applied to all cables to lessen the risk of physical cable damage and to provide proper aesthetic value.
 4. Route all cabling and pathways parallel to building surfaces and at 90 degree angles to the building structure.
 5. Cable runs shall be continuous and without splices.
 6. Wiring shall be free from grounds, shorts, opens, and reversals.
- C. Protection:
1. Maintain protection of all cabling throughout the entire duration of the project.
 2. Cabling shall not be left hanging or coiled where it potentially obstructs the Work of other contractors or trades. Cabling shall be bundled, supported, and protected up out of the way of other trades any time it is determined necessary to ensure the safety of personnel or protection of the cable.
 3. Do not terminate cables designated for different services onto the same patch panel unless otherwise clearly indicated on the drawings.
 4. Do not exceed minimum bend radius or pulling tension specifications set forth by the product manufacturer.
 5. Cable Separation and Organization
 - a. Cables of different services shall not be intertwined.
 - b. Cables of all service types shall be organized and kept segregated within cable trays, ladder rack, wire management and other pathways.
 - c. Terminate all cabling on specified termination hardware in numerical order and on specified outlets.
- D. Labeling
1. Every cable shall have a label applied to the jacket at each end.
 2. Each terminating device and port shall have a unique identifier.
 3. Label all cabling and terminations as specified and indicated on related drawings.
- E. Raceways
1. Install cabling within conduit or in surface raceway where specified in this or related sections or as indicated on the drawings.
 - a. Surface raceway is permissible for use only where expressly indicated on the drawings.
 2. Cabling shall be installed in a concealed manner. Cables may be visible only in the following areas. (Provide concealed rough-ins for all device and outlet locations.)
 - a. Equipment Rooms
 - b. Telecommunications Rooms
 - c. Building spaces equipped with cable trays but without finished ceilings to conceal the cables.
 3. Install cabling in cable tray and ladder rack where specified in this or related sections or as indicated on the drawings.
 4. Support cables using approved products and methods whenever conduit, surface raceway or cable tray are not specified. Cable supports shall be attached directly to building structure.

5. Entry/exit from raceways shall be made in a uniform and consistent manner and shall not exceed the minimum bend radius of the cable.
6. Route all cabling and pathways parallel or at 90 degree angles to the structure.
7. Support cabling with the appropriate cable supports and from the building structure.

F. Wall and Floor Penetrations

1. Provide conduit sleeves with bushings on each end for all cabling penetrations. Split bushings shall not be permitted. Patch and firestop around the sleeve. Firestop the interior of the sleeve after cable is installed.
2. Firestop all firewall penetrations to return the wall to its original rating. Outlet boxes installed in firewalls shall be similarly firestopped.

G. Cable Supports

1. Neatly dress, support and securely attach all cabling on backboards and in equipment racks.
2. Where cabling is not supported by cable tray or conduit, provide necessary cable support as specified. Provide nylon cable tie at the support to contain cabling within the support. Do not bundle cable between supports. Provide cable support as specified at intervals not to exceed 5 feet. Do not secure cabling to the support. Do not use cable supports with round surfaces (i.e. bridal rings).
3. Route all cabling and pathways parallel or at 90 degree angles to the structure. Support cabling with the appropriate cable supports and from the building structure.

H. Termination

1. Terminate each end of every cable per the manufacturer's printed instructions.
2. Terminate each cable in numerical order on adjacent ports on the specified termination hardware within the appropriate communications room.
3. Terminate cables using the tools and connectors specified and as recommended by the cable/connector manufacturers' printed instructions.

I. Separation from Sources of Interference

1. Route cables at least 1.2m (4 foot) from motors or transformers; 30 cm (1 foot) from conduit and cables used for AC power distribution; 12 cm (5 inches) from fluorescent lighting fixtures.

J. Backbone cabling:

1. Multimode and singlemode fiber optic cabling shall be terminated with fusion- spliced, factory polished pigtails.
2. Provide service loop as specified or a minimum of 5 feet at each end and 10 feet at each junction point.
3. Do not violate the minimum bend radius specified by the manufacturer of the cable.
4. Provide buffer tubing on all fiber strands from the connector to the cable break- out (minimum 6 inch pigtails) and secure to the cable jacket for all fiber optic cables that do not have a cladding.
5. Route intra-building backbone cabling through primary pathways between
6. Equipment Rooms/Telecommunications Rooms.

3.3 TESTING

- A. All cables shall be fully tested and verified compliant with these specifications. All fiber optic cables shall be tested with both a power meter and an OTDR with results stored and submitted in both hard copy and electronic format for review.

1. See Division 27 - Verification Testing of Structured Cabling for additional fiber optic backbone performance testing parameters and procedures.
- B. The Owner reserves the right to have a representative present during any or all testing procedures. Verification testing of copper and fiber may be performed at or near Project completion by the Consultant for quality assurance.
- C. Upon verification testing, if the Consultant finds the test results do not match the Contractor's results, the Consultant or a third party may at the Owner's request retest all of the cabling and submit those results to the Owner and deduct the verification testing costs from the Contractor's Contract amount.

END OF SECTION 271323

SECTION 271513

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Supply and installation of a complete and working Horizontal Cabling Systems for
 - a. Voice / Telephone
 - b. Data / Network
 - 1) Including Data provisions for Other Systems (i.e. Video Surveillance, Access Control, Control Data, Intrusion Detection, etc.).
 2. System includes but is not limited to:
 - a. Horizontal cabling.
 - b. Station outlets including frames, connector modules, and cover plates.
 - c. Patch panels

1.2 REFERENCES

- A. ANSI/TIA/EIA-568-B.1 – Commercial Building Telecommunications Cabling Standard.
- B. ANSI/TIA/EIA-569-A – Commercial Building Standard for Telecommunications Pathways and Spaces.
- C. ANSI/TIA/EIA-606 – The Administrative Standard for the Telecommunications Infrastructure of Commercial Building.
- D. ANSI/TIA/EIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications.
- E. ANSI/TIA/EIA 568 B.1 (SP-4425) General Cabling Systems Requirements
- F. ANSI/TIA/EIA 568-B.2 (PN-4426) 100 Ohm Twisted Pair Copper Cabling Systems
- G. "TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL" published by the Building Industry Consulting Services International (BICSI).

1.3 SYSTEM DESCRIPTION / DESCRIPTION OF WORK

- A. The system shall be a 4 pair UTP copper Horizontal cabling system.
1. Provide, test, and label all cables and terminations devices as described below and as shown on the plans.
 2. The system shall be an ANSI/TIA/EIA 568-B compliant Unshielded Twisted Pair (UTP) horizontal cabling system.
 3. The Horizontal voice cabling systems shall be Category 6 compliant system.
 4. The Horizontal data cabling system shall be Category 6 compliant system.
 5. See related Drawings for specific Project requirements.

6. The system shall consist of total connectivity for a complete and permanent installed communications link.
7. Refer to detail drawings for terminations standards and positioning of termination devices Provide, test, and label all cables and terminations devices as described below and as shown on the plans.
8. The cable distance between the termination point with a Communications Room(s) and the station outlet(s) shall be no greater than 90 meters (300 ft).
9. The total channel distance shall not exceed 100 meters (328 feet) distance between equipment in the Communications room and station equipment, including all patch cables and station attachment cables
10. All system cables shall be continuous between points of termination, without splices.
11. All system cables shall be UL/NEC rated for the location, manner and site conditions in which the cables are installed. This includes, but is not limited to:
 - a. Use of the cable rated for the application
 - b. Not exceeding fill capacities of raceways
 - c. All cable used shall be in compliance with Local, State, and Federal laws (at minimum the NFPA published "National Electric Code") as to acceptability for placement in the designed pathway. This includes, but is not limited to, cable fill capacities of raceways and plenum vs. non-plenum construction. The Contractor shall provide and install the appropriate cable for the appropriate conditions.

1.4 QUALITY ASSURANCE

- A. The Prime Contractor or his subcontractor responsible for this Section shall have a Registered Communications Distribution Designer (RCDD) on staff that will be ultimately responsible for this Project. The RCDD must have sufficient experience in this type project as to be able to lend adequate technical support to the field forces during installation, the warranty period, and any extended warranty periods or maintenance contracts. If in the opinion of the Owner, the RCDD does not possess adequate qualifications to support the Project, the Owner reserves the right to require the Contractor to assign an RCDD who, in the Owner's opinion, possesses the necessary skills and experience required of this Project.
- B. The lead technician(s) on the Project shall carry a current BICSI Technician Certificate or have five years of experience in projects of similar scope.
- C. The lead technician(s) on the Project shall have a thorough understanding of the following:
 1. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 568B Commercial Building Telecommunications Cabling Standard.
 2. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and spaces.
 3. American National Standards Institute/Telecommunications Industry Association – ANSI/TIA/EIA 606 The Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings.
 4. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 607 Commercial Building Grounding and Bonding Requirements for Telecommunications.
- D. All Work shall fully comply with these specifications and related Drawings and all manufacturers recommended installation practices.

1.5 SUBMITTALS

A. General

1. Product Data and Shop Drawing submittals for work of this section shall be SUBMITTED TOGETHER, complete, as a single submittal. Product Data and Shop Drawings are not to be submitted separately.
2. Samples shall be submitted with or immediately following submission of Product Data submittals.

B. Product Data

1. Manufacture datasheets for all system equipment
2. Manufacture datasheets for all cable
3. Manufacture datasheets for all connectors
4. Complete BOM list
 - a. BOM shall include the following information for each product:
 - 1) Contractor's quantity estimates
 - a) Submission/acceptance of this estimate does in no way relieve the Contractor of the responsibility to provide the materials as required to fulfill all work as specified and as shown on the Drawings.
 - b) Manufacturer name
 - c) Manufacturer model number (as it appears on manufacturer's product data sheet)
 - d) Manufacturer product description
 - e) Paragraph number of this section where the product is specified.

C. Shop Drawings

1. Plan Drawing(s)
 - a. Depicting the location of all drops and major equipment locations at the project site, coordinate with work of related sections.
2. Equipment Rack Elevations
 - a. Scaled
 - b. Depicting the locations of all system products installed within the rack, coordinated with work of other sections, as applicable.
3. System block wiring diagram, detailed.

D. Quality Assurance / Control Submittals

1. RCDD Certification for the staff member responsible for this project.
2. Resume of the last 10 projects of the RCDD responsible for this project
3. BICSI Technician's certificate for each lead Technician(s) on the project

E. Closeout Submittal

1. Communication Room Rack Layouts, drawing to scaled, depicting devices and rack space occupied by each installed component.
2. A diagram of the labeling scheme used on the Project.
3. Additional closeout documentation as required in Division 1 and Division 27 "General Requirements for Communications".
4. Cable manufacturer's certification of quality and performance.

1.6 WARRANTY

- A. Additional requirements: All cabling and connectivity products manufacturers, including patch cords, shall have in place an agreement recognizing each other for complete execution of warranty as specified. All performance and applications warranties shall be channel rated.

1. The cable manufacturer and the connectivity products manufacturer shall have a partnership agreement established in order to provide the required warranty.
2. Required warranty:
 - a. The ANSI/TIA/EIA 568-B Proposed Category 6 compliant cable system shall include as a minimum a 15 year extended product warranty and performance/applications assurance program up to 250 MHz systems.

PART 2 - RODUCTS

2.1 GENERAL

- A. This section is designed to provide the Contractor with a minimum Basis of Design and functionality for the products used for telecommunications infrastructure.
- B. This standard will be considered in force for the original response as well as for any additions or changes to this Project. Due to this, there may be items listed in the Products section that are not required under the scope of this contract.
- C. Products required by the drawings but not listed in Part 2, will be evaluated as a performance specification based on the information provided on the Drawings.

2.2 CABLES

- A. General
 1. All cables on this Project shall be color-coded. Refer to Division 27 Section "Identification for Communications".
 2. CMP (OFNP) and CMR (OFNR) references below are as required by the NEC published by the National Fire Protection Association.
 - a. Cables not specifically identified otherwise, shall be provided with CMP classification.
 - b. Exceptions:
 - 1) Cables run end-to-end within a completely closed conduit system.
 - 2) Proper cable classification is ultimately determined by building construction; reductions in classification for cables, not clarified or altered by addendum to the specifications, shall require a contract cost deduction through a change order.
- B. Twisted Pair Cables
 1. Electrical Requirements:
 - a. All Twisted Pair cable is required to have the appropriate Category classification as defined by EIA/TIA/ANSI 568B. The compliance to these electrical characteristics must be third party verified by the manufacturer. Part 1 of this specification Section will define the appropriate Category for each cable.
 - b. Recognized Categories:
 - 1) Category 1-2, Category 3, Category 5e, Category 6
 - 2) All requirements and testing parameters as set forth by EIA/TIA 568B.
 2. Construction
 - a. All Twisted pair cable will be properly constructed for the environmental conditions and to meet all applicable codes.
 - b. The following basic construction types are recognized for this Project:
 - 1) Premise Distribution 4 pair Cables - Category 6

- a) Fully ANSI/EI/TIA 568B.1 Category 6 compliant
- b) Cable shall have 2 individual insulated 24 AWG solid copper conductors formed into a twisted pair.
- c) Cable must be constructed of four individually insulated Unshielded Twisted Pairs (UTP)
- d) The cable construction must be available in plenum (CMP) and non-plenum riser (CMR) rated constructions.
- e) This cable construction is used in indoor pathways primarily as horizontal cabling but may also be used as backbone cable.
- f) Basis of Design shall be as manufactured by Panduit CMP (Confirm Color with CML)
(A) Additional approved manufacturer(s): Berk-Tek, Commscope, Mohawk

2.3 TERMINATION HARDWARE

A. General

1. Suggested layout of termination hardware is indicated on the Drawings. Coordinate layout of termination hardware with the Owner's Representative or Consultant/Architect/Engineer before installation.
2. Provide one single manufacturer for all twisted-pair termination hardware used together in a permanent link or whenever a Category Certification is required.
3. Termination devices on this Project shall be color-coded. ****See Detail
4. Drawings for details.
5. The manufacturer of the cable and the manufacturer of the connectivity products shall have a partnership agreement established in order to provide the required warranty. See Warranty requirements above and in related Section 27 00 01.00.
6. All devices shall be UL listed as required by the NEC published by the National Fire Protection Association.
7. All RJ-45 twisted pair termination devices are required to have the appropriate Category classification as defined by EIA/TIA/ANSI 568B. The compliance to these electrical characteristics must be third party verified by the manufacturer. Part 1 of this specification Section will define the appropriate Category for each cable.
 - a. Recognized Categories:
 - 1) Category 1-2, Category 3, Category 5e, Category 6, Category 6a.
 - 2) All requirements and testing parameters as set forth by the latest update to EIA/TIA 568B.

B. Station Outlet

1. The following basic termination devices are available and recognized for this Project.
 - a. Flush Faceplate – Single Gang Stainless Steel
 - 1) Single gang
 - 2) One Decora style opening
 - 3) 302 grade Stainless Steel
 - 4) Mountable on an outlet box, bracket, or raceway.
 - 5) Compatible with Decora Style Module Jack Frames specified herein.
 - 6) Basis of Design shall be Leviton 84401-040
 - a) Additional approved manufacturers: Hubbell, Ortronics, Panduit
 - b. Flush Faceplate – Double Gang Stainless Steel
 - 1) Double gang
 - 2) Two Decora style openings
 - 3) 302 grade Stainless Steel
 - 4) Mountable on an outlet box, bracket, or raceway.
 - 5) Compatible with Decora Style Module Jack Frames specified herein.

- 6) Basis of Design shall be Leviton 84409-40
 - a) Additional approved manufacturers: Hubbell, Ortronics, Panduit
- c. Furniture Faceplate
 - 1) Confirm item compatibility with Furniture Manufacturer On-Site
 - 2) 4 standard modular jack cutouts.
 - 3) Designed to snap into furniture knock-out.
 - 4) Basis of Design shall be Panduit CFFPL4BL
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
- d. Flush Faceplate – Single Gang
 - 1) Executive faceplate Frame
 - 2) Four position minimum on each faceplate
 - 3) Confirm color to match adjacent electrical devices; White color unless otherwise specified
 - 4) Mountable on an outlet box, bracket, or raceway.
 - 5) Compatible with module inserts specified herein.
 - 6) Basis of Design shall be Panduit CFPE4xxY
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
- e. Flush Faceplate – Double Gang
 - 1) Executive faceplate Frame
 - 2) Ten position minimum on each faceplate
 - 3) Confirm color to match adjacent electrical devices; White color unless otherwise specified
 - 4) Mountable on an outlet box, bracket, or raceway.
 - 5) Compatible with module inserts specified herein.
 - 6) Basis of Design shall be Panduit CFPE10xx-2GY
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
- f. Decora Style Module Jack Frame
 - 1) Four position minimum on each frame
 - 2) Confirm color to match adjacent electrical devices; White color unless otherwise specified
 - 3) Mountable on an outlet box, bracket, or raceway.
 - 4) Compatible with faceplates containing Decora style cut-out
 - 5) Basis of Design shall be Panduit CFG4xx
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
- g. Duplex Module Quad Jack Frame
 - 1) Four position minimum on each frame
 - 2) Confirm color to match adjacent electrical devices; White color unless otherwise specified
 - 3) Mountable on an outlet box, bracket, or raceway.
 - 4) Compatible with faceplates containing standard electrical duplex receptacle cut-out.
 - 5) Basis of Design shall be Panduit CF1064xxY
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
- h. Faceplate Blank Insert
 - 1) Provide blanks for all un-used positions in faceplates, surface boxes, or jack frames.
 - 2) Color to match outlet faceplate as described above; White color unless otherwise specified
 - 3) Basis of Design shall be Panduit CMBxx-X

- a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - i. Wall-Phone Jack
 - 1) Stainless Steel faceplate with mounting posts for keyhole slot telephone mounting
 - 2) Mountable on an outlet box, bracket, or raceway.
 - 3) Basis of Design shall be Panduit KWP6PY
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - j. F style bulkhead Insert
 - 1) Female to Female 75 ohm bulkhead connector.
 - 2) Color to match outlet faceplate as described above; White color unless otherwise specified
 - 3) Basis of Design shall be Panduit CMFSRxxY
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
- C. Communications Room Equipment Rack(s)
- 1. The following basic termination devices are available and recognized or this Project.
 - a. UTP Cat 6 Patch Panel 24 port
 - 1) Panel shall be black steel with PCB connection between interfaces
 - 2) Shall provide 24 ports in 1.75" of rack space (1 RU).
 - 3) Designed with jack labeling areas on both front and rear
 - 4) Fully compliant ANSI/TIA/EIA 568B Category 6
 - 5) RJ45 jack interface on front and 110 style IDC connections on rear
 - 6) Mountable in EIA standard 19" rack/cabinet rails.
 - 7) Basis of Design shall be Panduit DP24688TGY
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - b. UTP Cat 6 Patch Panel 48 port
 - 1) Panel shall be black steel with PCB connection between interfaces
 - 2) Shall provide 48 ports in 3.5" of rack space (2 RU).
 - 3) Designed with jack labeling areas on both front and rear
 - 4) Fully compliant ANSI/TIA/EIA 568B Category 6
 - 5) RJ45 jack interface on front and 110 style IDC connections on rear
 - 6) Mountable in EIA standard 19" rack/cabinet rails.
 - 7) Basis of Design shall be Panduit DP48688TGY
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - c. 110 Block Mounting Panel
 - 1) Panel shall be black steel pre-drilled for mounting standard 110 style devices and trough hardware Mountable in 4 rack spaces (7.00") EIA standard 19" rack/cabinet rails.
 - 2) Must use separate 110 style blocks and hardware listed under Wall Mounted Terminations below – Order without legs.
 - 3) Basis of Design shall be Panduit P110B100R4BY
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - d. 110 style 100 pair base
 - 1) Shall utilize Industry normal footprint
 - 2) Must have labeling areas on front and available label kits
 - 3) Fully compliant ANSI/TIA/EIA 568B Category 5e
 - 4) 110 style IDC termination system
 - 5) Optional jumper troughs available and designed to mount with base footprint
 - 6) Requires 110C connecting blocks below

- 7) Available without legs for mounting on rack/cabinet mounted panels or on Tower Systems
 - 8) Basis of Design shall be Panduit P110BW100-X with legs and Panduit P110B100-X without legs
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - e. 110 style 300 pair base
 - 1) Shall utilize Industry normal footprint
 - 2) Must have labeling areas on front and available label kits
 - 3) Fully compliant ANSI/TIA/EIA 568B Category 5e
 - 4) 110 style IDC termination system
 - 5) Optional jumper troughs available and designed to mount with base footprint
 - 6) Requires 110C connecting blocks below
 - 7) Available without legs for mounting on rack/cabinet mounted panels or on Tower Systems
 - 8) Basis of Design shall be Panduit P110BW300-X with legs and Panduit P110B300-X without legs
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - f. 110 style connecting Block – 4 pair
 - 1) Fully compliant ANSI/TIA/EIA 568B Category 5e 110 style IDC termination system
 - 2) Used for termination of 4 pair cables or a combination of 4 pair and multi-pair cables
 - 3) Basis of Design shall be Panduit P110CB4-XY
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - g. 110 style connecting Block – 5 pair
 - 1) Fully compliant ANSI/TIA/EIA 568B Category 5e
 - 2) 110 style IDC termination system
 - 3) Used for termination of multi-pair cables
 - 4) Requires 110C connecting blocks below
 - 5) Basis of Design shall be Panduit P110CB5-XY
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - h. 110 style Jumper Trough with legs
 - 1) Used for wire management around 110 style termination bases
 - 2) Available without legs for mounting on rack/cabinet mounted panels or on Tower Systems
 - 3) Basis of Design shall be Panduit P110JTW-X with legs and P110JT-X without legs
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
- D. Discrete Cable Connectors
- 1. The following basic termination devices are available and recognized on this Project:
 - a. Category 6 RJ-45 modular plug for solid cable.
 - 1) Each plug will use an insulation displacement pressure termination method with specifically designed installation tool.
 - 2) The plug shall be 8 position; 8 conductor.
 - 3) Designed for 23 gauge solid copper conductors.
 - 4) The strain relief of the plug shall be designed for clamping on round cable.
 - 5) Basis of Design shall be Panduit SP688-C
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics

PART 3 - EXECUTION

3.1 GENERAL

- A. This section is designed to provide a Basis of Design and functionality for the installation of technology systems infrastructure. Not all procedures will be necessary for the installation of this Project; however, this standard shall be considered in force for the original response as well as for any additions or changes to this Project.

3.2 INSTALLATION

A. Coordination

1. Review and coordinate proper pathways prior to installation.
2. Reference the TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL (TDMM) published by the Building Industry Consulting Services International (BICSI) for cable installation practices. This Specification may take exception to optional statements within the TDMM. Treat any conflict per this Specification under discrepancies or Conflicts.

B. General

1. Cable routing shall follow building structure lines and shall be installed with adequate length to reach to any location within the equipment racks with at least 5 feet of service loop at each end.
2. At point of final terminations, excess cable and the service loop shall be stored and dressed neatly.
 - a. At the station end of the cable the service loop shall be stored above the ceiling line at an accessible point and supported with an approved device designed for that purpose.
 - b. Within a communications room the service loop shall be dressed and stored within the ladder rack.
3. Provide strain relief at all connection points. Strain relief techniques shall be applied to all cables to lessen the risk of physical cable damage and to provide proper aesthetic value.
4. Route all cabling and pathways parallel to building surfaces and at 90 degree angles to the building structure.
5. Cable runs shall be continuous and without splices.
6. Wiring shall be free from grounds, shorts, opens, and reversals.

C. Protection

1. Maintain protection of all cabling throughout the entire duration of the project.
2. Cabling shall not be left hanging or coiled where it potentially obstructs the Work of other contractors or trades. Cabling shall be bundled, supported, and protected up out of the way of other trades any time it is determined necessary to ensure the safety of personnel or protection of the cable.
3. Do not terminate cables designated for different services onto the same patch panel unless otherwise clearly indicated on the drawings.
4. Do not exceed minimum bend radius or pulling tension specifications set forth by the product manufacturer.
5. Cable Separation and Organization
 - a. Cables of different services shall not be intertwined.
 - b. Cables of all service types shall be organized and kept segregated within cable trays, ladder rack, wire management and other pathways.

- c. Terminate all cabling on specified termination hardware in numerical order and on specified outlets.
- D. Labeling
1. Every cable shall have a label applied to the jacket at each end.
 2. Each terminating device and port shall have a unique identifier.
 3. Label all cabling and terminations as specified and indicated on related drawings.
- E. Raceways
1. Install cabling within conduit or in surface raceway where specified in this or related sections or as indicated on the drawings.
 - a. Surface raceway is permissible for use only where expressly indicated on the drawings.
 2. Cabling shall be installed in a concealed manner. Cables may be visible only in the following areas. (Provide concealed rough-ins for all device and outlet locations.)
 - a. Equipment Rooms
 - b. Telecommunications Rooms
 - c. Building spaces equipped with cable trays but without finished ceilings to conceal the cables.
 3. Install cabling in cable tray and ladder rack where specified in this or related sections or as indicated on the drawings.
 4. Support cables using approved products and methods whenever conduit, surface raceway or cable tray are not specified. Cable supports shall be attached directly to building structure.
 5. Entry/exit from raceways shall be made in a uniform and consistent manner and shall not exceed the minimum bend radius of the cable.
 6. Route all cabling and pathways parallel or at 90 degree angles to the structure.
 7. Support cabling with the appropriate cable supports and from the building structure.
- F. Wall and Floor Penetrations
1. Provide conduit sleeves with bushings on each end for all cabling penetrations. Split bushings shall not be permitted. Patch and firestop around the sleeve. Firestop the interior of the sleeve after cable is installed.
 2. Firestop all firewall penetrations to return the wall to its original rating. Outlet boxes installed in firewalls shall be similarly firestopped.
- G. Cable Supports
1. Neatly dress, support and securely attach all cabling on backboards and in equipment racks.
 2. Where cabling is not supported by cable tray or conduit, provide necessary cable support as specified. Provide nylon cable tie at the support to contain cabling within the support. Do not bundle cable between supports. Provide cable support as specified at intervals not to exceed 5 feet. Do not secure cabling to the support. Do not use cable supports with round surfaces (i.e. bridal rings).
 3. Route all cabling and pathways parallel or at 90 degree angles to the structure. Support cabling with the appropriate cable supports and from the building structure.
- H. Termination
1. Terminate each end of every cable per the manufacturer's printed instructions.
 2. Terminate each cable in numerical order on adjacent ports on the specified termination hardware within the appropriate communications room.
 3. Terminate cables using the tools and connectors specified and as recommended by the cable/connector manufacturers' printed instructions.

- I. Separation from Sources of Interference
 - 1. Route cables at least 1.2m (4 foot) from motors or transformers; 30 cm (1 foot) from conduit and cables used for AC power distribution; 12 cm (5 inches) from fluorescent lighting fixtures.

- J. Horizontal cabling
 - 1. The length of patch cords and cross connect jumpers installed in the Telecommunications Room shall be 5 m (15 ft) total or less.
 - 2. The length of patch cords and cross connect jumpers installed in the Equipment Room shall be 5 m (15 ft) total or less.
 - 3. Locate telecommunications outlets so that the cable assembly required to reach work area equipment will be no more than 5 m (15 ft) long.
 - 4. Provide service loops on all cables at the station end of 2 feet (coiled above the ceiling and with a minimum of 6 inches at the telecommunications outlet coiled in the box or raceway).
 - 5. Provide service loop at the Equipment Room/Telecommunications Room end of 5 feet coiled above the ceiling or neatly bundled in ladder rack above the cabinet/rack.
 - 6. Install telecommunications outlets securely at work area locations.
 - 7. Any necessary electrical components (e.g., impedance-matching devices) at outlets shall be located outside the faceplate via a standard plug connection.
 - 8. Provide surface raceway on all walls where existing pathway has not been provided and cables cannot be concealed inside the wall cavity. Do not conceal cabling inside of block walls. Install surface raceway plumb and level, straight and securely anchored to walls with screws, bolts, or anchors as appropriate.
 - 9. Provide a 6 inch service loop on each horizontal UTP cable that breaks out from the harness for termination and do not violate the minimum bend radius of the cable.

3.3 TESTING

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Tests and Inspections:
 - 1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

- E. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- F. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- G. End-to-end cabling will be considered defective if it does not pass tests and inspections.
 - 1. Prepare test and inspection reports.
- H. The Owner reserves the right to have a representative present during any or all testing procedures. Verification testing of copper and fiber may be performed at or near Project completion by the Consultant for quality assurance.
- I. Upon verification testing, if the Consultant finds the test results do not match the Contractor's results, the Consultant or a third party may at the Owner's request retest all of the cabling and submit those results to the Owner and deduct the verification testing costs from the Contractor's Contract amount.

END OF SECTION 271513

SECTION 273300

PUBLIC ADDRESS SYSTEM

PART 1 - GENERAL

1.1 Summary

- A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish a complete Public Address (PA) system in accordance with the plans and as specified herein. The contractor shall install all speakers, horns, cables and cable to be run to the main communications room. The Contractor shall make all connections and install all equipment in the communications room. The Contractor shall coordinate exact equipment mounting locations with The University prior to the installation of any equipment or cabling.

1.2 Quality Assurance

- A. Compliance with Local Requirements: Comply with the applicable building code, local ordinances, regulations, and the requirements of the authorities having jurisdiction.
- B. Comply with NFPA 70.
- C. Listing and Labeling: Provide PA system components specified in this Section that are listed and labeled by Underwriters' Laboratories, Inc. (UL).
- D. PA System shall be registered under Part 68 of the Federal Communications Commission (FCC).

1.3 Submittals

- A. Submit product data for each type of proposed system component specified, including dimensioned drawings showing minimum clearances and installed features and devices. Include list of materials and NRTL-listing data.
- B. Submit Shop Drawings showing detailed drawings of PA system.
- C. Submit wiring diagrams from manufacturer differentiating clearly between factory and field-installed wiring. Include diagrams for each component of the system with all terminals and interconnections identified. Make all diagrams specific to this Project.
- D. Submit a system operation description covering this specific Project, including method of operation. Manufacturer's standard descriptions for generic systems are unacceptable.
- E. Submit product certificates signed by the manufacturer of the PA system components certifying that their products comply with specified requirements.
- F. Submit the manufacturer's warranty.

1.4 Delivery, Handling, And Storage

- A. Deliver PA system components in factory fabricated containers or wrappings, which properly protect products from damage.
- B. Handle PA system components carefully to prevent breakage, denting and scoring finish. Wrap finished cabinets individually, in heavy containers for protection in transit. Do not install damaged units or components; replace with new.
- C. Store PA system components in original cartons in well ventilated space protected from moisture, construction traffic and debris.

1.5 Sequence of Operation

- A. The PA system shall be zone based for direct connection to loop start and ground start trunks, to PBX and KEY paging ports that supplies DTMF capability and to analog T/R lines.
- B. The system shall allow total amplifier power up to 250W.
- C. Momentary tones shall be placed throughout the system when a contact closure is received from the master clock of the building automation system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide the following equipment including, but not limited to, the following:
 - 1. Bogen PCM 2000 series (Basis of design)

2.2 Zone Paging Modules

- A. All modules shall be equipped with a ribbon cable, connector and power cable for interconnection to each other. Module face plates shall be black with connector types labeled in white. Each plate shall have knockouts for cabling and wire dressing. All connectors shall be RJ-11 or RCA type.
- B. Telephone interface module shall have LED power indicator and provide interface selection via DIP switches and include volume control for tone and BGM source. It shall also have RJ-11 outlets for night ringer, telephone line and override functions. A connector block with screw terminal connections shall be provided for BGM source and 2 form-C relay contacts.
- C. Central Processor Module (CPU) shall be provided for the first 9 zones of the system. CPU shall provide satellite system identification via DIP switches. It shall include a locking program/run selector switch (with LED), satellite data link RCA jack and 12VDC power source. A connector block with screw terminals shall be provided for paging amplification connections, low and high power BGM connections, emergency/shift change signal activation, AUX contact closure and 12VDC power source.
- D. A talkback module (PCMTBM) shall be provided for hands-free talkback capability.

- E. The Zone PA system shall have the following functions:
 - 1. Simultaneous high and low power paging.
 - 2. Minimum of 3 paging zones and maximum capacity of 99 zones, expandable in groups of 3 zones.
 - 3. Up to 32 field programmable zone groups, each consisting of 1 – 99 zones.
 - 4. Field programmable night ringer zone group.
 - 5. Field programmable emergency/shift change zone group. This feature shall be activated by a Owner supplied contact closure and sound a user-selected tone.
 - 6. Emergency all-facility page override.
 - 7. Background music with local music sourcing capability.
 - 8. Field programmable Code Call Zone Group. Owner shall have choice of pattern or echo code calls and repeat functions.
 - 9. 2 Form-C relay contactors for activating external equipment.
 - 10. Provide uninterrupted background music to zones not being paged.
 - 11. Non-volatile RAM for retention of programming information during power interruptions.
 - 12. Screwdriver adjustable volume controls.
- F. VOIP tie in module to enable access from IP phone system to paging system. Coordinate with Owner's phone system vendor.
- G. All modules shall be wall mountable.

2.3 EQUIPMENT

- A. Rack
 - 1. Provide equipment in data racks as specified in Section 27 11 16 "Communications Cabinets, Racks, Frames and Enclosures".
- B. Drop in Ceiling Tile Speakers
 - 1. UL listed, shallow depth lightweight speaker assembly, 1' x 2' ceiling tile loudspeaker system consisting of 8" O.D. dual cone loudspeaker with 5 oz. magnet and 5W-25/70V transformer.
 - 2. Quam 8C5PAX/TBLU or approved equal by Rauland or Atlas.
- C. Cabling
 - 1. Speaker cabling shall be plenum rated, 2-conductors twisted pair, 18 gauge stranded copper.
 - 2. West Penn 25224B or approved equal by General or Belden.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install system according to standards referenced in Part 1 of this Section.

3.2 EQUIPMENT INSTALLATION

- A. Install ceiling/wall mounted speakers and other equipment per manufacturer's recommendation.
- B. Flush wall mount volume controller as required.

3.3 WIRING INSTALLATION

- A. Wiring Method: Install paging system wiring in metal conduit where concealed and inaccessible, such as within walls and enclosed ceilings. Wiring above accessible ceilings may be routed in J-hooks. Where low voltage cable tray is available, speaker cables can be routed within.
- B. Final termination in the main communications room will be by the Contractor.
- C. Speaker circuits shall be designed not to exceed a 5 percent voltage drop.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Identification for Electrical Systems."

3.5 GROUNDING

- A. Ground equipment according to system manufacturer's instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.
- B. Ground equipment, conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.

3.6 FIELD QUALITY CONTROL

- A. Minimum System Tests: The minimum required tests are as follows:
 - 1. Verify the absence of unwanted voltages between circuit conductors and ground.
 - 2. Test all conductors for short circuits using an insulation-testing device.
 - 3. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.
- B. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests. A copy of the test reports shall be included in the Owner's O&M Manual.
- C. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

END OF SECTION 273300