Contents
SECTION 27 01 10 – OPERATION AND MAINTENANCE OF STRUCTURED CABLES AND ENCLOSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and the other sections of Division 27.

B. This section is inclusive to all Division 27 sections.

1.2 DRAWINGS

A. The drawings show the general arrangement and extent of the work only. Determine the exact location and arrangement of all parts as the work progresses.

B. All work shall be subject to the Owner’s direction and approval.

1.3 SUMMARY

A. This project consists of providing a complete structured cabling system for the new Science Building at Middle Tennessee State University. The structured cabling system includes voice and data cabling locations as shown on the drawings for this 3-story building. This new building will be connected to campus network via fiber, copper, and coax installed in a new underground duct bank.

1.4 QUALITY ASSURANCE

A. In addition to procedures stated in Division 1:

1. Cutting and Patching
   a. Perform required cutting, drilling and chasing to receive new equipment. In general, perform all patching and repairing necessary to restore to original condition, all surfaces that may become damaged during the installation. All work shall be executed by persons normally employed in the type of work to which they are assigned.
   b. Paint all structural steel and all steel parts used for hangers and for supporting conduits, junction boxes and technology equipment with one (1) coat of “red” oxide primer before erection. After steel is in place, paint again with a minimum of one (1) coat of paint, color as directed by the Architect.
   c. The contractor is responsible for all cutting, patching, plastering and painting associated with the new installation.

2. Clean Up
   a. Upon completion of the contract, remove all workmen’s appurtenances from the premises. Clean the premises of all debris caused by the work and leave the installation clean and in first-class operating condition.

3. Storage of Material and Equipment
   a. Store materials and equipment in a location approved by the Owner.
   b. Be responsible for the condition of all materials and equipment employed in the installation until final acceptance by the Owner.
   c. Be responsible for the replacement of all damaged or defective work, materials or equipment. Do not install sensitive or delicate equipment until major construction work is completed. Ensure that equipment is protected from all construction site activities.
   d. Observe and conform to all applicable safety regulations required by the Owner and O.S.H.A.
1.5 INTERPRETATION AND CONFLICTS

A. Bring any discrepancies determined or omissions found lacking in the Contract Documents to the Technology Consultant’s attention before submitting the bid. After award of Contract, the Owner or Technology Consultant will make the interpretation of any conflict.

B. The failure to question any controversial item will constitute acceptance by the Bidder who shall execute it to the satisfaction of the Owner after being awarded the Contract.

C. If mention has been omitted pertaining to details, items or related accessories required for the completion of any system, it is understood such item and accessories are included in the Contract. After the Contract is awarded, claims based on insufficient data or incorrectly assumed conditions, or claims based on misunderstanding the nature of the work, will not be recognized.

D. The General Conditions, Requirements, and Special Provisions, of any larger body of specifications, of which this Specification may be a part, are hereby made a part of this Specification. In the event that any clauses or provisions of the larger body of specification conflict with the letter or intent of this Specification, the Contractor shall immediately notify the Architect and the Technology Consultant for clarification and direction.

E. All work shown shall be new work provided under this Contract except that work labeled “present to remain” and that equipment labeled “to be furnished by others, but installed by the Contractor”.

1.6 LABELING AND IDENTIFICATION

A. Clearly LABEL all new equipment, devices and miscellaneous apparatus for easy identification and for safety.

1.7 LOCATION OF EQUIPMENT AND RACEWAY

A. The drawings are diagrammatic and indicate the general arrangement of equipment to be installed.

B. Coordinate the structural, electrical/electronic and finished conditions of work accordingly.

C. Coordinated locations of all equipment, raceways, junction boxes, cable runs, conduit runs, etc., shall be determined at the site. Install all items to accommodate the various conditions in the building and make deviations necessary without additional cost.

1.8 WIRING METHODS

A. Install all wire and cable located in finished areas in new or existing raceways as indicated on Drawings.

B. Install new raceways in the locations shown on the drawings and as specified.

1.9 ORDINANCES AND CODES

A. Nothing contained in the Specifications or shown on the drawings shall be construed as to conflict with any local, municipal or state laws and regulations, governing the installation or other contract work, and all such ordinances and regulations, including the latest: National Electric Code, ANSI/EIA/TIA standards and the National Electric Safety Code, are hereby incorporated and made a part of these Specifications, and shall be satisfied by the contractor at no additional expense to the Owner.

B. Secure all permits and inspection certificates for submission to the owner.

1.10 SYSTEM CONTINUITY
A. Reconnect all existing items that remain in use. Provide all materials and labor required to retain continuity of existing circuits or systems that are disrupted by these alterations even though not indicated on the drawings.

1.11 SUBMITTALS

A. Shop drawings shall be checked, corrected and approved by the contractor before being submitted to the Owner/Technology Consultant for approval. Before submitting shop drawings, the Contractor shall carefully examine them and shall certify by his stamp/signature that, to the best of his knowledge, they comply with the Contract Documents. The Contractor must receive written approval from the Owner or an authorized representative of the Owner, in writing, prior to fabricating or installing any materials. Approval will be given based upon shop drawings. The shop drawings shall indicate complete details of work to be performed. Drawings shall include a title block naming the Project, Architect, Technology Consultant, Contractor, drawing title, drawing number, revision number if applicable and date. Submit all Shop Drawings complete as a single submission. Isolated items will not be accepted, except with prior approval.

B. Where the shop drawings deviate from the requirements of the Contract documents, the Contractor shall (1) correct the shop drawings as required, or (2) where the deviations do not necessarily require correction, notify the Owner/Technology Consultant of the deviations.

C. Submit to the Architect four (4) sets of shop drawings or otherwise noted documents/equipment for the following equipment and obtain written approval before ordering materials. See the drawings and scope information for applicability of product to phase and project:

1. Patch Panels (UTP and fiber including connectors)
2. Cable (UTP and fiber)
3. Patch Cables
4. Outlets, Faceplates and Jacks
5. Cable management Devices
6. Inner Duct
7. Punch down blocks
8. Protection Devices
9. Racks and cabinets
10. Nameplates and Identification devices
11. Basket style cable tray
12. Ladder style cable tray
13. Grounding equipment
14. Hangers and Supports
15. Strain relief products
16. All other equipment identified or inferred and as may be required by the Architect, Technology Consultant or Owner.
D. Submit complete submittal list for Owner/Architect/Technology Consultant approval prior to purchasing any equipment.

E. In some cases, manufacturer warranty may call for the review of system documentation to assure that the system design meets manufacturer warranty requirements. In such instance, with prior approval of the Owner, the contractor shall provide a complete set of Project Documents and product data to the system manufacturer for review. The system manufacturer shall review the complete system package and provide documentation attesting to the system compliance with manufacturer warranty requirements. This documentation shall be included with the Contractor Shop Drawings submittal. The Technology Consultant will not review the Contractor Shop Drawings submittal, which does not include the manufacturer warranty compliance review documentation.

F. Each shop drawing shall contain reference to the applicable drawing and specification section and verification of compatibility with the systems involved.

G. All nameplate data shall be submitted with equipment submittals – refer to other sections for complete identification requirements.

H. Shop drawings shall show conformance with specified performance characteristics, or the Contractor shall assume responsibility for all deviations including all additional costs as a result of the deviations.

1.12 STANDARDS OF MATERIAL AND WORKMANSHIP

A. All work shall be executed by persons skilled in the work to which they are assigned. This shall include all copper and fiber connections including testing, and all plastering and painting.

B. All materials and equipment in the work shall be new and of first quality, produced by manufacturers of recognized reputation for each line of material and equipment. The fact that materials or equipment offered have been recently developed or are untried may be sufficient justification for their rejection.

1.13 PROTECTION OF WORK AND EQUIPMENT

A. This Contractor shall use the required safety precautions, methods and skills to prevent possible unsafe conditions or conditions unduly susceptible to fire.

B. When this Contractor is working in areas in which the building occupants have access, contractor shall provide suitable barriers around his operation.

C. This contractor is responsible for containing the undue spread of vapors or odors from his work area.

1.14 TESTS AND INSTRUCTIONS

A. Upon completion of the work, and upon the request of the Architect, the Contractor shall be prepared to test all systems in the presence of the Owner, Architect, or Technology Consultant. Such testing shall occur at a time that is mutually acceptable to all parties. The Contractor’s representatives assisting in the performance of these tests shall be thoroughly familiar with the details of the system and shall include the field supervisor responsible for installing the system.

B. Correct all failures or improper conditions.

C. Demonstrate to the Owner the proper care and maintenance of all new items.

1.15 GUARANTEE

A. Unless stated otherwise in Division 1:

1. The contractor and his surety shall guarantee in writing for a minimum period of one (1) year from the date of final acceptance that all materials, equipment and labor furnished by contractor are free from defects. Refer to cable system warranty for additional requirements.
2. The Contractor shall further guarantee that if any piece of material or equipment is found to be defective within the guarantee period because of faulty manufacture or faulty installation, in the opinion of the Owner, contractor will replace and install and test such material or equipment without any further expense to the Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 27 01 10
SECTION 27 05 43 – UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and the other sections of Division 27.

1.2 SCOPE

A. The minimum composition requirements and/or installation methods for the following materials and work are included in this section. The following is the list of sections found within this document:

1. Trenching and Excavation
2. Duct banks

1.3 QUALITY ASSURANCE

A. The contractor shall engage the services of a qualified installer for all excavation, conduit and concrete work.

B. All work shall be done in a neat and workmanlike manner. All methods of construction, details of workmanship that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the University Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval. Where "superior" is stated, equipment shall be superior in every way to that of the equipment specified and subject to approval.

C. Materials and work specified herein shall comply with the applicable requirements of:

1. The following Articles of the National Electric Code (NFPA 70)
   a. Nonmetallic underground conduit with conductors
   b. Rigid metal conduit
   c. Rigid nonmetallic conduit

2. The following National Electrical Manufacturers Association (NEMA) Standards
   a. NEMA, RN1, 1986 PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
   b. NEMA, TC3, 1982 PVC fittings for use with Rigid PVC Conduit and tubing
   c. NEMA, TC6, 1983 PVC and ABS Plastic Utilities Duct for Underground Installation
   d. NEMA, TC8, 1983 Extra strength PVC Plastic Utilities Duct for Underground Installation
   e. NEMA, TC9, 1983 Fittings for ABS and OVC Plastic Utilities Duct and Fittings for Underground Installation
   f. NEMA, TC10, 1983 PVC and ABS Plastic Communications Duct and Fittings for Underground Installation

3. The following American National Standards Institute (ANSI) standards:
   a. ANSI-C80.2, 1983 Specification for Rigid Steel Conduit, Enameled

4. The following U.L. Standards:
   a. U.L. 6, 1981 Rigid Metal Electrical Conduit
   b. U.L. 651, 1981 Schedule 40 and 80 PVC Conduit

5. The following BICSI Standards:
   b. BICSI latest version operation manuals
   c. BICSI ANSI/TIA/EIA 569-B.1
1.4 SUBMITTALS

A. Product data for:
   1. Dated copy of Dig Alert ID Notice application and permit number with time spans
   2. Conduit and sub duct materials

1.5 PROJECT CONDITIONS

A. The following conditions apply to excavation:
   1. Secure Dig Alert permit prior to trenching.
   2. Contractor is responsible for verifying subsurface conditions prior to excavation work.
   3. Identify, maintain, and protect existing building services that cross the excavation area (must be flagged by contractor).
   4. Protect utilities, sidewalks, structures, pavements and other facilities from damage caused by settling, lateral movements, undermining, washouts and other hazards created by excavation work.
   5. Locate and verify existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.
   6. Sequence work to minimize any service downtime. A detailed sequence of events will be required prior to any work is performed.

PART 2 - PRODUCTS

2.1 TRENCHING AND EXCAVATION FILL

A. Designed Backfill
   1. Sand: Clean, coarse, and free of organic matter, rocks and sharp stones.

B. For all trench loading designs and pipe encapsulation, use two sack cementious slurries for future access ease (1800 psi in 10 hours).

C. For permanent cover in less than 24 inch below sub-grade use five sack concrete mix.

D. Ordinary Fill (CUT): Well-graded, screened, natural inorganic soil, meeting the following requirements:
   1. Free of organic and other compressible materials, debris and frozen materials, and of stones larger than 2 in. maximum dimension.
   2. Be of such nature and character that it can be compacted to the specified densities.
   3. Free of highly plastic clays, of materials subject to decay, decomposition, or dissolution, and of cinders, ash and other corrosive materials.
   4. Maximum dry density of not less than 115 lbs. per cu. ft.

E. Material from excavation on the site may be used as ordinary fill if it meets the above requirements.

F. Caution Tape: Place 6” orange plastic warning tapes a minimum of 18” below grade, above all underground conduit and cable pathways.

G. Ductbanks
   1. Ductbanks must be composed of individual 4" diameter schedule 40 Non-Metallic Conduits.
   2. Galvanized rigid steel conduit bends shall be used at all conduit angles 90 Degrees or sharper passing through concrete slab pours.
   3. Rigid Non-Metallic Conduit must be Schedule 40 or higher. All out of ground non-metallic risers shall be schedule 80.
   4. Where ductbanks penetrate foundation, footings or outside walls, rigid metallic conduits with expandable rubber shields and/or bituminous taping shall be used.
   5. Seal all underground conduits after all cables are installed to prevent rodents, water or grass from entering the buildings.
   6. Provide a 6” wide Orange warning marker tape above duct 12” below grade within trench line.
   7. Install underground conduits a minimum of 12 inches from power or other foreign conduits.
8. All underground conduits shall be encased in concrete with a minimum of 2” thickness on each side of conduit groups. Refer to details on E-series drawings.

PART 3 - EXECUTION

3.1 TRENCHING AND EXCAVATION

A. Preparatory Work
   1. Contact USA Dig Alert for tracking number assignment and utility notification. All utilities should be clearly marked prior to excavation.

B. Build lines to grade and elevations shown.

C. Provide stakes, flag markers, grade boards, cleats, nails, and instruments.

D. Locate and stake each new run for its entire length. Verify elevations given.

E. Start excavation at low point. Notify Engineer of elevation discrepancies. Protect marks and stations. Before excavating work, coordinate with Owner's Site Representative and other trades.

F. Furnish schedule of operations to Owner and each trade. Provide and maintain temporary bridges, walks and bridges over excavations where underground utility lines, sewers, water lines, etc., cross access roads, walks, and streets. Make necessary arrangement with authorities having jurisdiction.

G. Provide the services of a Licensed Surveyor for layout of the following:

H. Examine substrates, areas and conditions, with the installer present, for compliance with requirements for installation tolerances and other conditions affecting installation.

I. Do not proceed with installation until unsatisfactory conditions have been corrected.

J. Protection
   1. Provide bracing, shoring, sheathing and other work for:
      a. Protection of personnel, the contract work, excavations, trees, shrubs, existing structures, and surrounding properties.
K. Slope sides of excavations to comply with OSHA, local codes and ordinances.

L. Provide, erect, and maintain barricades, warning signs, flags, and lights to provide protection for work, workmen, public, and property. Plank walks, pavements, and curbs to be crossed by equipment.

M. Protect adjacent property, existing fences, trees, shrubs, roads, curbs, sidewalks, manholes, hydrants, and other items.

N. Restore, repair, rebuild or replace any such items damaged or destroyed to condition equal to that existing before such damage occurred.

O. Establish conditions, before starting work, by taking photographs to determine state to which existing conditions must be restored. Submit an electronic copy via E-mail to the Technology Consultant.

P. Existing Utilities: Every attempt has been made to indicate existing utilities as accurately as possible from existing drawings, surveys, USA Dig Alerts, and other data sources. Report immediately when other utility lines are encountered, but not shown on the drawings. Notify the Technology Consultant where same exists, before starting work. Verify exact location of existing utility lines where work crosses existing utilities and where connections are to be made by pot holing before starting work. Notify private utility companies, municipalities, owner organizations, and other involved jurisdictions when excavation occurs within vicinity of existing underground service such as sewers, water, electric, gas, telephone, including such services owned by Owner. If existing service lines, utilities and utility structures which are to remain in service are uncovered or encountered during this excavation, they shall be protected from damage, and securely supported as directed and approved by the involved jurisdiction. Comply with state law with regard to work in vicinity of combustible gas piping. Immediately report damage or injury to utility lines to University Representative and involved jurisdiction. Remove plug or cap inactive or abandoned utilities encountered during construction operations. The location of such utilities shall be noted on the record drawings. Verify "inactivity" of services with involved jurisdiction before start of work.

Q. Cutting and Patching: Before starting work, obtain necessary permits and pay fees and charges for the same. Cut paved areas as called for, perpendicular to surface and in straight saw-cut lines. Replace pavements, roadways, streets, blacktop areas, walks, disturbed by excavating operations with materials equal to adjacent pavements.

R. Methods

1. Provide for buried work in contract both inside and outside of building. Excavate to proper depth and width for installation work as called for. Remove materials including masonry work, rubble, earth, brickwork, concrete, sand, debris, abandoned pipe lines, drains and sewers, rocks, boulders, and concrete, all of which is considered "earth excavation.” Provide for legal disposition of excess excavated materials. Make allowance for gravel fill, sand bases, form work, floor slabs, manholes, anchor and thrust blocks, sheet piping, drainage pumps, and work space. Start excavation at rough grade and provide form work and sheet piling where required.

S. Trench excavation

1. Open cut to proper depth and grade no wider than required for placement of work and not more than 100 ft. in advance of utility being installed.
2. Should trench bottom be wet, unstable, and/or otherwise incapable of supporting the contract work, immediately report same to Owner’ Representative. Should it be deemed unsuitable, excavate to depth as directed and back fill with gravel to trench depth, or provide concrete cradling.
3. Should rock be encountered, excavate 6 in. deeper and fill space between trench bottom and pipe with coarse sand, well tamped to form firm bed.

T. Shoring, bracing, sheathing

1. In addition to governing codes, protect sides of excavations with sheeting and bracing where necessary to prevent sliding or caving of banks and to protect adjacent structures. Remove as back fill is placed.
2. Provide at locations adjacent to existing manholes, hydrants, and similar items.
U. General excavation
1. All buried work shall include, but not be limited to, piping, tanks, ductbanks, conduits, footings, manholes, anchors, concrete pads, thrust blocks, fixture bases, and other work in contract.

V. Backfill
1. Provide bedding for slurry encapsulated piping with coarse sand from 6 in. below to 8 in. above. Apply by hand and compact under and at sides by mechanical means.
2. Piping, jackets and sand bed must be inspected and tested prior to backfill of any nature. Provide all necessary anchors, thrust blocks, shoring and access in preparation for testing.
3. Fill remainder of trench with clean cut, in 12 inch lifts using ordinary fill material (maximum minus 1” rock debris), except as otherwise specified. Do not use frozen material. Remove boulders, stones, broken rock, wood, bricks, blocks, and organic material debris from fill material before backfill operation.
4. Under roadways, manholes, drives, parking areas, walks, slabs, on grade and at utility entrance to building provide backfill in 6 in. layers with gravel or crushed stone, free from organic or other unsuitable material, to grade. Thoroughly compact each layer.
5. Compaction for dirt (cut) and/or fill imported must not be less than 95% density compared to maximum laboratory tests by weight, per modified ASTM D1557-64T for roadways, driveways and other paved areas. Non-traffic areas must not be less than 85% density. Submit an independent approved soil-testing laboratory must confirm certified results of compaction tests.

W. Removal of water
1. Provide pumps, hoses, pipe, labor and fuel, necessary to keep excavations free of water accumulation.
2. Maintain and operate equipment.
3. Discharge water is not to interfere with other trade's work nor cause undermining or disturbance of existing adjacent structures or land.
4. Grade to prevent surface water from flowing into all excavations and trenches.
5. Do not discharge dirt, backfill, debris, into sanitary or storm drainage systems. A fabric barrier is required for soil containment at all storm drains.

X. Rock Excavation
1. Rock Excavation defined as:
   a. Ledge rock requiring blasting or air hammer for removal.
   b. Boulders in excess of 1-1/2 cubic yards in size. Demonstrate that material in question cannot be removed with a 1-1/2 yd. backhoe or shovel.
2. Procedure: Should rock be encountered, remove procedure to be approved by the Owners representative.
3. Measurement of rock excavation will be taken 1 foot wider than the ductbank, maintenance hole, pipe or conduit being installed.

Y. Job completion
1. On completion of the work, clean the entire site, remove surplus earth, large stones and debris, to off-site legal disposal. Remove tools and equipment and leave the entire area in a neat condition.
2. Rough in sub-grade to 6 in. below finished grade. Scarify subsoil to depth of 2 in. to achieve bond between topsoil and native subsoil.
3. Repave, re-seed and completely restore the area to the condition prior to the start of excavation and trenching work.
4. Technology Consultant must review and approve any and all changes to the scope of restoration prior to final signoff. It is the Technology Consultant's expectation that all landscaping will be restored to original form prior to project implementation unless otherwise stated.
3.2 DUCT BANKS

A. Where duct banks enter manholes they shall be centered as nearly as possible to the center between roof and floor and end walls.

B. Fill conduit knock outs in manholes, vaults, and pull boxes, from the bottom up.

C. All ducts shall be encapsulating with 2-sack slurry.

D. Slurry shall be 4” thick at the top and 4” thick at the bottom / sides of ducts.

E. The minimum depth a trench should allow 24” of cover from the top of the conduit to final grade.

1. Bend radius minimums are as follows:

<table>
<thead>
<tr>
<th>Angle (Degrees)</th>
<th>Radius</th>
<th>Length</th>
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</thead>
<tbody>
<tr>
<td>7</td>
<td>4.6 m</td>
<td>0.71 m</td>
</tr>
<tr>
<td>30</td>
<td>4.6 m</td>
<td>2.54 m</td>
</tr>
<tr>
<td>30</td>
<td>3.7 m</td>
<td>2.06 m</td>
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<tr>
<td>45</td>
<td>2.7 m</td>
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<td>45</td>
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<tr>
<td>90</td>
<td>0.9 m</td>
<td>1.60 m</td>
</tr>
</tbody>
</table>

NOTES: All other conduit sizes shall maintain a minimum bend radius of at least 10 times the diameter of the conduit.
F. Telecommunications conduit should maintain 12” of separation from any power conduit.

G. Where possible, the trench walls shall act as forms for concrete encasement. Provide wood forms where soil conditions require it.

H. Securely tie raceways in place to prevent floating.

I. All conduit must be tested by the construction contractor using a mandrel ¼” smaller than bore of conduits. Technology Consultant must be allowed the option of being present during conduit mandrel operation.

J. Provide metallic elbows where conduits rise out of ground.

K. Seal all conduits watertight prior to pour.

L. Provide bushings on steel conduit and bell ends on PVC conduit entering and exiting in-ground boxes on conduit terminations.

M. Provide a 6” wide Orange warning marker tape above duct 18” below grade.

N. Duct banks should be constructed as follows:
   1. Conduit duct banks must be suspended 4 inches off the bottom of the trench line with 2 x 4 studs or #5 rebar every 6 feet. Plastic spacers designed for outside plant conduits are also acceptable.
   2. In order to prevent floating during the encapsulation process, horizontally #5 rebar pieces should be driven into the sides of the trench, perpendicular to the wall to restrain the pipe.
   3. All conduits must be uniformly spaced during the entire constructed run.

END OF SECTION 27 05 43
4.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and the other sections of Division 27.

B. This section is inclusive to all Division 27 sections.

4.2 SUMMARY

A. This Section includes general administrative and procedural requirements for the structured cabling system and campus inter-building distribution systems. It includes contractor qualifications, terminations and testing parameters. Reference individual sections for further expansion of these requirements.

B. Permits, Inspections, Codes and Regulatory References

C. General: Contractor shall obtain and pay for all permits and inspections required by laws, ordinances, rules, and regulations having jurisdiction for work included under this Contract, and shall submit approval certificates to the Technology Consultant.

D. Codes: The cabling system installation shall comply fully with all local, county and state laws, ordinances and regulations applicable to electronic and electrical installations.

E. The following industry standards are the basis for the structured cabling system described in this document.

TIA/EIA
TIA/EIA-568-B Commercial Building Telecommunications Cabling Standard
TIA/EIA-568-B.1 General Requirements
TIA/EIA-568-B.2 Balanced Twisted Pair Cabling Components Standard
TIA/EIA-568-B.3 Optical Fiber Cabling Components Standard
TIA/EIA-569-A Commercial Building Standard for Telecom Pathways And Spaces
TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
TIA/EIA-607 Commercial Building Grounding/Bonding Requirements

NFPA
NFPA 70 National Electric Code (NEC)

ISO/IEC
ISO 11801 Generic Cabling for Customer Premises
F. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

G. This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact this project.

4.3 ABBREVIATIONS AND DEFINITIONS

A. General: In addition to abbreviations defined in Division 1, utilize the following abbreviations and definitions for discernment with the Drawings and Specifications.

B. Abbreviations:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEC</td>
<td>National Electrical Code</td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Administration</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association</td>
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<tr>
<td>ASA</td>
<td>American Standards Association</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
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<td>NEMA</td>
<td>National Electrical Manufacturers Association</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriter’s Laboratories, Inc.</td>
</tr>
<tr>
<td>ICEA</td>
<td>International Cable Engineers Association</td>
</tr>
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<td>ASTM</td>
<td>American Society of Testing Materials</td>
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<td>ETL</td>
<td>Electrical Testing Laboratories, Inc.</td>
</tr>
<tr>
<td>TIA</td>
<td>Telecommunications Industry Association</td>
</tr>
<tr>
<td>ICIA</td>
<td>International Communications Industries Association</td>
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<tr>
<td>EIA</td>
<td>Electronic Industry Association</td>
</tr>
<tr>
<td>OEM</td>
<td>Original Equipment Manufacturers</td>
</tr>
<tr>
<td>EC</td>
<td>Electrical Contractor</td>
</tr>
<tr>
<td>SCC</td>
<td>Structured Cable Contractor</td>
</tr>
<tr>
<td>TC</td>
<td>Technology Consultant</td>
</tr>
<tr>
<td>GC</td>
<td>General Contractor</td>
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<td>O</td>
<td>Owner</td>
</tr>
<tr>
<td>AVC</td>
<td>AudioVisual Contractor</td>
</tr>
</tbody>
</table>
C. Definitions:
1. PROVIDE means to furnish, install, place, erect, connect, test and turn over to Owner complete and ready for the regular operation, the particular work referred to.
2. INSTALL means to join, unite, fasten, link, attach, setup or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation, the particular work referred to. It is also used to indicate the responsibility of receiving the item at the job site, providing adequate storage, unpacking or uncrating the item, physically securing the item or otherwise making ready the item for its intended use by following the instructions and approved methods of the manufacturer and those contained herein.
3. FURNISH means to indicate the responsibility to ship or deliver the item to the job site, freight prepaid, for receipt, staging and installation by others.
4. WIRING means the inclusion of all raceways, fittings, conductors, connectors, patch panels, labeling, junction and outlet boxes, connections, testing and all other items necessary and/or required in connection with such work.
5. CONDUIT means the inclusion of all fittings, hangers, supports, sleeves, etc.
6. AS DIRECTED means as directed by the Technology Consultant or his representative.
7. CONCEALED means embedded in masonry or other construction, installed behind wall furring or within double partitions or installed within hung ceilings.
8. ACCEPTED means as accepted by the Technology Consultant or his representative.
9. APPROVED means as approved by the Technology Consultant or his representative.
10. EQUAL means equivalent as approved by the Technology Consultant or his representative.
11. BIDDER is used to indicate that entity generating the bid response.
12. CONTRACTOR is used to indicate the successful Bidder to whom the Owner has awarded the contract.
13. PROVIDED BY OTHERS shall refer to material and work, which is related to this contract, but has been provided by parties other than the Contractor.
14. OWNER FURNISHED CONTRACTOR INSTALLED (OFCI) shall refer to equipment that will be furnished by the Owner for installation by the Contractor. The Contractor shall be responsible for installing and integrating this equipment as detailed herein.
15. The term SHALL is mandatory; the term WILL is informative; and the term SHOULD is advisory.
16. AS SHOWN means as shown on the drawings, shop drawings or other graphical elements of the contract documents.
17. AS REQUIRED means as required by some other part of the contract documents which may include reference specifications or manufacturer’s recommended practice.
18. OWNER or CLIENT means Middle Tennessee State University or their designated representative.
19. ARCHITECT means Thomas, Miller & Partners, LCC, Hastings Architecture Associates, LLC or their designated representative.
20. The SPECIFICATION is defined as the body of documentation provided to the Contractor with the Request for Quotation, as well as all addenda to said documentation. Throughout this document, words such as “herein” refer to the entire Specification, and not just this written document. The Specification includes, but is not limited to, this written specification document, all drawings, as listed in the List of Drawings, cable terminations and labeling schedule, additions and/or modifications as detailed in written addenda, additions and/or modifications as detailed in drawing additions or reissues.
21. TECHNOLOGY CONSULTANT refers to The Sextant Group, Inc., 1026 Atlanta Avenue, Suite D, Decatur, GA 30030.
22. For the purpose of Division 27, in the event of conflict with an abbreviation or definition in Division 1 and in Division 27, the Division 27 abbreviation or definition shall prevail.
4.4 PERMITS, CODES, STANDARDS, AND INSPECTIONS

A. Contractor shall obtain and pay for all permits and inspections required by laws, ordinances, rules and regulations having jurisdiction for work included under this Contract, and shall submit approval certificates to the Technology Consultant.

B. The installation shall comply fully with all local, county and state laws, ordinances and regulations applicable to electronic and electrical installations.

C. Unless stated in Division 1, the installation shall be in compliance with the requirements of the latest revisions of:
   1. Occupational Safety and Health Act (OSHA)
   2. Institute of Electrical and Electronic Engineers (IEEE)
   3. National Electric Code (NEC)
   4. National Board of Fire Underwriter’s (NBFU)
   5. National Electrical Manufacturer’s Association (NEMA)
   7. Legislative Act 235 (1965)-Handicapped
   8. Legislative Act 287 (1974)-Excavation
   9. Building Officials and Code Administrators (BOCA)
  10. Americans with Disabilities Act (ADA)
  11. Electronic Industry Association (EIA)
  12. Telecommunications Industry Association (TIA)
  13. All local codes and ordinances in effect and having jurisdiction.
  14. All requirements of electric and telephone utility companies.
  16. All approved published instructions set forth by equipment manufacturers.
D. Submit certificates issued by approved authorized agencies to indicate conformance of all work with the above requirements, as well as any additional certificates as may be required for the performance of this contract work.

E. Should any change in drawings or Specifications be required to comply with governmental regulations, the Contractor shall notify the Technology Consultant prior to execution of the work. The work shall be carried out according to the requirements of such code in accordance with the instructions of the Architect and the Technology Consultant at no additional cost to the Owner.

4.5 CONTRACTOR QUALIFICATIONS

A. All bidders shall demonstrate their qualifications by providing the following documents:

B. A list of the LAST five (5) Structured Cabling systems that were installed by the bidder:

C. The listing shall include only systems that included the installation of fiber optic cable and Category 5e or 6 twisted pair.

D. The listings shall be for the last five (5) projects that are completed and have been turned over to the owner.

E. The listing shall include a brief description of the project, size of the system, products used, Owner’s name, phone number, address, and representative, date started, and date of completion.

F. The bidder shall furnish a list of all test equipment that will be used in the installation and testing of the fiber optics, multi pair copper distribution cable and the twisted pair cable.

G. The bidder shall furnish a listing of the names of full-time employees that will work on the project and list their training and certification in the installations and testing of structured cabling.

H. The bidder shall have a Registered Communication Distribution Designer (RCDD) with five (5) years experience, on staff. Submit the RCDD Certificate and project information with bid.

I. All of the above documents shall be submitted along with the Bid Form, by the Bid due date.

J. The Contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to data and voice network systems. The Contractor shall at a minimum possess the following qualifications:
   1. Those licenses/permits required to perform telecommunications installations in the specified jurisdiction.
   2. Personnel trained and certified in the design of the Systimax GigaSPEED XL Category 6 Cabling System.
   3. Personnel trained and certified to install the Systimax GigaSPEED XL Category 6 Cabling System.
   4. The Contractor shall provide proof of current certification for the Systimax GigaSPEED XL Category 6 Cabling System.
K. Personnel must be knowledgeable in local, state, and national codes, and regulations. All work shall comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall apply.

L. The Contractor shall have been in the business of installing structured cabling systems for a minimum of five (5) years.

M. The Contractor must possess and maintain current liability insurance certificates.

4.6 WARRANTIES

A. Provide complete written warranty information for each item to include date of beginning of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.

B. Warranty and Certification of the Cabling systems and connectors:

C. The Contractor shall provide a 20-year performance and product warranty that all cable, connectors and connecting hardware shall be free from defects in material, workmanship and fabrication. Submit detailed warranty documentation with close out documentation.

D. The system shall be certified by the cable/connector manufacturer and warranted for the specified performance for minimum of 20 years. The Contractor shall conform to the manufacturer’s certification program including submittal of all required documentation to the manufacturer.

E. The Contractor shall obtain, from the manufacturer, a Registration Document and Certificate for the specific installation. Upon receipt of the Registration Document and Certificate, the Contractor shall forward a copy to the Technology Consultant and deliver the original to the Owner.

F. Any material, equipment or appurtenance whose operation or performance does not comply with the requirements of the Contract or any equipment which is damaged prior to acceptance will be held as defective and shall be removed and properly replaced at no additional cost to the Owner.

4.7 SUBMITTALS

A. The contractor shall provide product submittals for all system components. These components shall include all cable, termination devices; splice connectors, patch panels, associated racks and enclosures, patch cords and labeling devices. The selected contractor will allow sufficient time in project scheduling for client and review by the Architect’s Technology Consultant.

4.8 PROJECT DRAWINGS AND SPECIFICATIONS

A. The Contractor shall carefully examine the Drawings and Specifications of all trades and report all discrepancies to the Technology Consultant in writing to obtain corrective action. No departures from the Contract Documents will be made without prior written approval from the Technology Consultant.

B. Questions or disputes regarding the intent or meaning of Contract Documents shall be resolved by the interpretation of the Technology Consultant. The Architects’ interpretation is final and binding.

C. The Drawings and Specifications are not intended to define all details, finish materials, and special construction, which may be required or necessary. The Contractor shall provide all installations complete and adequate as implied by the project documents.

D. Drawings are diagrammatic only and do not show exact routes and locations of equipment and associated wiring. The Contractor shall verify the work of all other trades and shall arrange his work to avoid conflicts. In the event of a conflict, the Contractor shall obtain corrective action from the Technology Consultant.
E. If there is a conflict between contract documents, the document highest in precedence shall control. The precedence shall be: first; permits from agencies as required by law, second; special provisions, third; specifications, forth; drawings, fifth; reference specifications and sixth; vendor submittals.

4.9 COOPERATION AND COORDINATION WITH OTHER TRADES

A. This contractor shall be responsible for all cross connecting and coordination with vendors and other trades to provide a complete operational system.

4.10 PRODUCT LISTING

A. When two or more items of the same material or equipment are required, they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, conduit, fittings, sheet metal, solder, fasteners, and similar items, except as otherwise indicated.

B. Provide products that are compatible within systems and other connected items.

C. All powered equipment shall be UL listed and follow approval criteria defined by the local authority having jurisdiction.

4.11 RECORD DOCUMENTS

A. When all work has been completed and before final acceptance, the Contractor shall furnish to the Technology Consultant and Owner a complete set of documents that clearly represent all contract work "as-built". This shall be inclusive of all test results and drawings. The Contractor is responsible for assuring the accuracy of the As-Built documentation.

4.12 MAINTENANCE MANUALS

A. Prepare maintenance manuals (Record Document) in accordance with the following information for equipment items:
   1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
   2. Manufacturer’s data of each piece of equipment.

4.13 GENERAL WARRANTIES

A. Provide complete warranty information for each item to include date of beginning of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.

B. Any material, equipment or appurtenance whose operation or performance does not comply with the requirements of the Contract Documents or which are damaged prior to acceptance will be held as defective and shall be removed and properly replaced at no additional cost to the Owner.

PART 5 - PRODUCTS
5.1 GENERAL

A. Major items of equipment shall have manufacturer's name, address and catalog number on a plate securely attached. All equipment or apparatus of any one system must be the product of one manufacturer, or approved equivalent products of a number of manufacturer's that are suitable for use in a unified system.

B. All materials and equipment for which Underwriter's Laboratories have established standards shall bear a UL label of approval.

C. Where proprietary names are used, whether or not followed by the words "or as approved", they shall be subject to substitution only as approved by the Architect, Technology Consultant, and Owner.

D. Where the Contractor proposes substitute equipment, contractor shall submit acceptable evidence to indicate compliance with all requirements of the documents, including performance rating, size and resistance to wear and deterioration equivalent to the specified item. In instances where substituted equipment requires additional material or work beyond that shown or required by the specified item, said additional material or work, shall be the responsibility of this Contractor, regardless of the trade involved.

PART 6 - EXECUTION
6.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project identified with names, model numbers, types, grades, compliance labels, and other information needed for distinct identification; adequately packaged and protected to prevent damage during shipment, storage and handling.

6.2 INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of systems, materials, and equipment.

B. Coordinate systems, equipment, and materials installation with other building components.

C. Verify all dimensions by field measurements.

D. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for cabling installations.

E. Sequence, coordinate, and integrate installations of cabling materials and equipment for efficient flow of the Work.

F. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

G. Coordinate the cutting and patching of building components to accommodate installation of cabling equipment and materials.

H. Coordinate the installation of all materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.

I. 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.

J. Plywood on MDF/IDF walls shall be ¾” thick unless otherwise specified, void-free A/C grade, and treated on all sides with two coats of fire-resistant paint.

K. Ensure that the fire rating of all walls and floors is maintained.

6.3 CONDUIT AND RACEWAY

A. Actual locations of all equipment, raceways, junction boxes, cable runs, conduit runs, etc., shall be determined at the site.

B. Provide a pull box or pull point immediately before and after any conduit or raceway section containing three ninety-degree bends, or any single run exceeding fifty feet in length. Pull box openings must face in the direction from which personnel will approach and must have a minimum eight inches in front of and to all sides of the opening. Pull boxes shall not be used in place of a bend. Conduits must always exit the pull box from the opposite side it entered (no change of direction inside the pull box will be accepted).

C. Carefully investigate the structural, electrical/electronic and finished conditions of work accordingly.

6.4 FIRESTOPPING

A. General

1. Provide through penetration fire stop systems to prevent the spread of fire through openings made in fire-rated walls or floors to accommodate penetrating items such as conduit, cables and cable tray. Fire stop shall restore floor and wall to the original fire rated integrity and shall be waterproof. The fire stop systems and products shall have been tested in
accordance with the procedures of U.L. and material shall be U.L. classified as materials for use in through-penetration fire stops.

2. The fire stop system shall comply with the NEC and with NFPA 101-Life Safety Code (latest edition) and shall be made available for inspection by the local inspection authorities prior to cable system acceptance. The contractor shall be responsible for verifying the fire rating of all walls and floors having cabling penetrations. Coordinate sealant installation with work of other trades and with the general contractor on site.

3. Fire stop systems shall be UL Classified to ASTM E814 (UL 1479) or shall be approved by a qualified Professional Engineer (PE), licensed in Tennessee. A drawing showing the proposed fire stop system shall be provided to the Owner and Technology Consultant prior to installing the fire stop system(s).

6.5 GROUNDING AND BONDING

A. Ground communications systems and equipment in accordance with the ANSI/TIA/EIA-607 Grounding Standard and NEC requirements except where the Drawings or Specifications exceed NEC requirements. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, paging equipment, CATV equipment etc. entering or residing in technology spaces shall be grounded to the respective ground system using a minimum #6 AWG solid copper bonding conductor and compression connectors. All wires used for technology grounding purposes shall be identified with green insulated wires. All cables and bus bars shall be identified and labeled in accordance with the Technology Identification requirements.

6.6 TESTING

A. Contractor, at his own expense, shall make any tests directed by an inspection authority or by the Technology Consultant and shall provide all equipment, instruments and materials to make such tests.

B. Upon completion of work, all component parts, both singularly and as a whole, shall be set, calibrated, adjusted and left in satisfactory operation condition to suit load conditions, by means of instruments furnished by the Contractor.

C. Notify the Owner and Technology Consultant seven (7) days prior to the testing dates. Upon completion of a test, a statement of certification shall be forwarded to the Technology Consultant for his approval.

END OF SECTION 27 05 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and the other sections of Division 27.

B. Drawings and general provisions including Division 1, apply to this Section.

1.2 SUMMARY

A. This Section includes solid grounding of technology systems and equipment. It includes basic requirements for grounding for protection of life, equipment circuits and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

B. Comply with the ANSI/TIA/EIA Standard 607, “Grounding and Bonding Requirements” and the NEC.

1.3 SUBMITTALS

A. Submit the following:
   1. Product data for connectors and connections materials, and grounding fittings.
   2. Field-testing organization certificates, signed by the Contractor, certifying that the organization performing field tests complies with the requirements specified in Quality Assurance below.
   3. Report of field tests and observations certified by the testing organization.
1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors, terminals and fittings of types and rating required, and ancillary grounding materials, including stranded cable, copper braid and bus, ground rods and plate electrodes, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer: Qualified with at least 3 years of successful installation experience on projects with technology ground work similar to that required for this project.

C. Listing and labeling: Provide products specified in this Section that are listed and labeled. The terms "listed" and "labeled" shall be defined as they are in the National Electric Code, Article 100.

D. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.

E. Field-testing Organization Qualifications: To qualify for acceptance, the independent testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated.


G. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to electrical and electronic grounding.

H. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical and electronic grounding.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. B-Line Systems, Inc.
2. Burndy Corp.
5. General Electric Supply Co.
6. Ideal Industries, Inc.
7. Thomas and Betts Corp.
2.2 PRODUCTS

A. Supply types indicated and of sizes and rating to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.3 CONDUCTOR MATERIALS

A. Copper with min 98% conductivity.

2.4 WIRE AND CABLE CONDUCTORS

A. Coordinate with Division 26 Sections.

B. Equipment Grounding Conductor: Green insulated.

C. Grounding Electrode Conductor: Stranded cable.

D. Bare Copper Conductors:
   1. Conform to the following:

2.5 MISCELLANEOUS CONDUCTORS

A. Ground Bus: Bare annealed copper bars of rectangular cross section. All bus bars shall be two-hole lug type.

B. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.


2.6 CONNECTOR PRODUCTS

A. Listed and labeled as grounding connectors for materials used and approved by a nationally recognized testing laboratory.

B. Pressure Connectors: High-conductivity-plated units. All lugs shall be two-hole type.

C. Bolted Clamps: Heavy-duty units listed for the application.

2.7 GROUNDING ELECTRODES

A. For technology systems, provide a #6 AWG minimum insulated stranded copper conductor from the grounding electrode system to each telecommunication room, terminal cabinet and central location.

B. Bonding Plates, Connectors, Terminals and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by manufacturers for indicated applications.

C. Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials and bonding straps, as recommended accessories by manufacturers.

PART 3 - EXECUTION
3.1 GENERAL

A. Each facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building’s electrical building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA/EIA-607 Telecommunications Bonding and Grounding Standard.

B. The main communications entrance facility/equipment room shall be equipped with a telecommunications main grounding bar (TMGB). Each telecommunications room shall be provided with a telecommunications ground bar (TGB) connected to the TMGB by a #6 AWG minimum insulated stranded copper conductor. The TMGB shall be connected to the building electrical entrance grounding facility (master ground bus) with a #2 AWG minimum insulated stranded copper conductor. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between telecommunications equipment and the electrical system to which it is attached.

C. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, paging equipment, security equipment, CATV equipment etc. entering or residing in telecommunication spaces shall be grounded to the respective TGB or TMGB using a minimum #6 AWG insulated stranded copper conductor and compression connectors.

D. All cables and bus bars shall be identified and labeled in accordance with the Identification requirements Section 27 05 53.

E. Except as otherwise indicated, provide grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs), bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.

F. All bonding conductors shall not be placed in a ferrous metallic conduit. If it is necessary to place any bonding conductors in ferrous metallic conduit that exceeds 1 meter in length, the grounding conductors shall be bonded to each end of the conduit with a conductor sized as a #6 AWG minimum.

G. All connections to building steel shall be exothermically (CAD) welded and connected to the telecommunications grounding bus bar with a minimum #2 AWG cable.

H. All cable tray and equipment racks shall be bonded together with grounding straps of a minimum of a #6 AWG cable. Bonding cables shall be equipped with a compression type ground lug on both ends. The ground lugs shall be attached to a point on the rack that is free of paint and equipped with a star washer. After connecting the ground lugs, seal the connection.

I. All ground cable connections to the telecommunications ground bar shall be with compression type lugs. No setscrew type lugs shall be used.

J. All ground conductors shall be free of splices.

K. All ground conductors shall be routed in a neat and workmanlike manner and shall be free of sharp bends and kinks.

L. All new and existing protected entrance terminals in the telecommunications room shall be grounded and connected to the telecommunications grounding bar with a #6 AWG conductor.

M. Bond the Data/Communications cable tray located in the at the building service entrance points with a minimum of #2 AWG cable. Note that each tray is grounded at one building service entrance panel only. Connect the bonding conductor to the tray bonding conductor with a compression type fitting. No setscrew type lugs shall be used.

3.2 INSPECTION
A. Installer must examine areas and conditions under which technology grounding connections are to be made and notify the Technology Consultant in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.

3.3 APPLICATION

A. Provide technology grounding systems where shown, in accordance with applicable portions of NEC and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.

3.4 INSTALLATION

A. Ground communications systems and equipment in accordance with the ANSI/TIA/EIA-607 Grounding Standard and NEC requirements except where the Drawings or Specifications exceed these requirements.

B. Coordinate with other work as necessary to interface installation of grounding system with other work.

C. Route grounding conductors along the shortest and straightest paths without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.

D. Install bonding connections in accessible locations with approved components.

E. Each TGB shall be directly bonded to building steel and other permanent metallic systems where accessible.

F. The TGB and TMGB must be visibly labeled and physically secured.

G. Where the ground wire is exposed support at a minimum of every 24” both vertically and horizontally.

3.5 CONNECTIONS

A. Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

B. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer to in order of galvanic series.

C. Make connections with clean bare metal at points of contact.

D. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

E. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer’s published torque tightening values for connectors and bolts. Where manufacturer’s torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.

3.6 FIELD QUALITY CONTROL

A. Upon completion of installation of technology grounding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 10 ohms, take appropriate action to reduce resistance to 2 ohms, or less.

3.7 LABELING

A. All ground cables shall be labeled in accordance with ANSI/TIA/EIA 606.
END OF SECTION 27 05 26
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Provisions and Supplementary Conditions, Specification Sections, apply to this and the other sections of Division 27.

1.2 SUMMARY

A. This Section includes secure support from the building structure for technology items by means of hangers, supports, anchors, sleeves, inserts, seals and associated fastenings.

B. All support shall utilize threaded fasteners for all technology/attachments

1. Exception:
   a. Spring steel fasteners may be used in lieu of threaded fasteners only for ¾” raceways above suspended ceilings.

C. Types of supports, anchors, sleeves and seals specified in this section include the following:

1. Clevis hangers
2. Riser clamps
3. C-clamps
4. I-beam clamps
5. Conduit straps
6. Round steel rods
7. Lead expansion anchors
8. Toggle belts
9. Wall and floor seals

D. Supports, anchors, sleeves and seals furnished as part of factory-fabricated equipment, are specified as part of that equipment assembly or as specified in Division 26.

1.3 SUBMITTALS

A. Submit the following in accordance with Conditions of Contract and Supplementary Conditions Specifications Sections.

1. Product Data: Submit manufacturer’s data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve and seal.
2. Where multiple products are shown on one cut sheet, circle product to be used.
3. Shop Drawings: Submit dimensioned drawings of fabricated products, indicating details of fabrication and materials.
1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of supporting devices, of types, sizes, and ratings requires, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Contractor Qualifications: Firm shall have at least 3 years of successful installation experience with projects utilizing electronic/electrical supporting device work similar to that required for this project.

C. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of supporting devices.

D. MSS Compliance: Comply with applicable MSS standard requirements pertaining to fabrication and installation practices for pipe hangers and supports.

E. UL Compliance: Provide components that are UL listed and labeled.

F. FS Compliance: Comply with Federal Specification FF-S-760 pertaining to retaining straps for conduit, pipe and cable.

G. Components shall be listed and labeled by ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Major items of equipment shall have manufacturer’s name, address and catalog number on a plate securely attached. All equipment or apparatus of any one system must be the product of one manufacturer, or approved equivalent products of a number of manufacturer’s that are suitable for use in a unified system.

B. All materials and equipment for which Underwriter’s Laboratories have established standards shall bear a UL label of approval.

C. Where proprietary names are used, whether or not followed by the words “or as approved”, they shall be subject to substitution only as approved by the Architect, Technology Consultant, and Owner.

D. Where the Contractor proposes substitute equipment, contractor shall submit acceptable evidence to indicate compliance with all requirements of the documents, including performance rating, size and resistance to wear and deterioration equivalent to the specified item. In instances where substituted equipment requires additional material or work beyond that shown or required by the specified item, said additional material or work, shall be the responsibility of this Contractor, regardless of the trade involved.

PART 3 - EXECUTION
3.1 DELIVERY, STORAGE, AND HANDLING

A. Provide supporting devices that comply with manufacturer’s standard materials. Install in accordance with published product information, and as required for a complete installation; and as herein specified. Where more than one type of supporting device meets indicated requirements, selection is Contractor’s option.

B. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer’s written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NEC for installations of supporting devices.

C. Support all technology cables a minimum of every 4 feet with J-hooks, unless other supports are available.

D. Coordinate with the building structural system and electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

E. Do not fasten supports to pipes, ducts, mechanical equipment and conduit.

F. Obtain approval from the Architect before drilling or cutting structural members.

G. Install surface-mounted cabinets and panels with minimum of four anchors.

3.2 MISCELLANEOUS SUPPORTS

A. Support miscellaneous technology components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panels, control enclosures, pull boxes, junction boxes and other devices.

3.3 FASTENING

A. Unless otherwise indicated, fasten technology items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, cabinets, panels, boxes 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, and 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 may 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.

B. Holes cut into reinforced concrete beams or in concrete shall not cut reinforcing bars. If the Contractor cuts into any reinforcing bars, stop work and notify the Technology Consultant immediately. Fill all holes that are not used.

C. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration-and shock-resistant fasteners for attachments to concrete slabs.

3.4 TESTS

A. Test pull-out resistance of one of each type, size and anchorage material for the following fastener types:

1. Expansion anchors.
2. Toggle bolts.

B. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain and submit the Structural Engineer’s signed approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.
END OF SECTION 27 05 28.29
27 05 28.36 – CABLE TRAYS FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and the other sections of Division 27.

1.2 SUMMARY

A. Furnish all necessary labor, supervision, materials, equipment, tests and services to install complete cable support systems as shown on the drawings.

B. Wire basket support systems are defined to include, but are not limited to straight sections of continuous wire mesh, field formed horizontal and vertical bends, tees, drop outs, supports and accessories.

C. Ladder cable tray systems are defined to include, but are not limited to straight sections of ladder type cable trays, bends, tees, elbows, drop-outs, supports and accessories. Ladder cable tray is to be installed by the Contractor and supported independent of any cabinet or rack.

D. This section also defines additional requirements for conduit installations.

1.3 REFERENCES

A. NFPA 70 – National Electrical Code.


D. NEMA VE 2-2000 – Cable Tray Installation Guidelines.

E. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes.


1.4 DRAWINGS

A. The drawings indicate the general route of cable tray support systems. Data presented on these drawings is as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.

B. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor to make field surveys as part of his work prior to submitting system layout drawings.

1.5 SUBMITTALS

A. Submit drawings of cable tray (ladder type and wire basket) and accessories including connector assemblies, clamp assemblies, brackets, splice plates, splice bars, waterfalls, grounding clamps and hold down plates showing accurately scaled components. Show layout, support and installation details.
B. Submit manufacturer’s data on cable tray (ladder type and wire basket) support system including, but not limited to, types, materials, finishes, dimensions, colors and inside depths.

C. Comply with requirements of Section 27 00 00-Communications.

1.6 QUALITY ASSURANCE

A. Comply with NEC, as applicable to construction and installation of cable tray and cable channel systems (Article 392).

B. Comply with NFPA 70B, “Recommended Practice for Electrical Equipment Maintenance” pertaining to installation of cable tray systems.

C. Installer: Qualified with at least 3 years of successful installation experience on projects with technology raceway work similar to that required for this project.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver cable tray (ladder type and wire basket) support systems and components carefully to avoid breakage, bending and scoring finishes. Do not install damaged equipment.

B. Store cable tray (ladder type and wire basket) and accessories in original cartons and in clean dry space; protect from weather and construction traffic.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with these specifications, cable tray (ladder type and wire basket) cable support systems to be installed shall be as manufactured by B-line, Cablofil, Chatsworth, GS Metals Corporation or Technology Consultant approved equal.

2.2 SECTIONS AND COMPONENTS

A. Provide cable tray (ladder type and wire basket) of types and sizes indicated; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

B. Material and finish specifications for each metal cable tray type are as follows:

1. Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be electro-plated zinc in accordance with ASTM B633.

2. Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be coated after the wire basket runway has been fabricated in accordance with ASTM A123 (CSA Type 1). All hot-dip galvanized sections must be returned to the point of manufacture after coating for inspection and removal of all icicles and excess zinc. Failure to do so may result in damage to cables and/or injury to installers.

3. Electro-Galvanized Zinc: Support accessories and miscellaneous hardware shall be coated in accordance with ASTM B633 SC3. All threaded components shall be coated in accordance with ASTM B633 SC1.

4. To provide for allowable amounts of cable bend radius, provide cable fallouts or waterfalls at all points where cable transitions from horizontal to vertical.
2.3 CABLE TRAY AND SUPPORT SYSTEMS

A. All straight section longitudinal runs shall be straight (with no bends).

B. Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 4-inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.

C. Wire basket cable tray shall conform to the following nominal criteria:
   1. Straight sections shall be furnished in standard lengths.
   2. Wire basket shall have a 4 inch usable loading depth by the width identified on the drawings.
   3. All fittings shall be field formed as needed.
   4. The installation and all fittings of all raceways shall allow Category 6 cable and fiber optic cable to be pulled in and through in such a manner as to not exceed the pulling tension or minimum bending radius.
   5. All splicing assemblies shall be the bolted type using flange locknuts.
   6. Cable tray supports shall be center support hangers, trapeze hangers or wall brackets and shall be supported by 1/4 inch or 3/8 inch diameter rods.
   7. Special accessories shall be furnished as required to protect, support and install all cable tray support systems.
   8. Coordinate material and installation with the requirements of Section 27 05 28.29 Hangers and Supports for Communication Systems.

D. Ladder type cable tray shall conform to the following nominal criteria:
   1. Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
   2. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 6 inches on center. Spacing in radiused fittings shall be 9 inches and measured at the center of the tray's width. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails. Each rung must be capable of supporting the maximum cable load, with a safety factor of 1.5 and a 200 pound concentrated load when tested in accordance with NEMA VE-1, section 5.4.
   3. Ladder type tray sizes shall have 4 inch minimum usable load depth.
   4. Ladder type straight tray sections shall have side rails fabricated as I-Beams. All straight sections shall be supplied in standard 10 foot lengths, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.
   5. Ladder type tray widths shall be 12, 18, or 24 inches as shown on drawings.
3.1 INSTALLATION

A. Install cable tray (ladder type and wire basket) as indicated; in accordance with recognized industry practices (NEMA VE-2 2000), ensure that the cable tray equipment complies with requirements of the NEC, and all general installation practices.

B. Coordinate cable tray (ladder type and wire basket) with other electrical and mechanical work as necessary to properly interface installation of raceway with other work.

C. Provide sufficient space encompassing cable tray (ladder type and wire basket) to permit access for installing and maintaining cables.

D. For added support and stability, securely fasten cable tray (ladder type and wire basket) to top of racks and to walls in all MDF/IDF rooms at elevations shown on drawings.

E. Install all raceways parallel to the wall or ceiling lines unless otherwise noted. Support basket cable raceways every 4’ minimum and at 6” from ends or boxes.

F. Ground the raceway per NEC Article 250, 392 and ANSI/TIA/EIA-607.

G. Route raceways in a manner to avoid steam, water, or other liquid piping.

H. Fish or blow through every run of conduit before plastering to guard against obstructions or omissions and plug ends carefully with tight fitting wood plugs or bush caps to avoid filling with plaster, dust, etc. and to avoid the possibility of condensation.

I. Leave nylon or steel fish wire in all raceways where permanent wiring is not being installed under this contract.

J. Install conduit making the total cross-sectional area of each raceway of sufficient size to permit ready installation or withdrawal of the cables required therein.

K. Route cable tray (ladder type and wire basket) a minimum of 5” clearance from fluorescent light fixtures, 12” clearance from electrically operated equipment and all wiring at 120 or more volts and 4 ft. from transformers or large motors.

L. All technology conduits are to be provided with nylon bushings to allow for cable pulling without damage.

M. For cable support, provide strain relief a minimum of every 10’ in vertical conduits runs. Provide the proposed method and products as a product submittal.

N. In areas without suspended ceilings, install cable tray (ladder type and wire basket) raceways 6” below the lowest obstruction unless otherwise directed.

3.2 TESTING

A. Test cable tray (ladder type and wire basket) support systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance.

B. Manufacturer shall provide test reports witnessed by an independent testing laboratory of the “worst case” loading conditions outlined in this specification and performed in accordance with the latest revision of NEMA VE-1.

END OF SECTION 27 05 28.36
SECTION 27 05 53 – IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and the other sections of Division 27.

B. Drawings and general provisions including Division 1, apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for identification of components including but not limited to the following:

1. Identification labeling for cables and conductors
2. Operational or instructional signs
3. Equipment labels and signs

B. Refer to project drawings and other Division 27 sections for additional specific identification associated with specific items.

C. Comply with the EIA/TIA Standard 606, “The Administration Standard for the Telecommunications Infrastructure”.

D. The Contractor shall submit, for approval by the Technology Consultant and Owner, a labeling system for the cable installation. The Owner will coordinate the exact verbiage of the labeling scheme with the successful contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cabinets, ground bars, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

E. All label printing shall be machine generated using indelible ink ribbons or cartridges. Self-laminating labels shall be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Outlet, patch panel and wiring block labels shall be installed on, or in, the space provided on the device.

1.3 SUBMITTALS

A. Submit the following in accordance with Section 27 01 10 Operation and Maintenance of Structured Cabling and Enclosures.

1. Manufacturer’s data for each type of product specified.
2. Schedule of identification and nomenclature to be used for identification signs and labels.
3. Samples of each color, lettering style and other graphic representation required for identification materials.
1.4 QUALITY ASSURANCE

A. All work shall be in accordance with the general principles outlined in the BICSI TDMM manual latest edition and with the TIA-526, TIA-568-B.2-1 and TIA-606-A Standards.

B. UL Compliance: Comply with applicable requirements of UL Standard 969, “Marking and Labeling Systems”, with regard to type and size of lettering for raceways and cable labels.

C. NEMA Compliance: Comply with applicable requirements of NEMA Standards WC-1 and WC-2 pertaining to identification of power and control conductors.

D. Major items of equipment shall have manufacturer’s name, address and catalog number on the plate securely attached in a convenient place.

1.5 NUMBERING AND LABELING SCHEME

A. Workstation cable numbering standard: (AAAA-B-CC).
   1. Numerically base wire/jack numbers upon room number for wall box with an alphabetic character for jack identifier. For example; first jack in room 210A would be 210A-A. If more than 26 jacks were in a room, then 27th would be labeled 210A-AA. Begin numbering from left of main entrance to space and work around room in a clockwise direction.
   2. There shall not be any open places on the patch panel.
   3. Terminate all outlets from the same room sequentially on the same patch panel.
   4. If an outlet is added, it gets a new number that is next on the sequence even if it is on an existing faceplate.
   5. Labeling techniques: The label shall be black letters on white background. Labels must be produced by label-making equipment. The blank white label tags that are included in the faceplate hardware are to be installed with clear plastic shields in all positions on the faceplate.

B. Riser Cables
   1. Numbering scheme: Riser cables must be assigned specific numbers. Each shall be tagged with the building abbreviation and room number of the MDF/IDF at both ends of the cable clearly shown.
   2. Labeling techniques: Each cable is to be labeled on each end within 12” of where it terminates on the cross-connect panel. Cable tags must be securely fastened to the cable sheath. Wrap around tags protected by clear polyurethane tape may be used as well. Tags must be typed and be permanent. Cable tags that appear less than permanent will not be accepted. Directly writing on the cable sheath will not suffice as proper labeling of riser cables.

C. UTP cabling cross-connect panels.
   1. Numbering scheme: 25 pair cables from the Utility RJ21X blocks are terminated on blocks. Cable pairs are numbered in 25 pair increments. The first cable is numbered 1-25, the second 26-50, etc. Pair #1 is terminated on the left position of the top block. Subsequent cable pairs are terminated from left to right and from top to bottom.
   2. Labeling techniques: The first label block shall read, “Cables to RJ21X blocks, 1-25”. Subsequent label blocks shall denote the same for pairs 26 – 50, etc. The label shall be black letters on white background. Labels must be produced by label-making equipment. Handwritten labels are not allowed.

D. Fiber optic cross-connect panels.
   1. Numbering scheme: Fiber optic cables and terminations shall be numbered and labeled per current EIA/TIA Standards. The numbering scheme denotes the cable function (campus backbone, building entrance, or intrabuilding), sheath number, and buffer tube number.
   2. Labeling techniques: A label shall be installed onto the outside of the front face of the connector housing to read, “Horizontal fiber optic cables to outlets” or “Entrance/riser fiber optic cables” as appropriate. Labels must be produced by label-making equipment. Handwritten labels are not permitted. Horizontal fiber optic cables shall be labeled on the label tags on the closet connector housing. Each cable terminated shall be labeled with the following information: type of fiber optic cable and outlet number. For example, a label block for a multi-mode horizontal fiber optic cable
termination might read, “MM – 17”. Terminations are numbered by the outlet number, not the housing or connector panel position number. Only adapter positions that are terminated are labeled.

E. OSP fiber optic cables:

1. Numbering scheme: The numbering scheme denotes the cable function (campus backbone or building entrance). Each fiber optic cable sheath shall be tagged in each MDF and IDF with the number and type of strands in the sheath (i.e. 18SM/18MM) and the building name of the far end of the cable clearly shown. In each intermediate manhole or hand hole each cable sheath shall be tagged with the number and type of strands in the sheath and the building names of each of the cable endpoints clearly shown.

2. Labeling techniques: Each cable is to be labeled within 36” of where it enters each MDF or IDF. Cable tags may be cloth or plastic tape securely fastened to the cable sheath. Wrap around tags protected by clear polyurethane tape may be used as well. Tags must be typed and permanent. Cable tags that appear less than permanent will not be accepted. Directly writing on the cable sheath will not suffice as proper labeling. In intermediate manholes and hand holes, one wrap-around cable marker shall be installed on each cable sheath. Markers shall have a clear Mylar covering reading “Fiber Optic Cable – Caution” with space for cable designation. Cable markers shall be orange in color. Other types of tags, tapes, or sheath marking are not acceptable.

F. Equipment racks:

1. Numbering scheme: Each rack is numbered sequentially denoting the following information: building name, MDF/IDF room number, and rack number. There is no correspondence between the rack equipment configuration (type) and the rack number.

2. Labeling techniques: Two labels shall be installed onto the front face of each equipment rack, one at the bottom of the rack, and one at the top. All labels shall be black letters on white background. Provide engraved stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver’s standard letter style of the sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening.

G. Telecom room electrical receptacles:

1. Each electrical receptacle in MDF/IDFs shall be labeled with the following information: room number where electrical panel is located, panel number, and circuit number. Each receptacle is to be labeled on top or front of the faceplate or outlet box. Preprinted adhesive labels or tags shall be used.

PART 2 - PRODUCTS

2.1 TECHNOLOGY IDENTIFICATION PRODUCTS

A. Cable/Conductor Identification bands:

1. Provide Manufacturer’s standard wrap-around cable/conductor markers, of size required for proper application, and numbered to show circuit identification.

B. Equipment Labels

1. General: Provide engraved stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver’s standard letter style of the sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening.

2. Thickness: 1/16”, for units up to 20 sq. in. or 8” length; 1/8” for larger units.

C. Lettering and Graphics

1. General: Coordinate names, abbreviations and other designations used in technology identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the technology systems and equipment.

2. Fasteners for Plastic-Laminated Signs shall be self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and lock washers.
3. Exception: Where specifically approved contact type permanent adhesive may be used where screws cannot or should not penetrate substrate.

PART 3 - EXECUTION

3.1 GENERAL

A. Except as otherwise indicated, provide manufacturer’s standard products of categories and types required for each application.

B. Lettering and Graphics: Coordinate names, abbreviations, colors and other designations used in technology identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by standards.

C. Install identification devices as indicated, in accordance with manufacturers written instructions.

D. Sequence of work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

3.2 CABLE/CONDUCTOR IDENTIFICATION

A. Apply cable/conductor identification on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present. Match identification with marking system used on shop drawings, contract documents, and similar previously established identification for project’s technology work.

3.3 OPERATIONAL SIGNS

A. Provide instructional signs with approved legend where instructions or explanations are needed for system or equipment operation.

3.4 OUTLET IDENTIFICATION

A. Label each voice and data outlet with the proper designation and provide appropriate icon.

3.5 INSTALLATION

A. Provide equipment identification labels of engraved plastic-laminate on all equipment racks and on major units of technology equipment in buildings. Except as otherwise indicated, provide single line of text, with ½-inch high lettering on 1-½-inch high label (2-inch high where two lines are required), white lettering in black filed. Text shall match terminology and numbering of the Contract Documents and shop drawings.

B. Provide labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

END OF SECTION 27 05 53
SECTION 27 08 00 – COMMISSIONING COMMUNICATIONS SYSTEMS

PART 7 – GENERAL

7.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Provisions and Specification Sections, apply to this and the other sections of Division 27.

B. This section relates to the Structured Cabling Sections of this specification.

7.2 SUMMARY

A. This Section includes general administrative and procedural requirements for the structured cabling system and campus inter-building distribution systems. It includes terminations and testing parameters. Reference individual sections for further expansion of these requirements.

B. Codes: The cabling system installation shall comply fully with all local, county and state laws, ordinances and regulations applicable to electronic and electrical installations.

C. The following industry standards are the basis for the structured cabling system described in this document.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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<tbody>
<tr>
<td>TIA/EIA</td>
<td>Commercial Building Telecommunications Cabling Standard</td>
</tr>
<tr>
<td>TIA/EIA-568-B</td>
<td>General Requirements</td>
</tr>
<tr>
<td>TIA/EIA-568-B.1</td>
<td>Balanced Twisted Pair Cabling Components Standard</td>
</tr>
<tr>
<td>TIA/EIA-568-B.2</td>
<td>Optical Fiber Cabling Components Standard</td>
</tr>
<tr>
<td>TIA/EIA-568-B.3</td>
<td>Commercial Building Standard for Telecom Pathways And Spaces</td>
</tr>
<tr>
<td>TIA/EIA-606</td>
<td>Administration Standard for the Telecommunications Infrastructure of Commercial Buildings</td>
</tr>
<tr>
<td>TIA/EIA-607</td>
<td>Commercial Building Grounding/Bonding Requirements</td>
</tr>
<tr>
<td>NFPA</td>
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<tr>
<td>NFPA 70</td>
<td>National Electric Code (NEC)</td>
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<tr>
<td>ISO/IEC</td>
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<tr>
<td>ISO 11801</td>
<td>Generic Cabling for Customer Premises</td>
</tr>
</tbody>
</table>

D. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

E. This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact this project.

PART 8 - PRODUCTS
8.1 QUALITY ASSURANCE PARAMETERS

A. All work shall be performed in accordance with these guidelines, current industry testing standards, and with the test equipment manufacturer recommendations. All work shall be in accordance with the general principles outlined in the BICSI TDMM manual, latest edition. The system shall be AMP Netconnect Category 6 Cabling System Registered.

B. All equipment or apparatus of any one system must be the product of one manufacturer, or approved equivalent products of a number of manufacturer’s that are suitable for use in a unified system.

C. All materials and equipment for which Underwriter's Laboratories have established standards shall bear a UL label of approval.

D. Where proprietary names are used, whether or not followed by the words “or as approved”, they shall be subject to substitution only as approved by the Technology Consultant.

E. Where the Contractor proposes substitute equipment, contractor shall submit acceptable evidence to indicate compliance with all requirements of the documents, including performance rating, size and resistance to wear and deterioration equivalent to the specified item. In instances where substituted equipment requires additional material or work beyond that shown or required by the specified item, said additional material or work shall be the responsibility of this Contractor, regardless of the trade involved.

F. Furnish one new DSP-4300 Digital Cable Analyzer, which exceeds Cat 6 Level III accuracy and offers comprehensive documentation capability. This tester shall be used during testing of this project. Included features shall include the ability to integrate with labeling and cable management software, which yields downloadable 606-A cable IDs, ensuring data accuracy. 16-MB on-board memory saves 300 graphical tests, including a separate multimedia card for Cable ID loading and fast data transfer. This tester shall be turned over to Owner at project completion along with all tester product documentation and copper testing accessories.

PART 9 - EXECUTION

9.1 UTP CABLE TESTING

A. Riser and inter-building distribution cable testing: Each cable pair within all UTP riser cables shall be tested for continuity to ensure conductors are terminated in proper sequence, with correct polarity (tip and ring), and without conductor-to-conductor shorts, conductor-to-ground shorts, or opens.

B. Horizontal cable testing: All UTP station cables shall be tested to prove compliance with the current industry standard, TIA-568-B.2-1 Part 2: Balanced Twisted Pair Cabling Components, Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ω Category 6 Cabling and any subsequent addenda. Channel tests are the only acceptable test format for testing Category 6 cabling. Link tests will not be sufficient.

C. Horizontal cable testing equipment: The testing of UTP station cables shall be performed using the recommended test equipment specifically designed to test cables for all Category 6 parameters from 0 – 250 MHz. Testers shall be loaded with the most recent test values per the above referenced standard. The contractor may be required to provide documentation (or demonstration) that the testers used are properly programmed as described above.

D. The field test equipment shall meet the requirements of ANSI/TIA/EIA-568-A including applicable Technical Service Bulletins and amendments. The appropriate level III tester shall be used to verify Category 6 cabling systems.

9.2 FIBER OPTIC CABLE TESTING

A. Inter-building cable testing requirements:
   1. One direction.
      a. Test multi-mode strands at 850 nm and 1300 nm.
      b. Test single-mode strands at 1310 nm and 1550 nm.
c. Use optical time domain reflectometer (OTDR) for tests.
d. Record signature trace, length, and attenuation.

9.3 TEST RESULTS

A. Submission. Prior to acceptance, the contractor shall submit a copy of all applicable test results to the Owner/Technology Consultant in both electronic (file) and paper form.

B. Category 6 UTP cables: The test results submitted for Category 6 UTP cables shall include the following:
   1. Graphical/numerical data. Both graphical data plots and numerical data are required for the following test parameters:
      a. NEXT
      b. PS NEXT
      c. ELFEXT
      d. PS ELFEXT
      e. Attenuation
      f. Return loss
   2. Numerical data. Numerical data only is required for the following test parameters:
      a. Propagation delay
      b. Delay skew
      c. Resistance
C. UTP riser cables: Continuity tests shall be performed on each pair. The contractor shall submit a document confirming that these cables were tested satisfactorily per these guidelines.

D. Fiber optic cables: Test results for fiber optic cables shall consist of the measured attenuation, the maximum attenuation allowed per these guidelines, and whether the test passed or failed for each fiber optic cable link.

9.4 SYSTEM DOCUMENTATION

A. When all work has been completed and before final acceptance, the Contractor shall furnish to the Technology Consultant a complete set of documents that clearly represent all contract work “as-built”. This shall be inclusive of all test results and drawings. The Contractor is responsible for assuring the accuracy of the As-Built documentation.

B. The contractor shall submit, within forty (40) working days of the completion of each phase, three (3) full sets of As-Built documentation to the Technology Consultant for approval. Prior to delivery, each document section and each drawing shall be signed and dated by the Contractor’s project manager attesting to the accuracy of the as-built documents.

C. Electronic drawing files must conform to project drawing standards and be in the AutoCAD 2000 format. The As-Built drawings shall include at minimum, equipment locations, cable routes and outlet locations, and clearly show any deviations from the Contract Documents.

D. Note - The Technology Consultant is under no obligation to provide the Contractor with digital drawing files. However, digital drawing files may be provided to the Contractor for use in the development of Shop Drawings or As-Built drawings under a separate agreement between the Contractor and the Architect.

E. Test printouts and electronic documentation (CD’s) generated for each cable by the wire (or fiber) shall be submitted as part of the documentation package. The CD’s shall contain the electronic equivalent of the test results and be of a format readable from Microsoft Word or Excel.

F. The As-Built drawings shall include outlet locations. Their sequential number, as defined elsewhere in this document, shall identify outlet locations. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. These documents shall be modified accordingly by the contractor to denote as-built information as defined above and returned to the Technology Consultant.

G. The Technology Consultant may request that a 3% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by the Architect or Technology Consultant, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

H. Test Results documentation shall be clearly marked on the outside front cover with the words “Project Test Documentation”, “Middle Tennessee State University - Science Building” and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, and reference setup. The test equipment name, manufacturer, model number, serial number, software version and calibration date shall also be provided at the end of the document. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.

I. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

END OF SECTION 27 08 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and the other sections of Division 27.

B. Drawings and general provisions including Division 1, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Entrance protection for copper.
   2. Floor-standing equipment racks.
   3. Termination blocks and patch panels
   4. Cable Management
   5. Rack mounted power protection and power strips
   6. Rack mounted uninterruptable power supplies

B. Refer to following Specification Sections:
   1. Division 6 Section "Rough Carpentry" for wood framing and blocking for installation of wall-mounted equipment racks.
   2. Division 7 Sections for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
   3. Division 26 Sections for supports, anchors, identification products, electrical service and connections.
C. Provide cabinets and racks in accordance with the Contract Documents. Where conflicting data is indicated, verify mounting and equipment requirements prior to ordering.

D. This section contains specific parts selected by Owner and Technology Consultant. In the event that the parts specified are not available, Owner and Technology Consultant shall be contacted to specify replacements.

1.3 COORDINATION

A. This contractor shall be responsible for all coordination with the general and electrical contractor and data and voice vendors to provide a complete operational system.

B. Coordinate layout and installation of equipment racks with adjacent construction.

1.4 SUBMITTALS

A. Product Data: For copper protection devices, cabinets and equipment racks, termination blocks and patch panels, cable management devices, UPSs, and power strips.

B. Shop Drawings: Show fabrication and installation details of components for cabinets, equipment racks, and their associated parts and pieces to make a complete system.

C. Allow sufficient time in project scheduling for Owner and Technology Consultant review.

D. Submittals shall be checked by the supplier and made as complete systems including all required accessories and any special tools.

E. Manufacturer's installation and maintenance instructions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of enclosure through one source from a single manufacturer.

B. All work shall be in accordance with the latest edition of all applicable State, and Federal regulations and codes. Further, all work shall also be in accordance with EIA/TIA Standards, the BICSI TDMM manual, latest edition and with the manufacturer’s recommendations.

1.6 SEQUENCING AND SCHEDULING

A. Sequence all work to support the installation of the structured cabling system, electrical work and all cable tray systems installation.

PART 2 - PRODUCTS
2.1 MANUFACTURERS

A. Available Manufacturers are listed in subparagraphs for each Part 2 article below.

B. Other Manufacturers’ products must be submitted for Owner and Technology Consultant review for approval.

2.2 ENTRANCE PROTECTION

A. Acceptable manufacturers are Avaya, Circa Telecom, Marconi, TII Network Technologies, or Technology Consultant approved equivalent.

B. All lightning protection modules are to be solid state.

2.3 RACKS

A. Standard 19-in. four-post EIA cabinet or rack, with mounting rails that conform to English universal hole spacing per section 1 of ANSI/EIA-310-D-1992 providing window/square holes; for rack mounted installations in Main Distribution Frame (MDF) and Intermediate Distribution Frame (IDF) Rooms, the installer shall use a 7-foot high 19-inch equipment rack.

B. The racks shall be made by an ISO 9001 and 14001 Certified Manufacturer; Hubbell/Premise Wiring Rack System or approved equal. Use Hubbell Cat Number HPW84RR19 with Vertical Cable Manager VC76. Ensure product submittal includes all accessories and insures system compatibility.

C. The racks shall include vertical cable managers mounted on the front and rear of the channels with removable covers that can handle large quantities of cables and patch cords. Cable managers must retain cables even when covers are removed.

D. The racks shall have channels capable of utilizing and re-locating ten high-capacity, reusable hook and loop cable managers provided with racks, and have additional managers available in bags of ten.

E. The racks shall have cable access holes on side rails, which allow cables to be routed between adjacent racks.

F. The racks shall have standard 19-inch ANSI/EIA-310-C mounting holes having a full 45 RU on front and back of rails.

G. The racks shall utilize black grommets at all cable openings, including unused cable openings.

H. The racks shall have vertical cable management channels 7.38 in x 5.5 in x 7 ft which is located between racks. The channel shall include cable retainers, which can be hinged left or right and be located in any position along the channel.

I. The racks shall have floor mounting holes and a ground lug for 0-6 gauge ground cable provided.

J. Patch Panels:

1. Be available in black.
2. Be 8-position / 8-conductor with coherent pairing of IDC pins.
3. Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity.
4. Support industry standards for T568A or T568B wiring options on each individual outlet.
5. Be made by an ISO 9001 and 14001 Certified Manufacturer.
7. Include (1) 2RU horizontal wire management panel for each patch panel.
8. Use Systimax #1100D3-35 horizontal wire management panel.
9. Use hinged wall-mount bracket for 19” panels when no rack is available.
2.4 UNINTERRUPTABLE POWER SUPPLIES

A. Provide (1) APC Symmetra LX Series #SYA12K16PXR UPS unit for each telecommunications room as shown on the drawings. Include (1) APC Symmetra LX power distribution panel #SYAPD1 per UPS unit.

B. Provide (2) Geist RSPRN102-102D20TL5 power distribution units each with (1) Geist RSD2X8 current display.

PART 3 - EXECUTION

3.1 LIGHTNING PROTECTION

A. All copper cables, either multi-pair or coaxial, are to be terminated on lightning protection within 50 feet of the entrance into the building.

B. All pairs of inter-building twisted pair copper cable are to be protected on both ends to lightning protection blocks.

C. Lightning Protection Blocks are to be grounded to the nearest Telephone Main Grounding Bar (TMGB) or Telephone Grounding Bar (TGB).

3.2 RACKS

A. Preparation
   1. Coordinate requirements for riser bases, raised floor riser feet, anchors, bracing, and blocking to ensure adequate means for installation of racks/cabinets.
   2. Coordinate requirements for electrical cable pathways from overhead cable trays and management systems.

B. Installation
   1. Install racks in compliance with manufacturer's written instructions and shop drawings.
   2. Floor-standing racks/cabinets in the telecommunication rooms shall be securely attached to the concrete floor using minimum 3/8” in diameter hardware utilizing an approved length.
   3. Install equipment racks at locations and heights indicated on Drawings. Rows of racks/cabinets shall be placed with a 36-inch (minimum) clearance from the walls on all sides of the rack, unless otherwise indicated on Drawings. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks/cabinets. Where racks/cabinets are shown side by side, securely connect together using manufacturer’s ganging hardware to provide a stable system. Supply all miscellaneous parts and pieces to make a complete system.
   4. All racks/cabinets shall be grounded to the ground bus bar in accordance with the drawings and other Sections of this document.
   5. Rack mount screws not used for installing patch panels, keys and other hardware shall be bagged and left with the rack upon completion of the installation.
   6. Vertical cable managers shall be installed on both sides (left and right) of each rack in the telecommunications rooms. Horizontal cable managers shall be installed per rack equipment elevation drawings.

3.3 UNINTERRUPTABLE POWER SUPPLIES

A. Mount all UPS units in rack #1 each all telecommunications rooms.

END OF SECTION 27 11 00
SECTION 27 13 00 – COMMUNICATIONS BACKBONE CABLELING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and the other sections of Division 27.

B. This section is inclusive to all Division 27 sections.

C. Division 7 Sections for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.

1.2 DRAWINGS

A. The drawings show the general arrangement and extent of the work only. Determine the exact location and arrangement of all parts as the work progresses.

B. In all details, the work shall be subject to the Owner’s direction and approval. All work shall conform to its surroundings in best possible manner.

1.3 SCOPE OF WORK

A. General

1. This project includes the installation of fiber and copper cables.

2. All UTP terminations must follow 568A wiring schematic.

B. The Contractor shall provide a complete structured cabling system that will accommodate voice, data, and security for all rooms, all buildings defined in scope.

C. Outside Plant Backbone Cabling:

1. Install new fiber, copper, and coax backbone cables from Main IT Room 1131 to Business and Aerospace Building. Cables shall consist of (1) 24-strand MM fiber, (1) 48-strand SM fiber, (1) 100-pair copper cable, and (1) .5” hardline coax cable. Proper lightning protection is required on both sides of all copper and coax cables.

2. Install new fiber, copper, and coax backbone cables from Main IT Room 1131 to Learning Resource Center. Cables shall consist of (1) 12-strand MM fiber and (1) 12-strand SM fiber.

D. Intra-Building Backbone Cabling:

1. Install new fiber and copper backbone cabling from Main IT Room 1131 to all IDF's (Rooms 1015, 1105, 1144, 2015, 2104, 2128, 3015, 3100, and 3128). Cables shall consist of (1) 24-strand MM fiber, (1) 24-strand SM fiber, and (12) CAT6 cables.

2. Install new fiber backbone cabling from Main IT Room 1131 to Server Room 3115. Cables shall consist of (1) 12-strand MM fiber and (1) 12-strand SM fiber.

3. Install new rack mounted fiber distribution shelves with SC panels and connectors in all Telecom Rooms.

4. Terminate CAT6 backbone cables on wall-mounted 100 blocks.

PART 2 - PRODUCTS

2.1 BACKBONE CABLELING
A. Cables allowed for use in the backbone include: 100 Ω UTP multi pair copper cables. The cable shall support voice, data, and imaging applications. The bending radius and pulling strength requirements of all backbone cables shall be observed during handling and installation.


C. Copper Cables (4-pairs) shall:
   1. Be 100 Ω cables category 6.
   2. Be appropriate for the environment in which it is installed.
   3. Be Systimax GigaSPEED XL CAT6 UTP #1071004EBL (BLUE).

D. Copper Cables (greater than 4-pairs) shall:
   1. Be 100 Ω cables category 3 or greater
   2. Be categorized using power sum testing and meet the hybrid cable requirements for use in horizontal cabling.
   3. Be appropriate for the environment in which it is installed.
   4. Backbone pathways shall be installed or selected such that the minimum bend radius of backbone cables is kept within manufacturer specifications both during and after installation.
   5. Be General Cable #7525686 300-pair filled foam skin cable.

E. The backbone cables shall be installed in a star topology, emanating from the main cross-connect to each telecommunications room. An intermediate cross-connect may be present between the main cross-connect and the horizontal cross-connect. This is known as a hierarchical star topology.

F. Backbone pathways shall be installed or selected such that the minimum bend radius of backbone cables is kept within manufacturer specifications both during and after installation.

G. Fiber Cables Shall:
   1. Be manufactured by: Corning or equivalent.
      a. Corning MIC #024K81-33130-24 24-Fiber Multimode Riser Cable or equivalents for indoor applications.
      b. Corning MIC #024E81-33131-24 24-Fiber Singlemode Riser Cable or equivalents for indoor applications.
      c. Above parts “a” and “b” can be combined in a hybrid cable.
      d. Corning FREEDM LST Gel-Free #012KSF-T4130D20 12-Fiber Multimode Cable or equivalents for outdoor applications.
      e. Corning FREEDM LST Gel-Free #012ESF-T4101D20 12-Fiber Singlemode Cable or equivalents for outdoor applications.
      f. Corning FREEDM LST Gel-Free #024KSF-T4130D20 24-Fiber Multimode Cable or equivalents for outdoor applications.
      g. Corning FREEDM Loose Tube Gel-Free #048EWF-T4101D20 48-Fiber Singlemode Cable or equivalents for outdoor applications.
   2. Be terminated using SC connectors in rack mounted panels equipped with sufficient ports, slack storage space and splice trays if required to terminate and secure all fibers.
   3. Be installed in properly rated innerduct the entire length of the run from rack to rack.
   4. Have adequate riser sleeve/slot space available with the ability to ingress the area at a later date in all Telecommunications rooms, such that no drilling of additional sleeves/slots are necessary.

H. Backbone Terminations
   1. Fiber Terminations shall:
      a. Be manufactured by Corning #CCH-030U or CCH-040U Connector Housing plus appropriate CCH panels with SC connectors and splice trays.
      b. Be rack mounted.
c. Support 48 SC terminations.
d. Be terminated in separate shelves for inter-building and intra-building cables.
e. Support fusion spliced factory pre-connectorized pigtail terminations.

PART 3 - EXECUTION

3.1 SITE SURVEY

A. Prior to placing any cable pathways or cable, the Contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. The arrangements to remove any obstructions with the Project Manager need to be determined at that time.

3.2 PHYSICAL INSTALLATION

A. Industry requirements; The following installation, documentation, component and system industry specifications shall be met or exceeded:
   4. ANSI/TIA/EIA-569-A and addenda “Commercial Building Standard for Telecommunications Pathways and Spaces”.
   5. ANSI/TIA/EIA-606 and addenda “Administration Standard for the Telecommunications Infrastructure of Commercial Buildings”.
   6. ANSI/TIA/EIA-607 and addenda “Commercial Building Grounding and Bonding Requirements for Telecommunications”.
   8. ANSI/TIA/EIA-526-14A “Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant”.
   9. IEC/TR3 61000-5-2 - Ed. 1.0 and amendments “Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling”.
11. CENELEC EN 50173:2000 and amendments “Information Technology - Generic cabling systems”.

B. Cable Pathways
   1. Pathways shall be designed and installed to meet applicable local and national building and electrical codes or regulations.
   2. Grounding and bonding of pathways shall comply with applicable codes and regulations.
   3. Pathways shall not have exposed sharp edges that may come into contact with telecommunications cables.
   4. The number of cables placed in a pathway shall not exceed manufacture specifications, nor, will the geometric shape of a cable be affected.

C. Cable Routing
   1. In open ceiling cabling, cable supports shall be provided by means that is structurally independent of the suspended ceiling, its framework, or supports. These supports shall be spaced no more than 1.5 m (5 ft) apart.
2. Telecommunications pathways, spaces and metallic cables, which run parallel with electric power or lighting, which is less than or equal to 480 Vrms, shall be installed with a minimum clearance of 50 mm (2 in).

3. The installation of telecommunications cabling shall maintain a minimum clearance of 3 m (10 ft) from power cables in excess of 480 Vrms.

4. No telecommunications cross-connects shall be physically located within 6 m (20 ft) of electrical distribution panels, step down devices, or transformers, which carry voltages in excess of 480 Vrms.

5. In the telecommunications rooms where cable trays or cable racking are used, the Contractor shall provide appropriate means of cable management such as reusable color-coded hook and loop cable managers (ties) to create a neat appearance and practical installation.

6. In a false ceiling environment, a minimum of 9 inches shall be observed between the cable supports and the false ceiling.

7. Continuous conduit runs installed by the Contractor should not exceed 30.5 m (100 ft) or contain more than two (2) 90 degree bends without utilizing appropriately sized pull boxes.

8. Maximum conduit pathway capacity shall not exceed a 40% fill. However, Perimeter fill is limited to 60% fill for move and changes.

D. Pull Tension
1. The maximum cable pulling tensions shall not exceed manufacturer’s specifications.

E. Bend Radius
1. The maximum cable bend radii shall not exceed manufacturer’s specifications.

2. In spaces with UTP cable terminations, the maximum bend radius for 4-pair cable shall not exceed four times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.

3. During the actual installation, bend radius on 4-pair cable shall not exceed eight times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.

F. Slack
1. In telecommunications rooms a minimum of 3 m (10 ft) of slack should be left for all cable types. This slack must be neatly managed on trays or other support types.

G. Cable Tie Wraps
1. Hook and loop cable managers should be used in the telecommunications rooms where reconfiguration of cables and terminations may be frequent.

H. Grounding
1. Grounding and bonding shall be done per applicable codes and standards.

I. Fire Protection
1. Properly installed firestop systems shall be installed to prevent or retard the spread of fire, smoke, water, and gases through the building. This requirement applies to openings designed for telecommunications use that may or may not be penetrated by cables, wires, or raceways.

2. Fire stops shall comply with all applicable codes.

J. Workmanship
1. All work shall be done in a workman like fashion of the highest standards in the telecommunications industry. All equipment and materials are to be installed in a neat and secure manner, while cables are to be properly dressed. Workers must clean any debris and trash at the close of each workday.

END OF SECTION 27 13 00
PART 4 - GENERAL

4.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and the other sections of Division 27.

4.2 DRAWINGS
A. The drawings show the general arrangement and extent of the work only. Determine the exact location and arrangement of all parts as the work progresses.
B. In all details, the work shall be subject to the Owner’s direction and approval. All work shall conform to its surroundings in best possible manner.

4.3 SCOPE OF WORK
A. General: The Campus network-cabling solution shall be based upon structured cabling system components manufactured by Systimax. This shall include but may not be limited to cable management, faceplates, copper and fiber modules, patch panels, racks, 110 blocks, patch cords, labels and grounding lugs.
B. ALL UTP TERMINATIONS MUST FOLLOW 568A WIRING SCHEMATIC.
C. All copper and fiber optic cabling shall be manufactured by Systimax.
D. The installed system shall meet all requirements necessary to achieve certification for the Systimax GigaSPEED XL Category 6 twenty-five year warranty.
E. The Contractor shall provide a complete structured cabling system that will accommodate voice, data, security and video applications for all areas.
F. The Contractor shall provide upgrades and additions to the existing structured cabling system to accommodate voice, data, security and video applications.
G. Contractor shall provide other outlets as listed below or indicated on drawings.

PART 5 - PRODUCTS

5.1 HORIZONTAL CABLING
A. The Horizontal Subsystem is the portion of the telecommunications cabling system that extends from the work area telecommunications outlet/connector to the horizontal cross-connect in the telecommunications room. It consists of the telecommunications outlet/connector, the horizontal cables, and that portion of the cross-connect in the telecommunications room serving the horizontal cable.
B. Cable Types
1. All UTP cables shall conform to ANSI/TIA/EIA-568-A Commercial Building Telecommunications Cabling Standard (latest amendment and including all applicable addenda) and ISO/IEC 11801 (International) Generic Cabling for Customer Premises standard (latest amendment and including all applicable addenda).
C. Copper: The cable manufacturer for 4-pair UTP category 6 cables shall also meet the following cable specifications:

1. Attenuation: Qualified Cables shall exhibit worst case attenuation less than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst-case qualified cable attenuation performance for selected frequency points of interest is also provided.

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>1-250 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worst Case</td>
<td>( \leq 1.82 \sqrt{f + 0.017} \cdot f + \frac{0.20}{\sqrt{f}} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency Points of Interest</th>
<th>MHz</th>
<th>20.2 dB</th>
<th>30.0 dB</th>
<th>34.1 dB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>250</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Near End Crosstalk (NEXT) Loss: Qualified Cables shall exhibit worst case NEXT Loss greater than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst-case qualified cable NEXT Loss performance for selected frequency points of interest is also provided.

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>1-250 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worst Case Cable NEXT Loss</td>
<td>( \geq 76 - 15 \log\left(\frac{f}{0.772}\right) )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency Points of Interest</th>
<th>MHz</th>
<th>45.9 dB</th>
<th>40.8 dB</th>
<th>39.1 dB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>250</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Power Sum Near-End Crosstalk (PSNEXT) Loss: Qualified Cables shall exhibit worst case PSNEXT Loss greater than the values derived using the equations shown in the chart below from 1MHz to the highest referenced frequency value. Worst-case qualified cable PSNEXT Loss performance for selected frequency points of interest is also provided.

<table>
<thead>
<tr>
<th>Systimax 71E Series GigaSPEED XL CAT6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
</tr>
<tr>
<td>Worst Case PSNEXT Loss</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency Points of Interest</th>
<th>MHz</th>
<th>\begin{tabular}{c} Frequency Points of Interest \ MHz \ 100 \ 200 \ 250 \end{tabular}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>44.6 dB</td>
<td>39.4 dB</td>
</tr>
</tbody>
</table>

4. Equal Level Far-End Crosstalk (ELFEXT): Qualified Cables shall exhibit worst case ELFEXT greater than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst-case qualified cable ELFEXT performance for selected frequency points of interest is also provided.

<table>
<thead>
<tr>
<th>Systimax 71E Series GigaSPEED XL CAT6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
</tr>
<tr>
<td>Worst Case ELFEXT</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency Points of Interest</th>
<th>MHz</th>
<th>\begin{tabular}{c} Frequency Points of Interest \ MHz \ 100 \ 200 \ 250 \end{tabular}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>29.3 dB</td>
<td>23.2 dB</td>
</tr>
</tbody>
</table>
5. Power Sum Equal Level Far-End Crosstalk (PSELFEXT): Qualified Cables shall exhibit worst case PSELFEXT Loss greater than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst-case qualified cable PSELFEXT performance for selected frequency points of interest is also provided.

<table>
<thead>
<tr>
<th>Systimax 71E Series GigaSPEED XL CAT6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
</tr>
<tr>
<td>Worst Case PSELFEXT</td>
</tr>
<tr>
<td>Frequency Points of Interest MHz</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

6. Return Loss: Qualified Cables shall exhibit worst case Return Loss greater than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst-case qualified cable Return Loss performance for selected frequency points of interest is also provided.

<table>
<thead>
<tr>
<th>Systimax 71E Series GigaSPEED XL CAT6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
</tr>
<tr>
<td>Worst Case Return Loss Frequency MHz</td>
</tr>
<tr>
<td>1 ( \leq f &lt; 10 )</td>
</tr>
<tr>
<td>10 ( \leq f &lt; 20 )</td>
</tr>
<tr>
<td>20 ( \leq f \leq 300 )</td>
</tr>
<tr>
<td>Frequency Points of Interest MHz</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

7. Propagation Delay (ANSI/TIA/EIA-568-A-1): Qualified Cables shall exhibit worst case Propagation Delay less than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst-case qualified cable Propagation Delay performance for selected frequency points of interest is also provided.
### Systimax 71E Series GigaSPEED XL CAT6

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>1-250 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Worst Case Propagation Delay</strong></td>
<td>$&lt; 476 + \frac{36}{\sqrt{f_{\text{Hz}}}}$</td>
</tr>
<tr>
<td>Frequency Points of Interest</td>
<td>MHz</td>
</tr>
<tr>
<td>100</td>
<td>548 ns</td>
</tr>
<tr>
<td>250</td>
<td>547 ns</td>
</tr>
<tr>
<td>250</td>
<td>546 ns</td>
</tr>
</tbody>
</table>

8. **Delay Skew (ANSI/TIA/EIA-568-A-1):** Qualified Cables shall exhibit worst case Delay Skew less than the values specified in the chart below per 100 m from 1 MHz to the highest referenced frequency value.

<table>
<thead>
<tr>
<th>Systimax 71E Series GigaSPEED XL CAT6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency Range</strong></td>
</tr>
<tr>
<td><strong>Worst Case Delay Skew</strong></td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>250</td>
</tr>
<tr>
<td>250</td>
</tr>
</tbody>
</table>

9. **Attenuation to Crosstalk Ratio (ACR):** Using “pair-to-pair NEXT Loss”, all Qualified Cables shall exhibit worst case ACR performance for the specified frequency range shown in the following table.

<table>
<thead>
<tr>
<th>Systimax 71E Series GigaSPEED XL CAT6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency Range</strong></td>
</tr>
<tr>
<td><strong>Worst Case ACR</strong></td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>200</td>
</tr>
<tr>
<td>250</td>
</tr>
</tbody>
</table>

10. **Power Sum Attenuation to Crosstalk Ratio (PSACR):** Using “Power Sum NEXT Loss”, Qualified Cables shall exhibit worst case PSACR performance for the specified frequency range shown in the following table.
Systimax 71E Series GigaSPEED XL CAT6

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>1-250 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>24.3 dB</td>
</tr>
<tr>
<td>200</td>
<td>9.4 dB</td>
</tr>
<tr>
<td>250</td>
<td>3.5 dB</td>
</tr>
</tbody>
</table>

11. Cable shall be Systimax GigaSPEED XL CAT6 UTP #1071004EBL (BLUE).

PART 6 - EXECUTION

6.1 SITE SURVEY

A. Prior to placing any cable pathways or cable, the Contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. The arrangements to remove any obstructions with the Project Manager need to be determined at that time.

6.2 PHYSICAL INSTALLATION

A. Industry requirements; The following installation, documentation, component and system industry specifications shall be met or exceeded:

1. ANSI/TIA/EIA-568-B.1 and addenda "Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements”.
2. ANSI/TIA/EIA-568-B.2 and addenda "Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted-Pair”.
4. ANSI/TIA/EIA-569-A and addenda "Commercial Building Standard for Telecommunications Pathways and Spaces”.
5. ANSI/TIA/EIA-606 and addenda "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings”.
6. ANSI/TIA/EIA-607 and addenda "Commercial Building Grounding and Bonding Requirements for Telecommunications”.
8. ANSI/TIA/EIA-526-14A "Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant”.
9. IEC/TR3 61000-5-2 - Ed. 1.0 and amendments “Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling”.
11. CENELEC EN 50173:2000 and amendments “Information Technology - Generic cabling systems”.

B. Cable Pathways

1. Pathways shall be designed and installed to meet applicable local and national building and electrical codes or regulations.
2. Grounding / Earthing and bonding of pathways shall comply with applicable codes and regulations.
3. Pathways shall not have exposed sharp edges that may come into contact with telecommunications cables.
4. The number of cables placed in a pathway shall not exceed manufacture specifications, nor, will the geometric shape of a cable be affected.
C. Cable Routing

1. All horizontal cables, regardless of media type, shall not exceed 90 m (295 ft) from the telecommunications outlets in the work area to the horizontal cross connect.

2. The combined length of jumpers, or patch cords and equipment cables in the telecommunications room/closet and the work area should not exceed 10 m (33 ft) unless used in conjunction with a multi-user telecommunications outlet.

3. Two horizontal cables shall be routed to each work area. At least one horizontal cable connected to an information outlet shall be 4-pair, 100Ω unshielded twisted-pair (UTP).

4. Horizontal pathways shall be installed or selected such that the minimum bend radius of horizontal cables is kept within manufacturer specifications both during and after installation.

5. In open ceiling cabling, cable supports shall be provided by means that is structurally independent of the suspended ceiling, its framework, or supports. These supports shall be spaced no more than 1.5 m (5 ft) apart.

6. Telecommunications pathways, spaces and metallic cables, which run parallel with electric power or lighting, which is less than or equal to 480 Vrms, shall be installed with a minimum clearance of 50 mm (2 in).

7. The installation of telecommunications cabling shall maintain a minimum clearance of 3 m (10 ft) from power cables in excess of 480 Vrms.

8. No telecommunications cross-connects shall be physically located within 6 m (20 ft) of electrical distribution panels, step down devices, or transformers, which carry voltages in excess of 480 Vrms.

9. For voice or data applications, 4 pair UTP or fiber optic cables shall be run using a star topology from the telecommunications room serving that floor to every individual information outlet.

10. The Contractor shall observe the bending radius and pulling strength requirements of the 4 pair UTP and fiber optic cable during handling and installation.

11. Each run of UTP cable between the horizontal portion of the cross-connect in the telecommunication room and the information outlet shall not contain splices.

12. In the telecommunications room where cable trays or cable racking are used, the Contractor shall provide appropriate means of cable management such as reusable color-coded hook and loop cable managers (ties) to create a neat appearance and practical installation.

13. In a false ceiling environment, a minimum of 3 inches (75 mm) shall be observed between the cable supports and the false ceiling.

14. All horizontal pathways shall be designed, installed and grounded to meet applicable local and national building and electrical codes.

15. The number of horizontal cables placed in a cable support or pathway shall be limited to a number of cables that will not cause a geometric shape of the cables.

16. Maximum conduit pathway capacity shall not exceed a 40% fill. However, Perimeter fill is limited to 60% fill for move and changes.

17. Horizontal distribution cables shall not be exposed in the work area or other locations with public access.

18. Cables routed in a suspended ceiling shall not be draped across the ceiling tiles. Cable supports shall be mounted a minimum of 75 mm (3 in) above the ceiling grid supporting the tiles.

D. Work Area Termination

1. All UTP cables wired to the telecommunications outlet/connector shall have 4-pairs terminated in eight-position modular outlets in the work area. All pairs shall be terminated.

2. The telecommunications outlet/connector shall be securely mounted at planned locations.

3. The height of the telecommunications faceplates shall be to applicable codes and regulations.

4. The maximum cable pulling tensions shall not exceed manufacturer’s specifications.

E. Telecommunications Room Termination

1. All UTP cables for voice work are outlets shall be terminated on wall mounted 110-blocks.

2. All UTP cables for data work are outlets shall be terminated on rack mounted patch panels.

F. Bend Radius

1. The maximum cable bend radii shall not exceed manufacturer’s specifications.

2. In spaces with UTP cable terminations, the maximum bend radius for 4-pair cable shall not exceed four times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.
3. During the actual installation, bend radius on 4-pair cable shall not exceed eight times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.

G. Slack
1. In the work area, a minimum of 300 mm (12 in) should be left for UTP, while 1 m (3 ft) be left for fiber cables.
2. In telecommunications room/closets a minimum of 3 m (10 ft) of slack should be left for all cable types. This slack must be neatly managed on trays or other support types. Provide sufficient slack for voice cables to permit future relocation of terminations from wall mounted 110-blocks to rack mounted patch panels.

H. Cable Tie Wraps
1. Tie wraps shall be used at appropriate intervals to secure cable and to provide strain relief at termination points. These wraps shall not be over tightened to the point of deforming or crimping the cable sheath.
2. Hook and loop cable managers should be used in the telecommunications rooms where reconfiguration of cables and terminations may be frequent.

I. Grounding
1. All grounding / earthing and bonding shall be done to applicable codes and regulations.

J. Fire Protection
1. Properly installed firestop systems shall be installed to prevent or retard the spread of fire, smoke, water, and gases through the building. This requirement applies to openings designed for telecommunications use that may or may not be penetrated by cables, wires, or raceways.
2. Fire stops shall comply with applicable codes.

K. Workmanship
1. All work shall be done in a workman like fashion of the highest standards in the telecommunications industry. All equipment and materials are to be installed in a neat and secure manner, while cables are to be properly dressed. Workers must clean any debris and trash at the close of each workday.

END OF SECTION 27 15 00
SECTION 27 16 00 - COMMUNICATIONS CONNECTING CORDS, DEVICES, AND ADAPTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and the other sections of Division 27.

B. This section is inclusive to all Division 27 sections.

C. Division 7 Sections for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.

1.2 DRAWINGS

A. The drawings show the general arrangement and extent of the work only. Determine the exact location and arrangement of all parts as the work progresses.

B. In all details, the work shall be subject to the Owner’s direction and approval. All work shall conform to its surroundings in best possible manner.

1.3 SCOPE OF WORK

A. General

1. This project includes the supply of patch cords, adaptors and devices

2. All UTP terminations must follow 568A wiring schematic.

PART 2 - PRODUCTS

2.1 CORDS, DEVICES, AND ADAPTORS

A. This portion of the communications system includes termination of copper and fiber cables using modules and adaptors, faceplates, and patch cords.

2.2 Work Area: This section outlines specifications for the work area equipment cords, and telecommunications outlets at the users work area. The connection between the information outlet and the device (computer/telephone) is achieved by means of this subsystem.

A. Work Area Equipment Cords shall meet or exceed the following criteria:

1. Category 6, modular equipment cords shall:
   a. Be round, and consist of eight insulated 24 AWG, stranded copper conductors, arranged in four color-coded twisted-pairs within a flame-retardant jacket.
   b. Be equipped with modular 8-position (RJ45 style) plugs on both ends, wired straight through with standards compliant wiring.
   c. Be backwards compatible with lower performing categories.
   d. Use modular plugs which exceed FCC CFR 47 part 68 subpart F and IEC 60603-7 specifications, and have 50 micro inches minimum of gold plating over nickel contacts.
   e. Be resistant to corrosion from humidity, extreme temperatures, and airborne contaminants.
   f. Be available in any custom length and standard lengths of 0.9, 1.5, 2.1, 3.1, 4.6, 6.1, 7.6 meters (3, 5, 7, 10, 14, 20, and 25 feet).
   g. Be made by an ISO 9001 and 14001 Certified Manufacturer.
   h. Electrical Specifications:
(1) Have a DC resistance per lead: 9.38 Ω / 100 m maximum.
(2) Have an input impedance without averaging: 100 Ω + 15% from 1 to 100 MHz, + 22% from 100 to 200 MHz and + 32% from 200 to 250 MHz.
(3) Is 100% transmission tested with laboratory grade network analyzers for proper performance up to 250 MHz. Vendor shall guarantee cords are compatible with Category 6 links.
   i. Be UL VERIFIED (or equivalent) for TIA/EIA Category 6 electrical performance.
   j. Be UL LISTED 1863.
   k. Be Systimax GigaSPEED XL Modular Cords #GS8E-BL (BLUE).
   l. Quantities shall be:
      (1) Supply 20% of cords at 3’ length.
      (2) Supply 20% of cords at 5’ length.
      (3) Supply 20% of cords at 7’ length.
      (4) Supply 20% of cords at 10’ length.
      (5) Supply 20% of cords at 14’ length.

B. Information Outlets
   1. Category 6: All high density information outlets for 100 Ω 22-26 AWG copper cable shall:
      a. Be available in black, white, gray, ivory and light ivory.
      b. Be 8-position / 8-conductor with coherent pairing of IDC pins.
      c. Have available a gravity feed (45 degree angled) low profile as well as flush mount design.
      d. Provide universal application/multi-vendor support.
      e. Utilizes tri-balance technology with optimized pair balance design and linear crosstalk response to address applications up to 250 MHz.
      f. Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity.
      g. Support industry standards for T568A or T568B wiring options on each individual outlet.
      h. Allow installation from the front or rear of the faceplate, and allow for the jack to pass through the faceplate without re-termination.
      i. Be side-stackable for high-density solutions.
      j. Provide color-coded, slide-in icons available for circuit identification.
      k. Be constructed of high impact, flame-retardant thermoplastic.
      l. Have, as an option, an outlet, which can be mounted into an IEC 60603-7 compliant opening (keystone).
      m. Be made by an ISO 9001 and 14001 Certified Manufacturer.
      o. Be UL VERIFIED (or equivalent) for TIA/EIA Category 6 electrical performance.
      p. Be UL LISTED 1863 and cUL C22.2 approved.
      q. Be Systimax GigaSPEED XL Category 6 MSG400 Series Jacks # MSG400-262 (WHITE).

C. Faceplates: All faceplates shall:
   1. Be applicable to both fiber and copper applications.
   2. Have write on designation labels for circuit identification together with a clear plastic cover.
   3. Be available in single-gang and double-gang configurations.
   4. Have as a minimum the standard stainless steel faceplate.
   5. Have surface mount boxes available for both single and double gang faceplates.

D. Telecommunications Room: This section outlines specifications for the equipment cords between the rack mounted patch panels and active electronic equipment.
   1. Telecommunications Equipment Cords shall meet or exceed the following criteria:
      a. Category 6, modular equipment cords shall:
      b. Be round, and consist of eight insulated 24 AWG, stranded copper conductors, arranged in four color-coded twisted-pairs within a flame-retardant jacket.
      c. Be equipped with modular 8-position (RJ45 style) plugs on both ends, wired straight through with standards compliant wiring.
      d. Be backwards compatible with lower performing categories.
e. Use modular plugs which exceed FCC CFR 47 part 68 subpart F and IEC 60603-7 specifications, and have 50 micro inches minimum of gold plating over nickel contacts.

f. Be resistant to corrosion from humidity, extreme temperatures, and airborne contaminants.

g. Be available in any custom length and standard lengths of 0.9, 1.5, 2.1, 3.1, 4.6, 6.1, 7.6 meters (3, 5, 7, 10, 14, 20, and 25 feet).

h. Be made by an ISO 9001 and 14001 Certified Manufacturer.

i. Electrical Specifications:
   (1) Have a DC resistance per lead: 9.38 Ω / 100 m maximum.
   (2) Have an input impedance without averaging: 100 Ω + 15% from 1 to 100 MHz, + 22% from 100 to 200 MHz and + 32% from 200 to 250 MHz.
   (3) Is 100% transmission tested with laboratory grade network analyzers for proper performance up to 250 MHz. Vendor shall guarantee cords are compatible with Category 6 links.

j. Be UL VERIFIED (or equivalent) for TIA/EIA Category 6 electrical performance.

k. Be UL LISTED 1863.

l. Be Systimax GigaSPEED XL Modular Cords #GS8E-BL (BLUE).

2. Quantities shall be:
   a. Supply 20% of cords at 3’ length.
   b. Supply 20% of cords at 5’ length.
   c. Supply 20% of cords at 7’ length.
   d. Supply 20% of cords at 10’ length.
   e. Supply 20% of cords at 14’ length.

3. The 110-to-modular patch cords shall:
   a. Be 100% transmission tested with laboratory grade network analyzers for proper performance (manufacturer shall guarantee cords are compatible with category 6 links).
   b. Be available in 4-pair size with eight-position modular plug.
   c. Have factory-assembled cords available with black, white, red, yellow, blue and green jacket colors.
   d. Have a DC resistance per lead: 9.38 Ω / 100 m maximum.
   e. Meet or exceed TIA/EIA category 6 electrical performance.
   f. Must be certified by Underwriters Laboratories to United States Standards and C22.2 Canadian Telecommunications Standards.
   g. Be Systimax Hybrid RJ45 – 110 # CPC110GSD8PS1074DT568B-55Fxxx (IVORY), length of 40’.

PART 3 - EXECUTION

3.1 Termination

A. All UTP cables wired to the telecommunications outlet/connector shall have 4-pairs terminated in eight-position modular outlets in the work area. All pairs shall be terminated.

B. The telecommunications outlet/connector shall be securely mounted at planned locations.

C. The height of the telecommunications faceplates shall be to applicable codes and regulations.

D. The maximum cable pulling tensions shall not exceed manufacturer’s specifications.

E. Bend Radius
   1. The maximum cable bend radii shall not exceed manufacturer’s specifications.
   2. In spaces with UTP cable terminations, the maximum bend radius for 4-pair cable shall not exceed four times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.
   3. During the actual installation, bend radius on 4-pair cable shall not exceed eight times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.
F. Slack
1. In the work area, a minimum of 300 mm (12 in) should be left for UTP, while 1 m (3 ft) be left for fiber cables.
2. In telecommunications room/closets a minimum of 3 m (10 ft) of slack should be left for all cable types. This slack must be neatly managed on trays or other support types.

G. Fire Protection
1. Properly installed firestop systems shall be installed to prevent or retard the spread of fire, smoke, water, and gases through the building. This requirement applies to openings designed for telecommunications use that may or may not be penetrated by cables, wires, or raceways.
2. Fire stops shall comply with applicable codes.

H. Workmanship
1. All work shall be done in a workman like fashion of the highest standards in the telecommunications industry. All equipment and materials are to be installed in a neat and secure manner, while cables are to be properly dressed. Workers must clean any debris and trash at the close of each workday.

END OF SECTION 27 16 00
SECTION 27 32 26 - RING-DOWN EMERGENCY TELEPHONES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and the other sections of Division 27.

B. This section is inclusive to all Division 27 sections.

1.2 DRAWINGS

A. The drawings show the general arrangement and extent of the work only. Determine the exact location and arrangement of all parts as the work progresses.

B. All work shall be subject to the Owner’s direction and approval.

1.3 SUMMARY

A. Furnish all necessary labor, supervision, materials, equipment, tests and services to install complete emergency ring-down telephones as shown on the drawings.

1.4 SUBMITTALS

A. Submit drawings of emergency telephones and accessories including mounting details, color and finishes, graphics, and faceplate designs.

B. Submit manufacturer’s data on emergency telephones including but not limited to, types, materials, finishes, dimensions, colors and inside depths.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver emergency telephones and components carefully to avoid breakage, bending and scoring finishes. Do not install damaged equipment.

B. Store emergency telephones and accessories in original cartons and in clean dry space; protect from weather and construction traffic.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with these specifications, emergency telephones to be installed shall be as manufactured by Code Blue or Technology Consultant approved equal.

2.2 PEDESTAL STYLE EMERGENCY TELEPHONES

A. General description:

1. The Pedestal Style Emergency telephones will be owner-furnished, contractor-installed (OFci). Refer to drawing E001 for exact locations on site.
2. The unit shall be an easily identifiable, vandal resistant communications device that is Americans with Disabilities Act (ADA) compliant, multi-functional, freestanding, and constructed of heavy steel. The unit shall be aesthetically pleasing and virtually impervious to damage, and shall include a high quality, vandal resistant, hands-free communications device, a powerful strobe light, and a vivid blue beacon that serves to identify the unit from a great distance.

3. The communication system shall be designed so that a single touch on the communications device button shall immediately and automatically dial a preprogrammed number. This shall simultaneously activate the blue strobe light and an optional peripheral device such as a remote preset for closed circuit television (CCTV). Immediately after establishing the phone connection with the receiving party, the communications device shall be capable of sending a signal identifying the specific unit being activated. The strobe shall continue to flash, drawing attention to this location until the receiving party terminates the call.

B. Construction

1. The unit shall be a concentric steel cylinder (bollard) with a 12.75 inch diameter, a .25 inch wall thickness, and a height of 9 feet.

2. Tamper resistant fasteners manufactured by the McGard Company shall be used. It shall not be possible to enter the unit or remove any component without a special computer designed bit-wrench designed for this purpose. These bit-wrenches are supplied only by the manufacturer of the unit. All other types of fasteners shall not be acceptable due to the abundance of non-proprietary tools available for their removal.

3. The unit shall have an internal anchor baseplate that is fully welded to the bollard two inches above its base. The base plate shall be fabricated with a minimum of .50 inch thick A-36 grade steel plate, and shall have a 5 inch diameter center hole for electrical conduit access, as well as four oblong holes on an 8 inch circular bolt pattern for the anchor bolts. External mounting is not acceptable.

4. The unit shall have an access opening for anchor mounting and electrical wiring that is near the base of the bollard.

5. The opening shall have a cover plate flush with the unit, whose wall thickness and radius shall be the same as the bollard. The cover plate shall fit precisely into the opening, have a weather resistant gasket to prevent water from entering the unit, and shall be held in place by two 1/4-20 by 1 inch countersunk, tamper resistant, proprietary fasteners as supplied by the manufacturer.

6. There shall be two lens openings each 10 inches high and 17 inches wide with 153 degrees of arc. The openings shall be cut into the face of the unit 180 degrees apart, with the bottom of the openings to be approximately 14 inches from the top of the unit. The corners of the cuts shall be uniformly rounded, and the edges of the cuts shall be straight and free of burrs and other visual imperfections. The four edges of each opening shall form a square when viewed in elevation from the front or rear of the unit.

7. A heavy cylindrical lens made of clear, Lexan XL type polycarbonate shall be inserted into the bollard and mechanically and chemically fastened to the bollard interior. The lens shall be fully sealed with silicon around its entire edge to render the installed lens water, insect, and vandal resistant. The lens shall be treated so that it will be virtually impervious to damage from ultra-violet radiation, aging, cracking, yellowing or breaking.

8. A dome top assembly shall enclose the top of the bollard, and shall consist of a cover plate, a gasket, a blue strobe light, and a Lexan type polycarbonate dome cover with a passive vent.
   a. The cover plate shall be of high quality, high-density cast iron that shall be free of defects. It shall have a diameter that equals the diameter of the bollard, and shall have three tabs each with 10-24 X 1 inch stainless steel thumbscrews to facilitate mounting the finished assembly to the bollard.
   b. A cylindrical, transparent dome that is six inches tall with a 12.50-inch outer diameter shall cover the top of the cover plate. The dome shall be made of clear Lexan XL type polycarbonate, and shall be sloped so that water does not pool on top of the unit.
   c. The dome shall be placed over the blue strobe light and shall fit over the concentric ring in the cover plate. It shall be attached to the cover plate by means of three 10-24 X 1 inch tamper resistant proprietary fasteners attached through the dome and into the three offset tabs in the cover plate. The space between the dome and cover plate ring shall have a bristle style gasket to allow passive venting while minimizing entrance of insect and moisture.
   d. A gasket shall be placed between the dome top assembly and the bollard, and shall provide a weather resistant seal when the assembly is properly installed on top of the bollard.

9. A second opening shall be cut into the face of the unit at a point beginning 38.5 inches above the bottom of the bollard. The opening shall be 14.5 inches high at the forward edge, and 12.25 inches high at the rear edge. The lower edge of the opening shall be sloped from the rear to the front at an angle 35 degrees from the horizontal. The upper horizontal edge of the opening shall constitute an arc.
of 160 degrees in the face of the unit, and the sides of the opening shall be parallel and the same length.
   a. The opening shall be totally enclosed by a 7 gauge steel plate that shall have an opening to allow for communications device. The plate shall be seal welded to the bollard so that the faceplate and the bollard appear to be one unit.

C. Mounting
   1. The freestanding unit shall be mounted onto four bolts that are set in concrete. Standard 3/4 x 24 inch galvanized anchor bolts with galvanized nuts and washers shall be used as supplied. Unit shall mount one-half inch above the concrete to allow air movement.

D. Electrical
   1. All electrical components shall have quick-disconnect terminals for easy service or removal. All wiring shall be concealed within the bollard and shall not be visible from the outside of the unit.
   2. The unit shall require 120 VAC and draw a maximum of 3 amperes under normal operation. The entire unit shall be surge protected.
   3. The speakerphone shall require 20 mA loop current at the unit. A 22 to 26 AWG shielded twisted pair cable shall be used. Longer cable runs shall require the heavier gauge cable.

E. Lights
   1. Strobe light – A strobe light shall be located at the top of the unit. The strobe light shall generate approximately 1,000,000 candlepower and have a flash rate of no less than 60 flashes per minute. A deep blue polycarbonate prismatic refractor that distributes the light in a horizontal pattern, making the flash bright and visible even at great distances shall cover the strobe.
      a. The strobe light shall be automatically activated when the “PUSH FOR HELP” button on the communications device is touched, and shall continue to flash until the answering party deactivates the unit. The strobe cannot be turned off at the unit itself.
   2. Area light/beacon – A high intensity discharge (HID) 70-watt, high-pressure sodium area light shall be located under a reflective disk that is situated within the bollard near the top of the unit. The area light shall be centered between the lenses, and shall be partially surrounded by a heavy-gauge, deep blue, translucent, prismatic refractor made of Lexan type polycarbonate.
      a. Reflectors shall direct the light of the lamp outward and downward from the unit. This shall create a pool of light around the unit, making persons standing near the unit visible to passersby and/or to a responding officer. The area light shall always be illuminated.
   3. Faceplate light – A long life, LED light fixture shall be concealed within the unit above and directly forward of the communications device. This fixture will direct light onto the communications device faceplate, and shall be vandal resistant.

F. Communications
   1. The unit shall have a high quality, vandal resistant and ADA compliant speakerphone communications device.
   2. The speakerphone shall have one 1.5 inch piezoelectric button labeled “PUSH FOR HELP,” one 3/8 inch diameter red light emitting diode (LED) labeled “Call Placed,” and one 3/8 inch diameter green LED labeled “Call Received.” The speakerphone shall have an internally mounted electronics enclosure, auxiliary power, and shall be capable of playing up to two digitally stored voice messages upon activation. The electronics enclosure shall be capable of using interchangeable faceplates: a single-button faceplate, a two-button faceplate, or a two-button faceplate with keypad. The speakerphone shall be programmable from a remote location and have a three number dialing capability per button. Battery backup shall be rated for 16 hours of active talk time and 32 hours of standby. Line powered phone devices, DIP switch programming, and push-to-talk devices are not acceptable.

G. Finish
   1. The unit shall be finished with a coating process known to be highly graffiti resistant and UV resistant.
   2. Substrate preparation shall be as required to comply with applicable ASTM impact and adhesion standards.
      a. D2794 Direct and Reverse Impact
      b. D523 Gloss @ 60 degrees
      c. D3359B Cross Hatch Adhesion
      d. B117 Salt Spray Resistance
3. The polyurethane finish shall be a multicoat system available in 10 standard colors and custom colors as specified by the user and approved by the manufacturer.
4. The primer coat and finish coat shall each have a minimum coverage thickness of 2.0 mils.
5. Other types of protective finishes are not acceptable.

H. Graphics
1. The graphics shall be a durable engineering grade reflective vinyl for high visibility and legibility.
2. The standard graphics text shall be “Emergency,” “Assistance,” “Security,” or “Courtesy” and shall be available in 30 inch lengths. Standard colors shall be “reflective white,” “reflective blue,” and “reflective black.”

I. Options
1. The unit shall be capable of communicating through a full duplex radio frequency (RF) communications system operating within the 2.4-2.485 frequency band (license free). It shall be capable of transmitting calls by means of radio frequency and then routing them into a PBX or central office line. Push-to-talk interfaces are not acceptable. Radio frequencies of 400 and 800-900 MHz are not acceptable due to frequency interference from other communications devices. Refer to the RF specification for further details.
2. The unit shall be capable of cellular communications instead of a hard-wire phone line. Refer to the cellular specification for further details.
3. A solar powered ventilation fan (active) shall be available for applications where high humidity is prevalent.
4. With the use of the NightCharge™ option, it shall be possible to power the unit from a power grid that is not active 24 hours per day. Refer to the NightCharge™ specification for further details.
5. There shall be an option of customized paint colors and graphics. Colors other than standard shall be available based on RAL number specified by the user and approved by the manufacturer.
6. The unit shall be capable of accepting an integrated overhead camera mount that accepts a 1½ NPT dome camera supplied by others.

J. Warranty
1. The unit shall be warranted for a period of two years. Reference manufacturers warranty for further details.

K. Models
1. The pedestal emergency ring-down telephone shall be Code Blue CB 1-s. The optional “Overhead Camera Mount” shall be provided.
2. The speaker phone shall be Code Blue CB3100-s.

2.3 WALL MOUNTED EMERGENCY TELEPHONES

A. General Description
1. The unit shall be an easily identifiable, vandal resistant communications device that is Americans with Disabilities Act (ADA) compliant, multi-functional, either wall or pole mounted, and constructed of heavy steel. The unit shall be aesthetically pleasing and virtually impervious to damage, and shall include a high quality, vandal resistant, hands-free communications device, and an optional remotely mounted combination blue strobe and beacon that serves to identify the unit from a great distance.
2. The communication system shall be designed so that a single touch on the communications device button shall immediately and automatically dial a preprogrammed number. This shall simultaneously activate a blue strobe and an optional peripheral device such as a remote preset for closed circuit television (CCTV). Immediately after establishing the phone connection with the receiving party, the communications device shall be capable of sending a signal identifying the specific unit being activated. The strobe shall continue to flash, drawing attention to this location until the receiving party terminates the call.

B. Construction
1. The housing shall be fabricated of 11 gauge steel. The unit shall be 10.25 inches wide, 15.25 inches high, 6 inches deep at the top, and 5 inches deep at the bottom. There shall be a faceplate fabricated of 11 gauge steel welded to the housing. The bottom shall have a .75 inch diameter opening for the
passage of a phone line and electric wiring. The back shall have four holes for the accommodation of mounting hardware.

2. Tamper resistant fasteners manufactured by the McGard Company shall be used. It shall not be possible to enter the unit or remove any component without a special computer designed bit-wrench designed for this purpose. The special bit-wrenches are supplied only by the manufacturer of the unit. All other types of fasteners shall not be acceptable due to the abundance of non-proprietary tools available for their removal.

C. Mounting

1. The unit shall attach to the wall with four each 3/8 x 3 inch masonry type anchors that are included with the unit. See Section 9 of this specification for optional pole mounting information.

D. Electrical

1. All electrical components shall have quick-disconnect terminals for easy service or removal. All wiring shall be concealed within the enclosure and shall not be visible from the outside of the unit.
2. The unit shall require 24 VAC and draw a maximum of 2.5 amperes under normal operation. The entire unit shall be surge protected.
3. The speakerphone shall require 20 mA loop current at the unit. A 22 to 26 AWG shielded twisted pair cable shall be used. Longer cable runs shall require the heavier gauge cable.

E. Lights

1. Faceplate light: A long life, LED light fixture shall be concealed within the unit above and directly forward of the communications device. This fixture directs light onto the communications device faceplate, and shall be vandal resistant.

F. Communications

1. The unit shall have a high quality, vandal resistant and ADA compliant speakerphone communications device.
2. The speakerphone shall have one 1.5 inch piezoelectric button labeled “PUSH FOR HELP,” one 3/8 inch diameter red light emitting diode (LED) labeled “Call Placed,” and one 3/8 inch diameter green LED labeled “Call Received.” The speakerphone shall have an internally mounted electronics enclosure, auxiliary power, and shall be capable of playing up to two digitally stored voice messages upon activation. The electronics enclosure shall be capable of using interchangeable faceplates: a single-button faceplate, a two-button faceplate, or a two-button faceplate with keypad. The speakerphone shall be programmable from a remote location and have a three number dialing capability per button. Battery backup shall be rated for 16 hours of active talk time and 32 hours of standby. Line powered phone devices, DIP switch programming, and push-to-talk devices are not acceptable.

G. Finish

1. The unit shall be finished with a coating process known to be highly graffiti resistant and UV resistant.
2. Substrate preparation shall be as required to comply with applicable ASTM impact and adhesion standards.
   a. D2794 Direct and Reverse Impact
   b. D523 Gloss @ 60 degrees
   c. D3359B Cross Hatch Adhesion
   d. B117 Salt Spray Resistance
3. The polyurethane finish shall be a multicoat system available in 10 standard colors and custom colors as specified by the user and approved by the manufacturer.
4. The primer coat and finish coat shall each have a minimum coverage thickness of 2.0 mils.
5. Other types of protective finishes are not acceptable.

H. Graphics

1. The graphics shall be a durable engineering grade reflective vinyl for high visibility and legibility.
2. The standard graphics text shall be “Emergency,” “Assistance,” “Security” or “Courtesy,” and shall be available in 11 inch lengths. Standard colors shall be “reflective white,” “reflective blue,” and “reflective black.”
I. Options
   1. The unit shall have the option of a pole mounting hardware kit to facilitate mounting the unit on a pole.
   2. The unit shall be capable of utilizing a remote mount combination blue beacon and strobe unit with a mounting bracket.
   3. There shall be an option of customized paint colors and graphics. Colors other than standard shall be available based on RAL number as specified by the user and approved by the manufacturer.

J. Approvals
   1. The unit in its standard configuration shall be certified by a recognized third party testing organization to conform to UL 60950-1/CSAC22.2 No. 60950-1-3.

K. Warranty
   1. The unit shall be warranted for a period of two years. Reference manufacturers warranty for further details.

L. Models
   1. The wall mounted emergency ring-down telephone shall be Code Blue CB 4-r
   2. The speaker phone shall be Code Blue CB3100-s.

PART 3 – EXECUTION

3.1 INSTALLATION
   A. Station wiring for all telephone systems shall be four-pair telephone cables. Station and feeder cables shall not be spliced together.
   B. The power source for all telephone systems (except for the fire telephone system) shall be -48Vdc fed from the DC distribution power panel.
   C. Quantity and approximate locations of telephone system equipment are shown on the Contract Drawings.
   D. Except as otherwise indicated, provide manufacturer’s standard products of categories and types required for each application.

3.2 TESTING
   A. The following tests shall be performed on each telephone system, as applicable.
      1. Station to station calling.
      2. Station to trunk calling.
      3. Trunk to station calls.
   B. Initiate traffic to/from the system that shall activate the various progress and signaling signals/tones generated by the respective system:
      1. Dial tone.
      2. Station busy tone.
      3. All trunks busy (congestion) tone.
      4. Ringback tone.
      5. Station ringing.
      6. Distinctive ringing.
      7. Delayed ringing at LMA Central (90 seconds for Elevator intercom to ET system).
      8. Maintenance and Administration data is received, accepted, and transmitted in accordance with District and manufacturer’s specifications.
      9. Transmission and signal levels across all interfaces with other systems and subsystems.

END OF SECTION 27 32 26