MEP PROJECT MANUAL TABLE OF CONTENTS

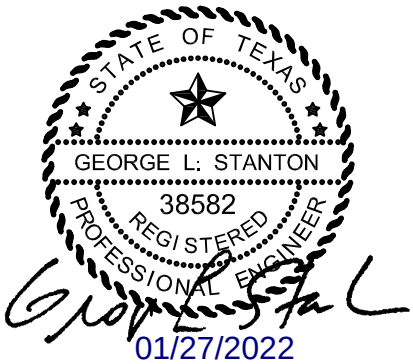
BROWN THEATER 7TH FLOOR DIMMING REPLACEMENT AT WORTHAM THEATER

STANTON ENGINEERING GROUP, LLC PROJECT #2144

MEP SPECIFICATIONS

MEP DRAWING LIST

END OF SECTION



SECTION 26 0000 GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

B. The General Electrical Requirements as specified in Sections 26, apply to the work specified in this Section.

C. Equipment shall meet applicable requirements include in the NEC, UL, NEMA and ANSI Standards and be so labeled.

1.2 GENERAL REQUIREMENTS

A. Provide all supervision, labor, equipment and materials required for the installation of complete and operating electrical systems in the building. Pay all fees and obtain all permits related to construction activities and utility service installation.

1.3 SCHEDULE

A. The facilities are an active theater and there is limited summer availability to perform the required work. The contractor shall include in their bid any and all after-hours work, supplemental crews, double-shifts, expedited equipment fees, or other methods of guaranteeing the work shall be completed within the designated window.

B. Access to the Facilities:

01	On-site work:	Starting Monday, June 27, 2022.
02	Substantial Completion:	By Close of Business, Friday, August 5, 2022
03	Final Completion:	Friday, August 26, 2022

04 Any work or access to the facilities outside the June 27 – August 5 window shall require formal approval by the Owner, including remedial work to reach final completion.

1.4 DRAWINGS AND SPECIFICATIONS

A. GENERAL: Drawings and Specifications are intended to be complimentary. Any work described in either of them, will be work required under this contract. Where there is a conflict between the Drawings and Specifications it shall be clarified by RFI. Barring clarification prior to bidding the most expensive option shall be included and clarification shall be made during construction. Should any work required by the drawings and specifications be in violation of any Federal, State, County or City laws, ordinance or regulation, those laws and regulations shall prevail, and shall be complied with by the Contractor as a part of this work with no extra compensation.

B. EQUIPMENT AND DEVICE LOCATION: The drawings indicate approximate locations of the various items of electrical systems. These items are shown approximately to scale and attempt to show how these items should be integrated with building construction. Locate all the various items by on-the-job measurements, conformance with Contract Documents and cooperation with other trades. The drawings are schematic in nature and

are not intended to show exact locations of conduit, but rather to indicate distribution, circuitry and control.

C. MINOR RELOCATION: In certain instances, the Engineer may require minor relocation of outlets, switches, etc. of up to five (5) feet. If Contractor is informed of necessary relocation before work is begun on this portion of the job, no extra compensation will be allowed.

1.5 REQUIREMENTS FOR ALL MATERIALS

A. U. L. LABEL: All materials must be new and of good quality and shall bear the stamp of approval of the Underwriters' Laboratories, Inc. (U. L.). Equipment and materials shall be used and installed consistent with the U. L. testing and U. L. requirements.

B. MISCELLANEOUS ACCESSORIES: Provide all parts and accessories necessary for a complete installation for the systems and equipment specified.

C. HAZARDOUS MATERIAL: All materials shall be certified to not contain any asbestos, PCB's or other material banned by the Environmental Protection Agency.

1.6 INSTALLATION REQUIREMENTS

A. COORDINATION: The Contractor shall cooperate with other trades on the job and make installations in the proper sequence during the construction of the buildings, and he shall notify the Engineer well in advance of construction of all interference of his work with that of other trades and of building construction. This notification shall not relieve the contractor of his responsibilities to coordinate his work with the total project. Where various items of equipment and materials are specified and scheduled, the purpose is to define the general type and quality level, not to set forth the exact trim required to fit the various types of ceiling, wall or floor finishes. Provide materials which will fit properly the types of finishes actually installed.

B. BASIS OF DESIGN: Equipment that is scheduled is the basis of the design and has been coordinated for space, installation and electrical requirements. Equipment and models from other acceptable manufacturers have not been verified or coordinated and may vary from scheduled equipment. Contractor shall verify these requirements prior to using other equipment in his bid and include any additional costs for installation of the substitute equipment. Confirm electrical installation requirements of equipment provided by other trades prior to installation. Incorrectly installed materials shall be replaced at no cost to the Owner.

C. WORKMANSHIP: All work shall be performed in a neat workmanlike manner and in the best practice of the trade. Only workmen skilled in the trades shall be employed to perform the work included in these specifications.

D. EQUIPMENT PROTECTION: Do not deliver equipment to jobsite until it is actually needed for installation. Protect equipment from damage due to construction activities and the weather. Equipment allowed to stand in weather will be rejected and Contractor is obligated to furnish new equipment at no cost to Owner.

1.7 ALTERNATES

A. Determine the scope of each specified alternate proposal by carefully reading all Divisions of the Documents. The Bid Form contains information explaining the extent of the construction to be performed under a specific alternate. Alternate proposals, which are not predominantly electrical in scope, are described in other Divisions of these Documents.

01 No alternates shall be allowed for the theatrical controls and dimming equipment. ETC shall be the only acceptable manufacturer.

1.8 CODES

A. All materials and their installation shall be in accordance with the National Electrical Code, local building codes and the National Safety Code. Nothing in the plans and specifications shall be construed to permit work not conforming to the most stringent of the codes. Particular attention shall be paid to the U. L. codes for fireproofing of conduit, electrical devices and light fixtures that are part of or pass through fire rated ceilings, walls, and floors.

1.9 VISITING THE SITE

A. The Contractor shall be familiar with the Drawings and Specifications and shall have examined the premises and understand the conditions under which he will be obligated to operate in performing the contract. No allowance shall be made consequently for any error through negligence in this regard.

1.10 ELECTRICAL SERVICE

A. GENERAL: Obtain (during the bidding period) from the Power Company all required information to provide a complete electrical service installation as shown on the Drawings.

B. SERVICE: The service characteristics are 480Y/2400V, 3 phase, 4 wire. The Power Company is CenterPoint Energy.

01 Equipment voltage characteristics are 208Y/120V, 3 phase, 4 wire.

C. FEES: Refer to Front End Sections for requirements.

1.11 TEMPORARY SERVICE

A. Provide a temporary electrical service for construction power. Size and voltage as required for construction activities as specified by the General Contractor. Construction site distribution shall be overhead and comply with the latest NEC and OSHA Standards and the current edition of the National Electrical Safety Code (NFPA 70e) for safety in the workplace. Remove all temporary wiring upon project completion.

B. Where the Owner allows the use of the building permanent service for construction activities the contractor shall pay all fees, kilowatt hour charges, etc. related to its use.

1.12 GUARANTEE

A. All materials, apparatus and equipment furnished and installed under this Section of these Specifications shall be new and free from any defects when accepted by the Owner and shall be guaranteed in writing for a period of one year from the date of acceptance by the Owner. . All extended warranties shall be from the date of acceptance by the Owner regardless of when the equipment was delivered to the job site or started up by the contractor.

1.13 SUBMITTALS

A. All submittals shall be submitted in PDF form. Submittal will be reviewed with comments incorporated in this PDF. After final approval, Contractor shall provide a hard copy for use at the project site.

B. The purpose of these submittals is to attempt to aid the contractor in such a manner that improper or unacceptable materials are not delivered to or installed on the job. Shop drawings shall be approved before installation of the material under consideration. Approval of these submittals shall not be construed as releasing the Contractor from compliance with the Contract Documents. All materials and equipment shall be subject to final acceptance by the Engineer at completion of construction.

C. Equipment and material submittals must show sufficient data to indicate complete compliance with contract documents as follows:

01 Proper sizes and capacities.

02 That the item will fit in the available space in a manner that will allow proper service.

03 Floor plans, elevations, wiring diagrams, etc. necessary to verify proposed installation.

D. Catalog data must be clearly marked to indicate the item or model number being submitted and must include all specified accessories. All information on a catalog sheet not pertaining to the item being submitted must be marked out.

E. All submittals shall include a table of contents listing all items in that specific submittal. All submittals on the project need not be submitted in PDF. The front sheet of each copy of the submittal shall have the following typed information:

01 Job name and location.

02 General Contractor's name, address, project manager's name and telephone number.

03 Submitting Sub-contractor's name, address, project manager's name and telephone number.

04 Supplier's company name, address, salesman's name and telephone number.

F. For any item to be installed in or on a finished surface (such as tee bar acoustical ceiling, plaster wall), Contractor certifies by making the submittal that he has checked all applicable contract Documents and that the item submitted is compatible with the surface finish on which it is to be installed.

G. Submit shop drawings and/or brochures as indicated in individual sections and for:

Wiring Conduit

Theatrical Lighting Controls

Structured Cabling Components

H. Major theatrical lighting control equipment will not be approved until contractor has submitted and received approved 1/4" scale coordination drawings of electrical rooms showing sizes of proposed equipment, including access space, and other equipment also located in the room.

I. If a submittal is returned to the Contractor marked "Rejected" or "Revise and Resubmit", only one (1) additional submittal will be permitted without the Contractor incurring

charges for the additional re-submittals. SEG shall be reimbursed by the Contractor for any expense in connection with any necessary submission in addition to the two (2) submissions allowed. Contractor will be billed by SEG at a rate of $125/hr for these occurrences.

1.14 SUBSTITUTIONS

A. The names of manufacturer and model numbers have been used in the Contract Documents to establish types of equipment and standards of quality and are intended to be the Basis of Bid. No attempt has been made to determine if each manufacturer listed for a particular item of equipment will produce material that will comply with all requirements. If only one manufacturer is named for a specific item of equipment (except lighting fixtures), the specified manufacturer will be the only acceptable one. Where more than one manufacturer is named for a specific item of equipment, only one of these manufacturers will be considered for approval. Where only one manufacturer is mentioned with the phrase "or approved equal", Contractor may submit an alternate manufacturer as outlined in Special Conditions and this Article. If a submittal contains sufficient information to prove compliance with the Contract Documents, then that submittal will be acceptable.

01 No alternates shall be allowed for the theatrical controls and dimming equipment. ETC shall be the only acceptable manufacturer.

B. All other brands, including any additional names which may be listed as “Alternates” or “Approved Equal” must conform with the specifications, size, accessories, etc. of the first named brand and be subject to Paragraph D and E of this Article. Alternate equipment must be equal from the standpoint of materials, construction and performance. Request for substitution must be accompanied by complete data and descriptive sheets during the bidding period as described in Paragraph D and E of this Article.

01 Submitted on Bidder’s letterhead attached to Proposal Form with individual deductive amounts stipulated and the documentation required in Paragraph E-03.

02 All savings for Owners selection of deductive amounts by acceptance of alternate or substituted items are to be paid to the Owner.

C. All equipment within common group or category (e.g. switchgear, lighting fixtures, fire alarm, etc.) shall be same manufacturer.

D. Proposed Substitutions/Approved Equals:

01 Submitted no less than 14 calendar days prior to bid date.

02 Submit proposed substitutions with catalog data and/or manufacturer’s shop details indicating all modifications required to conform with specified brand. Include all relevant items necessary to make a determination of equal status or submittal shall be deemed incomplete and rejected.

03 If submittal contains sufficient information to prove compliance with the Contract Documents, then that alternate submittal will be acceptable. Approved submittals for bidding purposes only will be published by addenda.

E. Substitutions with prior approval:

01 Submitted on Bidder’s letterhead attached to Proposal Form with individual additive/deductive amounts stipulated and the documentation required in Paragraph B-2.

02 Owner reserves the right to accept or reject any or all substitution proposals before execution of Contract.

03 Provide all design/engineering services required to make adjustments in space, systems, utilities, etc. and pay all additional costs of utilities, construction or professional services that may be incurred due to the acceptance of any substitution.

1.15 FOUNDATIONS AND EQUIPMENT SUPPORTS

A. GENERAL: Provide all foundations and supports.

B. CONCRETE HOUSEKEEPING PADS: 4" high concrete pad to be provided for all floor mounted equipment. Concrete pads shall be sized for the equipment to be supplied. Pad shall exceed base dimensions by approximately 4" all around. Reinforce pads with 6" x 6" woven wire mesh and #4 bar around perimeter. Tool pad to form chamfered edge. Coordinate sizes and locations with the General Contractor.

01 Existing concrete pads may be reused where of suitable size and in good condition.

C. INSIDE ELECTRICAL EQUIPMENT: Securely attach panels to block walls with concrete bolts. When attaching to sheetrock or other less substantial walls, provide blocking and unistrut cross supports to securely attach panel to structural members. Where panels are required to be freestanding provide angle iron support structure bolted to floor and building structure.

D. VIBRATION ISOLATION: Install equipment on waffle pad type isolators.

1.16 NOISE

A. Eliminate any abnormal noises which are not considered by the Engineer to be an inherent part of the systems as designed. Abnormal buzzing in equipment components will not be acceptable.

1.17 TESTING BY CONTRACTOR

A. GENERAL: All wiring, instruments, apparatus and equipment shall be tested for continuity, ground and short circuits before the circuits are energized. For 120 Volts circuits, the neutral/s may require disconnecting. A complete record of all testing shall be submitted to Owner at completion.

B. GROUND TESTING: The resistance of the grounding system to ground shall not exceed 3 ohms for water pipe ground or 6 ohms for driven ground rods. If tests indicate a higher value, additional ground rods shall be installed to reduce the resistance to a value of 6 ohms or less. Whenever connection is required to an existing ground conductor, tests shall be made before connection to ensure that the existing ground conductor is unbroken and continuous. Testing shall be in accordance with generally accepted practice.

C. INSULATION TESTING: Test all electrical equipment bussing, underground feeders and feeders 1/0 and larger at 85% of rated insulation value. Insulation tests shall be made with a 500 volt "Megger" as manufactured by James G. Biddle Company or equal. Test one conductor at a time with other two grounded. Attempt to raise voltage to maximum in one minute. Do not exceed 2 MA. Polarization Index (amps ratio - 1 minute/10 minutes) to be at least 3 unless approved otherwise.

D. INFRARED SCANNING: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard, switchboard, switchgear, automatic transfer switches, and splices in cables/conductors No. 3 AWG or larger.

Remove box and equipment covers so equipment interiors and splices are accessible to the portable scanner.

01 Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard and splice in cables/conductors No. 3 AWG or larger no more than eleven (11) months after date of Substantial Completion or one (1) month before the end of the warranty period whichever is sooner.

02 Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values and produce a thermal image of the tested location. Provide calibration record for device.

03 Record of Infrared Scanning: Prepare a certified report that identifies locations/equipment checked and that describes scanning results. Include images generated by thermal scanner, notation of deficiencies detected, remedial action taken, and observations after remedial action.

E. GROUND PENETRATING RADAR: Where concrete flooring or paving must be cut to install MEP systems, contractor shall take measures to prevent damaging existing underground services. Contractor shall utilize ground penetrating radar and electrical circuit tracing equipment in the area to be excavated to determine the existence of underground services. When saw cutting, limit the depth of the cut to less than the thickness of the concrete. Breakout the concrete manually with special care in areas of possible underground services.

F. ADDITIONAL TESTING: The Contractor shall make such other tests as required by the Authority Having Jurisdiction (AHJ) or as may be or become necessary to assure satisfactory operation of each unit device or equipment.

1.18 CLOSEOUT REQUIREMENTS

A. AS-BUILT DRAWINGS: Obtain a set of project drawings and keep these at jobsite during construction. During the course of construction, mark on these prints any changes which are made, noting particularly locations for those items which will need to be located for servicing. At completion of job, mark each sheet "Record Drawings", date and deliver to Engineer.

B. OWNER'S INSTRUCTIONS: Provide the following periods of instruction for each site to the Owner's designated personnel upon completion of the system's installation. Provide additional training as noted in individual equipment specifications.

01 Reference 260010 Closeout Requirements.

C. CLOSEOUT MANUALS:

01 Reference 260010 Closeout Requirements.

1.19 MOUNTING HEIGHTS

A. GENERAL: Heights are measured to centerline from the finished floor. Where devices are located in block walls Engineer may require height to be adjusted so junction box is in a desired relationship with the mortar joint. Device must still be mounted within the acceptable height range for ADA.

1.20 ELECTRICAL INSPECTIONS

A. GENERAL: Contractor shall request inspections to review any and all electrical installations. Inspections shall include but not be limited to: system tests, grounding

tests, underground installations prior to backfill, rough-in installations, wall cover inspections, above ceiling inspections, final inspection.

B. GOVERNMENTAL INSPECTIONS: Contractor shall test and demonstrate systems, allow for Engineer and Owner inspections, and correct all punch list items before arranging for inspections from the Fire Marshall or other final “Certificate of Occupancy” inspection requirements. This will require that the contractor complete systems in a timely manner to meet construction schedules.

C. Contractor shall provide a MINIMUM of 48 hour notice prior to requested inspection time, no exceptions.

D. INSPECTION REPORTS: After each inspection, SEG will generate an inspection report and distribute promptly. The Contractor will then be given 7 working days from date of report to address all deficiencies listed on the report. The GENERAL CONTRACTOR shall verify that all items on each inspection report have been addressed by their subcontractors in this time period. Once verified the GENERAL CONTRACTOR shall sign-off on each deficiency listed on the report and return the signed-off copy of the inspection report to SEG via e-mail. After the signed-off report is returned to SEG, the GENERAL CONTRACTOR shall request a re-inspection by SEG to close the report. If after 7 working days no re-inspection is requested by the GENERAL CONTRACTOR to close a report, SEG reserves the right to re-inspect whenever our schedule allows, with these re-inspections still being subject to Paragraph E below.

E. TEST REJECTIONS AND RE-INSPECTIONS: If a test is rejected or a re-inspection of an issued SEG Inspection Report is found to NOT be completely addressed, only ONE (1) additional inspection will be permitted without the Contractor incurring charges for each additional inspection required. SEG shall be reimbursed $1000 by the GENERAL CONTRACTOR for expenses in connection with EACH inspection in addition to the two (2) re-inspections allowed.

1.21 DEMOLITION AND REMODELING

A. In areas of demolition, contractor shall remove all electrical devices, conduit and wiring not to be reused. Any material that has salvage value shall be offered to the Owner, and if accepted, delivered to his warehouse or other designated location. If not accepted it shall be properly disposed of with the other construction debris.

B. Resupport, rehang, and rebundle existing conduit and cabling to remain. Rework existing circuits and installation to accommodate for renovation/demolition work including but not limited to changes in ceiling heights, ceiling types, and wall locations. Group cabling by type/trade and all materials shall be properly supported per applicable codes and standards.

C. Where partial circuits or systems are to be reused, ensure that they remain active. Where existing equipment is removed and reinstalled or replaced with new equipment, modify, extend and relocate existing feeder and other wiring, and connect to equipment. Relocate conduit as necessary to allow new or modified construction. Repair existing electrical systems damaged by construction activities.

D. Remove and replace ceilings as necessary to install or modify electrical systems.

E. Where ceilings are removed or replaced, remove and reinstall lights, speakers, security devices, fire alarm devices and other existing electrical and low voltage devices in the ceiling. Any low voltage cabling laying on ceilings shall be supported from structure per applicable codes and standards. Segregate fire alarm and security from other cabling.

F. Where existing adjustable circuit breakers are to be reused, adjust for revised loads. Where existing fused switches are to be reused, replace fuses with proper size for revised loads. Where new circuit breakers are to be installed in existing panels, verify

that the circuit breaker will fit in the allotted space. Provide NEMA 1 enclosure installed adjacent to panel and wire connect to bussing if there is insufficient space.

G. Where light fixtures are to be replaced or added in existing areas, verify and coordinate existing voltages with fixtures to be supplied prior to ordering fixtures.

H. Where auxiliary systems such as fire alarm, security, data, sound, etc., interface with existing equipment that is replaced or modified (mechanical, electrical or plumbing), disconnect and reconnect these systems.

END OF SECTION

SECTION 26 00 10 ELECTRICAL SYSTEMS CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

B. The General Electrical Requirements as specified in Sections 26, apply to the work specified in this Section.

PART 2 - MATERIALS AND METHODS

2.1 CLOSEOUT REQUIREMENTS

A. AS-BUILT DRAWINGS: Obtain a set of project drawings and keep these at jobsite during construction. During the course of construction, mark on these prints any changes which are made, noting particularly locations for those items which will need to be located for servicing. At completion of job, mark each sheet "Record Drawings", date and deliver to Engineer.

B. CLOSEOUT MANUALS: At completion of job, furnish three copies of spare parts lists, operating instructions, product cutsheets, test results, manufacturer's studies/settings/reports and as-builts for all equipment furnished under this Division. These lists and instructions shall be published by the manufacturer of the equipment. Bind in 3-ring binders with project name. Provide a CD with a digital copy of complete closeout manual with each binder.

01 DOCUMENTATION:

a. Low Voltage Circuit Protective Devices
   (i) Complete device and equipment documentation.

b. Theatrical Lighting and Rigging
   (i) Complete device and equipment documentation.
   (ii) User manuals.
   (iii) As-built drawings indicating device layout, wiring, and sequence of operations.
   (iv) Warranty information.

c. Division 27:
   (i) Refer to Division 27 sections.

02 TRAINING SESSIONS:

a. Provide digital copy of each recorded training session with digital turnover documents.

03 TESTING:

a. 260000 – Building insulation testing report
b. 260000 – Building ground testing report
c. 260000 – Building infrared scanning report

04 SPARE PARTS:

a. Deliver all spare parts and loose items to the Owner at the end of the project. Provide a spare parts list and signed transmittal listing all items with closeout documentation.

05 WARRANTY:

a. Provide manufacturer's warranty information, including any extended warranties included in the project.
b. Provide warranty letter from each contractor and sub-contractor.
c. Provide copy of extended service contracts, if any, included in the project.

2.2 GUARANTEES, WARRANTIES, AND SERVICE CONTRACTS

A. GENERAL FOR ELECTRICAL SYSTEMS: All materials, apparatus and equipment furnished and installed under this Section of these Specifications shall be new and free from any defects when accepted by the Owner and shall be guaranteed in writing for a period of one year from the date of acceptance by the Owner unless noted to have extended warranties.

B. THEATRICAL LIGHTING

01 The dimming manufacturer shall provide a comprehensive two (2) year warranty on the entire lighting system from date of acceptance.

C. DIVISION 27:

01 Refer to Division 27 sections for additional information.

2.3 SPARE PARTS

A. GENERAL: Upon completion of the installation, deliver to the Owner all tools and spare parts that are furnished by the Equipment Manufacturer for use with the equipment furnished under this Contract. Include a spare parts list and signed transmittal with closeout documents.

B. Reference individual specification sections for additional information.

C. THEATRICAL LIGHTING CONTROLS EQUIPMENT:

01 Provide one (1) Spare CEM3

02 Provide three (3) Spare D50, 50 Amp Modules

03 Provide twelve (12) Spare D20, 20 Amp Modules

D. DIVISION 27:

01 Refer to Division 27 sections for additional information.

2.4 TRAINING

A. All training sessions for specific systems equipment (Theatrical Lighting Controls Equipment, etc.) shall be recorded and the recordings be included in the closeout materials.

B. Schedule the instruction in coordination with the Owner's Representative after submission and approval of formal training plans and closeout documentation.

C. GENERAL: Base electrical systems 1 hour.

01 Provide training/demonstration. Material covered shall include:

a. Maintenance of equipment.
b. Locations of equipment.

D. THEATRICAL LIGHTING

01 4 Hours for on-site staff

02 During the warranty period, the manufacturer shall provide a toll-free 24-hour-per-day number for telephone technical support and service request.

E. DIVISION 27

01 Refer to Division 27 sections for additional information.

2.5 SCHEDULED WARRANTY ITEMS

A. After 10 months but no more than 11 months from Owner acceptance the contractor shall perform:

01 A warranty walk with the Owner, Owner's Representative, and Engineer and correct any identified items.

B. Perform an Infrared scan of the electrical systems as indicated in 260000 General Electrical Requirements, generate a report to be reviewed by the Engineer, and correct any identified items.

END OF SECTION

SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

B. The General Electrical Requirements as specified in Sections 26, apply to the work specified in this Section.

C. Equipment shall meet or follow applicable requirements in other sections of the specifications and on the drawings.

D. Equipment shall meet applicable requirements include in the NEC, UL, NEMA and ANSI Standards and be so labeled.

E. Provide Shop Drawings per Section 26 00 00.

1.2 RELATED WORK

A. Section 26 0526 – Grounding and Bonding for Electrical Systems

B. Section 26 0961 – Theatrical Lighting Controls Equipment

C. Section 27 0000 – Communications General Requirements

D. Section 27 1000 – Structured Cabling General Requirements

E. Section 27 1500 – Communications Horizontal Cabling

1.3 GENERAL INSTALLATION REQUIREMENTS

A. All electrical work dealing with electrical circuits or power requirements of 110 volts or higher shall be performed by a licensed journeyman electrician supervised by the designated master electrician of record.

01 A licensed electrical contractor and its designated master electrician of record is responsible for supervision of all licensees performing work on behalf of the contractor to assure compliance with applicable statutes and rules and in particular, standards of conduct set out in the Texas state Electrician Administrative Rules.

02 It may be necessary for the designated master electrician of record to be present on-site as required the Authority Having Jurisdiction, Owner, Architect, Engineer, or construction issues that may arise and shall be done at no additional cost to the Owner.

B. All cables not installed in conduit shall be plenum rated.

C. All conductors and cable shall be properly labeled at both ends and at any intermediate splice.

D. All low voltage cables shall be installed in continuous length without splice.

E. All miscellaneous plenum rated cables shall be supported from and near structure with nylon straps or D-rings. Refer to individual specification sections for additional requirements. Do not weave through joists for support. All exposed cabling, and cabling

above inaccessible ceilings shall be installed in raceway.

F. Install conduit sleeves with protective grommets for all wall penetrations for plenum rated cables.

G. Seal all sleeve and conduit penetrations of walls with grout or hardening caulk, suitable for wall material, to mechanically attach sleeves to the wall. Provide fire rated sealant at fire rated walls.

H. In areas of remodeling, remove all conduit and wire that is not to be reused. Resupport existing conduit and wire to remain.

I. Provide grounding bushings for all connections at concentric and eccentric knockouts, and where reducing washers are used.

J. All junction boxes and other devices above ceiling that may require maintenance shall be located within 18” of the ceiling.

K. All junction and pull boxes shall be marked noting electrical circuits and relay circuits of wiring within the box. Circuit labels shall be written on the cover in black permanent marker and shall be readable from the floor level without removing the cover.

L. Where concrete flooring or paving must be cut to install MEP systems, contractor shall take measures to prevent damaging existing underground services. Contractor shall utilize ground penetrating radar and electrical circuit tracing equipment in the area to be excavated to determine the existence of underground services. When saw cutting, limit the depth of the cut to less than the thickness of the concrete. Breakout the concrete manually with special care in areas of possible underground services.

PART 2 - MATERIALS AND METHODS

2.1 RACEWAY SYSTEMS

A. REQUIRED: Complete raceway systems for all wiring. This includes, but is not limited to feeders, branch circuit wiring, low voltage lighting controls, temperature controls wiring, data cabling, video cabling, sound systems wiring, security systems wiring and fire alarm system wiring. Generally auxiliary system and controls wiring is plenum rated so conduit system would consist of junction boxes and conduit in walls, above inaccessible ceilings and sleeves through walls. Control and interlock wiring shall be provided under the Mechanical Section. Refer to technology drawings for conduit sizes and locations for technology and security systems.

B. SLEEVES

01 Provide sleeves for all wiring passing through walls, floors not on grade and roof slabs.

02 Sleeves shall be sized with maximum 40% conduit fill.

03 Sleeves through floors shall be increased one trade size with a minimum size of 2” to provide spare capacity for the future.

04 Floor slab sleeves shall extend minimum 3" above floor level. Fully grout and seal the penetration around the sleeve to prevent water from entering the space below. Grouting shall form a 1” curb above floor level around the sleeve.

05 Sleeve interiors through floors and through fire walls shall be fire caulked or otherwise protected to maintain the fire rating of the wall.

B. LOW VOLTAGE CONDUIT:

01 Conduit, j-boxes, and pull boxes shall be provided by the Division 26 contractor for installation of low voltage devices and cabling. Refer to other sections and the drawings for specialty box requirements.

02 Where conduits for low voltage cabling are installed above grade they shall utilize standard radius bends and 90 degree factory elbow to exit the wall.

a. Minimum bend radius shall match a standard radius factory elbow:

Above Grade Low Voltage Conduit Minimum Bend Radius			
Conduit Size	Bend Radius	Conduit Size	Bend Radius
3/4"	4.5”	2”	9.5”
1”	5.75”	2.5”	10.5”
1.25”	7.25”	3”	13”
1.5”	8.25”	4”	16”

b. Final section of the elbow shall be no higher than 18” above the ceiling and be flat/horizontal.

c. Provide a single piece, protective, nylon bushing on the end of all low voltage conduits. Split bushings shall only be acceptable where there are existing cables to be protected or with prior written approval.

03 Where conduits for low voltage cabling are installed below grade they shall utilize a large radius sweeps.

a. Minimum bend radius shall be 24”.

C. RACEWAY CAPACITY: It shall be the Contractor's responsibility to determine the correct sizes of all types of raceway, to be installed, as instructed in the NEC and all applicable Codes. Runs of underground conduit longer than 80 feet shall be one size larger than NEC requirement, 4" maximum.

D. INSTALLATION:

01 LOCATION: Conceal all raceway systems in ceilings, walls and floors, except feeders serving equipment in mechanical and electrical equipment rooms, and in such other areas as indicated where conduit may be exposed. Keep conduits at least 8" away from any heat producing items.

a. All junction and pull boxes above accessible ceilings shall be mounted so that the access panel is no higher than 18” above the ceiling.

02 ROUTING: Conduit shall be installed parallel to building coordinates. Install all horizontal conduit at structure unless mounted to a wall.

03 EXPOSED RACEWAY: Run parallel to walls, ceiling or structural members, in a manner to present a neat appearance. Before installation, explain to the Inspector the proposed method of routing and obtain his approval. Hold all horizontal conduit at ceiling or structure, unless mounted on wall. Exposed conduit visible in public and finished spaces shall be painted to match.

04 SUPPORT: Provide adequate and sturdy support for all parts of raceway system.

a. Conduit concealed in walls or slabs may be supported with wire hangers, provided they are of heavy gage and spaced to give adequate strength.

b. Exposed conduit must be supported with materials specifically made for this purpose; do not use wire hangers.

c. Do not attach any parts of raceway system to air conditioning ducts or ceiling systems.

d. Wiring above ceiling without conduit shall be supported from structure or wall with J hooks, cable rings, or other manufactured devices designed for this service.

05 CONTINUITY: Make all joints and connections in a manner which will ensure mechanical strength and electrical continuity. Use double locknuts and insulated bushings for rigid conduit, and insulated type connectors for EMT conduit 1" and larger for connections to boxes. Use insulated grounding bushings wherever connection is subject to vibration or moisture, such as near mechanical equipment, when internal ground wire is installed, and when concentric or eccentric knockouts are encountered, as well as where reducing washers are used.

06 PULL BOX LOCATIONS: As required by the National Electrical Code and utility provider requirements.

07 EXPANSION FITTINGS: Install O. Z. or equal expansion fitting in each run of conduit which crosses a building expansion joint, and in all runs longer than 200 feet.

08 CORROSION PROTECTION: For all non-coated metal raceway in contact with concrete or mortar, tape with 3M corrosion protective tape, or equal. Tape shall extend for approximately 6" before entering and after exiting concrete. Conduit through slabs at grade shall be PVC coated rigid galvanized steel.

09 PULL WIRE: Install nylon pull cord in all low voltage raceway systems and empty electrical power raceway systems.

10 OPENINGS: Keep all raceway openings closed in a manner to prevent entry of moisture and foreign materials until conductors are installed.

11 FIRE PROOFING: All power and low voltage raceway components passing through or installed within U. L. fire rated walls, ceiling or floor structures shall be fireproofed in the manner prescribed by the U. L. Fire Resistive Index and local building codes. All penetrations shall be fireproofed with 3M Fire Barrier CP25WB caulk, moldable putty or FS-195 wrap/strip installed per the manufacturer's recommendations.

12 SEALING: All conduit, junction box, outlet box and other penetrations of the building envelop shall be sealed with non-hardening caulking or other non-hardening material as required by the International Energy Conservation Code.

E. MANUFACTURERS: All components of raceway systems must bear U. L. label.

2.2 CONDUIT

A. CONDUIT TYPES

01 RIGID GALVANIZED STEEL – Threaded fittings

02 EMT – Steel conduit

a. Provide steel compression fittings.

b. Provide insulated throat watertight fittings where conduit is exposed to dampness inside building.

03 FLEXIBLE METAL CONDUIT – Greenfield, galvanized steel conduit for field installation of conductors (maximum 24")

B. TYPE OF CONDUIT FOR VARIOUS LOCATIONS:

01 INSIDE OF BUILDING: IN CEILING CAVITIES, IN EXPOSED FLOOR OR ROOF STRUCTURE AREAS, OR IN DRY WALL TYPE CONSTRUCTION: Galvanized steel EMT or rigid galvanized steel.

02 FLEXIBLE METAL CONDUIT CONNECTIONS: Use only for connection to motors and transformers from rigid conduit system. Maximum length shall be two feet.

03 CONDUIT SLEEVES THROUGH WALLS AND FIREWALLS: EMT extending a minimum of 3” beyond wall with protective bushing at each end. Size to handle cabling with a maximum of 40% fill.

C. MINIMUM CONDUIT SIZE: 3/4"

D. FITTINGS:

01 RIGID CONDUIT: All rigid galvanized steel conduit shall have threaded fittings with insulated bushings.

02 EMT CONDUIT: Provide insulated bushings for all EMT conduit 1" or larger or housing #6 or larger wires.

03 GROUNDING: Provide fitting with grounding lug where conduit attaches to a painted box (disconnect switch, starter, transformer case, etc.), conduit attaches to a box through a knockout which has an associated larger knockout or a reducing washer is used, or conduit contains a feeder from switchgear to switchgear or between switchgear and transformer.

04 TELEPHONE, DATA AND LOW VOLTAGE CONDUIT: Provide protective bushing on the end of telephone, data, sound system or other low voltage conduit stubbed into the ceiling cavity.

a. Bridgeport 90° Insulated Bushings

b. Bridgeport Mighty-Rite Split Bushings

c. Raco Specification Grade Insulated Bushings

d. Raco Universal Split Insulating Bushings

e. Or approved equal.

E. LOW VOLTAGE CONDUCTORS: Low voltage conductors except data cabling and theatrical control cabling may be run in accessible ceilings without conduit. Provide conduit sleeve with protective end fittings through all walls and floors where raceway system is not installed. All exposed conductors shall be in conduit. All splices shall be in supported junction boxes. Low voltage conductors installed without conduit shall be independently supported on ring hangers, and plenum rated. Low voltage conductors for audio and data wiring shall be stranded unless otherwise recommended by the manufacturer.

01 All conduit bends and 90’s for technology conduits shall be long radius sweeps.

02 Provide protective end fittings on all low voltage conduits.

2.3 PULL BOXES

A. REQUIRED: Pull boxes, junction boxes, wiring troughs and cabinets wherever required for proper installation of various electrical systems.

B. ABOVE GRADE CONSTRUCTION: Made of code gage steel with sides formed and welded, screw covers unless shown to have hinged doors. Hinged doors to be same as

furnished on panel boards, with same locking device. Knockouts shall be factory made or formed in field with a cutting tool which will provide a clean, symmetrically cut hole. Do not gang boxes or use extension rings to increase capacity. Boxes outside shall be steel NEMA 3 Type. Pull boxes near cooling towers shall be PVC coated aluminum or stainless steel.

2.4 OUTLET BOXES

A. REQUIRED: For all switches, light fixtures, receptacles and the various other outlets shown.

B. CONSTRUCTION: Galvanized steel, one-piece construction, in all cases suitable for intended use. Provide "gang" boxes where devices are shown grouped. Use hot dipped galvanized cast iron for floors or exterior locations. Boxes outside shall be steel NEMA 3 Type.

C. TYPES FOR VARIOUS LOCATION:

01 CEILINGS: 4" square, 2-1/8" deep.

a. All devices installed in lay-in ceilings shall have bracket to support device from ceiling tees.

b. Caddy Heavy Duty T-Grid Box Hanger or equal.

02 SURFACE MOUNTED: Boxes surface mounted on walls or floor shall be Bell, cast aluminum box with appropriate plate and threaded hubs.

2.5 CONDUCTORS

A. REQUIRED: A complete system of conductors in all raceway systems except where shown otherwise. No conductors are to be installed in telephone conduit. Emergency or exit circuitry shall be installed in a separate raceway system.

B. BUILDING WIRE: 600 Volt, stranded, soft drawn annealed copper, 98% conductivity, continuous from outlet to outlet. Minimum wire size #12 except remote control wire may be #14. All wires shall be color coded with same color connected to same ungrounded phase throughout the installation.

01 All wire shall be type THHN, THW-2, THWN-2 (wet rated for 90° C), or XHHW-2.

C. MANUFACTURERS: Collier, General Cable, General Electric, Simplex, Triangle and Southwire Co.

D. CONNECTORS: Make all splice connections with permanent, pressure-type connections. #18-#8 AWG connections shall be made with Ideal Buchannan Splice Cap Crimp Connectors, or equal. Install Snap-On, Insulating, Splice Cap on all connectors. Splices for #6-#4 AWG connections shall be made with Burndy Heat Shrink Insulated, Butt Splice connectors or equal. Submit proposed method of splicing larger conductors for Owner/Engineer approval.

E. TEST: After installation of all conductors, and before final acceptance, make such tests as are required to determine proper functioning of all circuits. Furnish all necessary instruments required to make such tests and correct any deficiencies found.

2.6 CONNECTIONS TO MOTORS, EQUIPMENT AND DEVICES

A. POWER WIRING: Make wiring connections to all electrical equipment being installed as a part of this Contract. In addition, make final connections to and provide matching

cords/plugs for Owner furnished equipment. In particular provide and install all cords, plugs, whips, hardwiring, etc. for Owner provided control equipment and similar equipment. Confirm connections and equipment requirements prior to rough-in.

B. CONNECTIONS TO EQUIPMENT: Make connection to each motor and other equipment subject to vibration with not less than 18" or more than 24" of flexible conduit. All horizontal runs of conduit (not strapped to walls) must be kept above 7 feet high, with a vertical drop to equipment. Conduit blocking walk and service space is not acceptable and will require relocation. Conduit on and adjacent to equipment must be located to allow free access to all removable panels for equipment service. Wire adjacent to heat producing equipment, such as boilers and electric heaters, must be of a type approved for this use.

2.7 CIRCUITRY

A. The intent of the drawings is to indicate schematically the circuitry required.

B. Do not install more than four current carrying conductors in a conduit, except a total of ten #12 or #10 conductors, including grounding conductors, may be installed in 3/4" or larger conduit.

C. Segregate data processing circuits and stage dimming circuits from other types of circuits.

D. Do not install 240/208/120 volt conductors in the same conduit with low voltage conductors or conductors of other voltage systems.

E. The work performed in grouping conductors in a single raceway shall comply with all applicable articles in the latest edition of the NEC and Local Codes which shall include, but shall not be limited to, ampacity de-rating of conductors and maximum capacities of raceways.

2.8 POWER CONDUCTOR COLOR CODING

A. 208Y/120 VOLT SYSTEMS: Conductors shall have insulation of the proper color as listed below:

Phase A	- Black
Phase B	- Red
Phase C	- Blue
Neutral	- White
Ground	- Green
Isolated Ground	- Green w/ yellow stripe

B. If the existing facility has a consistent but different color coding, match existing.

C. Contractor may use colored tape marking for size 8 and larger phase and neutral conductors, and size 4 and larger ground conductors.

D. Switch legs are to be color coded the same as the un-switched phase, i.e., all wiring from lighting control panels and contactors shall retain the phase color.

2.9 GROUNDING

A. Reference section 26 05 26 Grounding and Bonding for Electrical Systems.

2.10 SIGNS AND NAMEPLATES

A. Provide all signs/labels as required by local codes and authority having jurisdiction.

B. Provide an engraved nameplate for each panel, switchboard, transformer, disconnect switch, fused switch, and starter stating the name as listed on the drawings (or load serviced), equipment voltage and where its power is derived. Provide short circuit label on all new switchboards and panelboards.

C. Refer to individual equipment specifications for additional labels required.

END OF SECTION

SECTION 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

B. The General Electrical Requirements as specified in Sections 26, apply to the work specified in this Section.

C. Equipment shall meet or follow applicable requirements in other sections of the specifications and on the drawings.

D. Equipment shall meet applicable requirements include in the NEC, UL, NEMA and ANSI Standards and be so labeled.

E. Provide Shop Drawings per Section 26 00 00.

1.2 RELATED WORK

A. Section 26 0500 – Common Work Results for Electrical

1.3 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

1.4 REFERENCE STANDARDS

A. ANSI/TIA-607-B-2011 - Commercial Building Grounding and Bonding Requirements for Telecommunications

B. IEEE C2-2007 - National Electrical Safely Code

C. IEEE 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.

D. NECA 1 – Standard for Good Workmanship in Electrical Construction; 2015.

E. NETA ATS – Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

F. NFPA 70 – National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. NFPA 70E - Standard for Electrical Safely in the Workplace

H. UL 467 – Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.5 GENERAL COORDINATION REQUIREMENTS

A. Drawings and Specifications are intended to be complimentary. Any work described in either of them, will be work required under this contract. Where there is a conflict between the Drawings and Specifications it shall be clarified by RFI. Barring clarification prior to bidding the most expensive option shall be included and clarification shall be made during construction.

B. Reference the Drawings, Floor Plans, Details, and Specifications for additional information. Specific grounding required as noted in the drawings, specifications, and design standards in excess of NEC 250 grounding requirements shall be done. More stringent requirements shall take precedence over NEC 250 listed minimum requirements.

C. Should any work required by the Drawings and Specifications be contrary to the requirements of the applicable codes or standards contractor shall request clarification by RFI before proceeding with the work.

PART 2 - MATERIALS AND METHODS

2.1 GROUNDING AND BONDING REQUIREMENTS

A. GENERAL: Permanently and securely ground the theatrical lighting controls equipment, conduit system, panel boards and all other components of the electrical system installed or connected by the Sub-contractor. Follow NEC and building code requirements.

B. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

C. Do not use products for applications other than as permitted by NFPA 70 and product listing.

D. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

E. Provide a ground conductor in all raceways and cables. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

F. Grounding System Resistance:

01 Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

G. Bonding and Equipment Grounding:

01 Circuit Grounds:

a. Provide a green ground wire sized per the NEC for every circuit.

b. Provide an additional green w/ yellow strip isolated ground wire for all computer and isolated ground circuits. Refer to drawings.

02 Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.

a. Make firm ground to raceway system.

b. Equipment connected with flexible conduit or SealTite shall have the specified ground wire installed inside conduit. Do not install on the outside of the conduit.

c. Where enclosure is painted, remove paint where ground lugs are installed.

03 Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.

04 Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.

05 Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

06 Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.

07 Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

01 Provide products listed, classified, and labeled as suitable for the purpose intended.

02 Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 00:

01 Use insulated copper conductors unless otherwise indicated.

C. Connectors for Grounding and Bonding:

01 Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.

02 Manufacturers - Mechanical and Compression Connectors:

a. Advanced Lightning Technology (ALT): www.altfab.com

b. Burndy LLC: www.burndy.com

c. Harger Lightning & Grounding: www.harger.com

d. Thomas & Betts Corporation: www.tnb.com

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Make grounding and bonding connections using specified connectors.

01 Remove appropriate amount of conductor insulation for making connections

without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.

02 Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.

03 Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.

04 Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.

05 Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

D. Identify grounding and bonding system components in accordance with Section 26 0500.

3.2 TESTING

A. Notify the Owner’s representatives three days prior to scheduled testing dates so they may be present at the time of testing.

END OF SECTION

SECTION 26 0961 THEATRICAL LIGHTING CONTROLS EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General, Supplementary and Special Conditions, apply to the work specified in this Section.

B. The General Electrical Requirements as specified in Sections 26, apply to the work specified in this Section.

C. Equipment shall meet or follow applicable requirements in other sections of the specifications and on the drawings.

D. Equipment shall meet applicable requirements include in the NEC, UL, NEMA and ANSI Standards and be so labeled.

E. Provide Shop Drawings per Section 26 0000.

1.2 RELATED WORK

A. Section 26 0000 – General Electrical Requirements

B. Section 26 0010 – Electrical Systems Closeout Requirements

C. Section 26 0500 – Common Work Results for Electrical

D. Section 26 0526 – Grounding and Bonding for Electrical Systems

E. Section 27 0000 – Communications General Requirements

F. Section 27 0553 – Identification for Communications Systems

G. Section 27 1000 – Structured Cabling General Requirements

H. Section 27 1500 – Communications Horizontal Cabling

I. Section 27 1600 – Communications Connecting Cords, Devices, & Adapters

1.3 SCHEDULE

A. The facilities are an active theater and there is limited summer availability to perform the required work. The contractor shall include in their bid any and all after-hours work, supplemental crews, double-shifts, expedited equipment fees, or other methods of guaranteeing the work shall be completed within the designated window.

B. Access to the Facilities:

01	On-site work:	Starting Monday, June 27, 2022.
02	Substantial Completion:	By Close of Business, Friday, August 5, 2022
03	Final Completion:	Friday, August 26, 2022

04 Any work or access to the facilities outside the June 27 – August 5 window shall require formal approval by the Owner, including remedial work to reach final completion.

1.4 INTENT

A. The intent of this specification is to define parameters for furnishing and installing a complete and working replacement dimming system for the 7th Floor Brown Theater Theatrical Lighting Dimmers. Performance deviations will not be accepted. One company shall be responsible for installing or coordinating the install of all aspects of the control equipment including the work required by other trades and subcontractors. Work under this section shall include the furnishing of all labor, materials, tools, transportation services, supervision, etc., necessary to complete installation of new theatrical equipment.

B. All work must be done in compliance with the National Electric Code and applicable local codes.

C. Contractor is responsible for providing a complete and working system. All items needed for a complete and working system meeting the design intent of the plans and specifications are to be included, even if not specifically listed.

1.5 APPROVED EQUIPMENT

A. Dimming and control equipment:

01 Approved manufacturer:

a. Electronic Theatre Controls (ETC) shall be the only acceptable manufacturer.

1.6 SUBSTITUTIONS

A. Specific items of equipment are listed by trade names. The Owner has determined that these are the particular items desired by the Owner for quality and operation. It is neither the purpose nor intent of these documents to eliminate competitive bids. In order to allow proper and fair comparison of pricing, each contractor is required to submit his base bid price on the specified equipment.

01 No substitutions shall be allowed for the theatrical controls and dimming equipment. ETC shall be the only acceptable manufacturer.

1.7 QUALITY ASSURANCE

A. To ensure a uniform installation and single responsibility, one manufacturer shall provide all dimming, control system components, and fixtures. Mixing of equipment brands will not be accepted.

B. Manufacturer shall provide local on-site service for the system for a period of two years from date of acceptance by the Owner. This person or firm must be regularly engaged in the service of dimmers. A salesperson or sales agent without dedicated service personnel does not meet this requirement.

C. This specification details specific operational and functional needs of the owner. Deviations from the performance requirements will not be accepted from any supplier. Contractor assumes the responsibility of removing any non-complying material discovered during the warranty period and replacing it with specification compliant equipment.

1.8 CONTRACTOR QUALIFICATIONS

A. The Contractor shall be an authorized dealer of the specified manufacturer and have been actively engaged in the sales, installation, repair and maintenance of theatrical lighting equipment in the Houston Market for no less than five full (5) years.

B. Contractor shall be a Dealer and an Authorized Service Center with dedicated service personal currently certified in the maintenance, service, and repair of dimming manufacturer's equipment.

C. Contractor shall have an office or dedicated service personnel located within 50 miles of the job site

D. Authorized ETC Installers

01 Barbizon Light of the Rockies, Houston Office

02 Mainstage Theatrical Lighting, Houston Office

03 Texas Scenic Company, Houston Office

04 Techland Houston

E. Additional contractors/installers wishing to be approved may submit for approval no later than ten days before bid date. Approval will be granted by addenda only

F. Contractors submitting for approval shall include a list of ten projects of similar size and scope. List shall include job name and location, date of project completion, contract size, general job description and scope, and references for each project.

1.9 SERVICES

A. The Theatrical Contractor shall provide a complete turnkey installation, including all electrical permits and electrical work required. All electrical work shall be performed by an electrician holding a current license in the state of Texas.

B. Services of a qualified technician, representing the manufacturer, and employed full time in the service of control systems, shall be provided. This technician shall terminate all low voltage control wiring, inspect the installation, and energize the system. He shall also instruct the owner in proper operation and maintenance of the system.

C. During the warranty period, the manufacturer shall provide a toll-free 24-hour-per-day number for telephone technical support and service request.

1.10 WARRANTY

A. Reference 260010 Closeout Requirements.

1.11 TRAINING

A. Reference 260010 Closeout Requirements.

1.12 SPARES:

A. Reference 260010 Closeout Requirements.

PART 2 - PRODUCTS

2.1 POWER CONTROL SYSTEMS

A. General

01 The installation rack shall be the Sensor3 120V as manufactured by Electronic Theatre Controls, Inc., or equal. The Power Control System enclosure shall consist of up to 48 module spaces.

B. Electrical

01 Sensor3 racks shall operate at 120V, three phase, four wire + ground, 47-53 or to 57-63 Hz at 800 amps max. Other voltage and phase options are available upon request. Sensor racks shall automatically compensate for frequency variations during operation. Provisions shall be made for optional amp trap devices for fault current protection. Standard SCCR fault current protection shall be 100,000A.

02 All load and neutral terminals shall accept up to #4 AWG (25mm2) wire. Systems providing smaller terminals do not allow contractor wire sizing flexibility and shall be deemed unacceptable.

03 Load terminals shall be located at the front of the wiring cavity. Front access racks having terminals located at the back of the rack or on the side near the back of the rack such that adjacent load cabling may block terminal access shall not be acceptable.

C. Electronics

01 Power control electronics (CEM3) shall be contained in a single module that can be plug-in capable without use of tools. Power control and dimming systems that require tools for removal of control electronics shall not be acceptable.

02 All data and power input for CEM3 control electronics shall be located on a separately removable/pluggable termination connector on the backplane such that backplane can be replaced without removal and discrete secondary conductor terminations. Systems that require discrete termination of DMX, Ethernet, power input, and dimmer control output directly on terminals on the control module or pluggable backplane shall not be permitted.

03 The power controller shall directly support the following network protocols:

a. Net3 protocol suite including ANSI E1.31 Streaming ACN (sACN)
b. ANSI E1.17 Architecture for Control Networks (ACN)

Systems that do not support the above listed industry standard ACN protocols for Ethernet setup, control and feedback integrated directly between the power system and control system shall not be deemed acceptable.

04 The power controller shall directly support 2 ports of control input using ANSI E1.11 USITT DMX512-A

05 Control signal connections within the enclosure shall be sent between control module and dimmer/power modules using flat ribbon cables. Systems using cat5 cable and RJ45 connections or discrete hand wired conductors for internal connections between control module and dimmer/power modules shall not be acceptable.

06 System shall provide an optional low voltage connection to maintain power of control electronics through brown out, instantaneous, and sustained power outages. Systems that do not provide optional low voltage backup power connection to the power controller shall not be acceptable.

07 Control electronics shall be housed in a formed steel body with cast-aluminum face panel.

D. Physical

01 The Sensor3 rack shall be a free-standing, dead-front switchboard, substantially framed and enclosed with 16 gauge, formed steel panels. All rack components shall be properly treated, primed and finished. Exterior surfaces shall be finished in fine-texture, scratch-resistant, epoxy paint. Removable top and bottom panels shall facilitate conduit termination on the 48 module rack. Knockouts shall serve the same purpose on 12 and 24 module racks.

02 Sensor3 racks shall be available in three sizes, with the following dimensions.

a.	SR3-12 (12 module)	25.8”H x 14.8”W x 13.3”D
b.	SR3-24 (24 module)	45.8”H x 14.8”W x 16.8”D
c.	SR3-48 (48 module)	83.1”H x 14.8”W x 22.8”D

03 Racks shall be designed for front access to allow back-to-back or side-by-side installation.

04 Racks shall be designed to allow easy insertion and removal of all modules without the use of tools. Supports shall be provided for precise alignment of modules into power and signal connector blocks. With modules removed, racks shall provide clear front access to all load, neutral and control terminations. Racks that require removable panels to access load, neutral or control terminations shall not be acceptable.

05 An optional bus bar kit shall be available from the factory to allow adjacent racks to be powered by a single line feed. No soft buss rack-to-rack wiring shall be required. Racks that require discrete cabling to connect adjacent racks shall not be acceptable.

06 Module spaces shall be mechanically keyed to accept only the 20A or below, 50A, or 100A module specified for that space. Racks that allow modules of varying wattages to plug into the same space shall not be acceptable. The rack shall be configurable to accept mixed dimmer types and sizes throughout the rack.

07 Each rack shall provide a lockable full-height door containing an integral electrostatic air filter that shall be removable for easy cleaning. A single low-noise fan shall be located at the top of each rack. Design of the rack and modules shall draw all cool air intake air through the integral electrostatic air filter at the front of the rack, discretely through each module housing and directly out the top of the rack such that exhausted hot air from adjacent modules does not heat the module(s) above, below, or to the side of each other. System designs that draw the same heated air through multiple modules shall not be acceptable.

08 The fan shall maintain the temperature of all components at proper operating levels with dimmers under full load, provided the ambient temperature of the dimmer room does not exceed 40°C/104°F. Racks that do not employ both locking doors and electrostatic air filters shall not be acceptable.

09 The fan shall turn on whenever any circuit in the system is activated. In the event of an over-temperature condition, only the affected dimmer module(s) shall shut down and a message shall appear on the control module LCD. The fan shall remain on during thermal shutdown of individual dimmer modules. Systems that do not include over-temperature sensing and preventative thermal shutdown shall not be acceptable.

10 A fan sensor shall be provided. In the event of momentary fan failure, error message will be displayed and sent remotely over Ethernet to optional logging

systems. Systems that do not provide optional system event logging shall not be deemed acceptable.

11 If the ambient room temperature drops below 0°C/32°F or rises above 40°C/104°F, a warning shall appear on the dimmer rack LCD. If the temperature rises above 46°C/115°F, the rack shall shut down until the condition is corrected.

12 A 3 x .5-inch LED status indicator (beacon) shall be mounted in the rack door. The beacon shall be visible throughout a wide viewing angle. In normal operating conditions, this LED is illuminated. If the rack's control module senses an error condition, the beacon shall flash until the error is corrected. An optional indicator shall be available for remote locations. Racks have no external means of visually showing that an error is present shall not be acceptable.

2.2 POWER CONTROL ELECTRONICS

A. General

01 The Power Control electronics shall be contained in one plug-in Power Controller. Each power controller shall plug into a dimming cabinet with no need for tools or discrete wire connections. A simple user interface shall be provided for group configuration, testing and diagnostics. The Power Control System shall be Sensor 3 as manufactured by Electronic Theatre Controls, Inc.

02 Power control shall be UL/cUL Listed and CE Marked. Power and dimming control that require tools for removal of control electronics shall not be acceptable.

B. Physical (Control Interface)

01 The control electronics shall be contained in one plug-in module, housed in a formed steel body with cast-aluminum face panel, and self-retaining ejection handles to ease removal from the rack.

02 A backlit eight-line by 20-character graphical LCD shall be provided for system configuration, live control and status display.

03 The following features shall be available in power control to reduce setup and tech times:

a. Full number pad shall be provided for quick access to dimmers. Power Control that does not provide 0-9 number pad and logic keys for AND, THRU, and AT for fast access, selection, and control of circuit/dimmer numbers shall not be acceptable.
b. Power control shall provide NEXT and LAST buttons to progress through individual circuits/dimmers during pre-show lighting checks for lamp burnouts.
c. Shortcut buttons for Setup, About and live control shall be provided. These functions shall be separated in such a way that user intending to check status or settings does not accidentally render their system unusable. These buttons shall also serve to reduce maximum time to access any feature or setting on a single dimmer, range of dimmers or an entire rack.

Power control that does not include the above features shall not be acceptable.

04 The front panel shall have five status LED indicators: power, network activity, DMX A, DMX B, and panic state.

C. Control Signals and Physical Communications Media ports

01 The power control shall be provided with an Ethernet control signal input. This input shall be fully configurable with a range of patching and priority programming capabilities. The Ethernet signal shall supply seamless integration between the dimmer racks and both the entertainment and architectural lighting control systems. The Ethernet signal shall also enable remote configuration, playback, file storage and monitoring features on a personal computer on the network. Dimming systems that require Ethernet to DMX translation devices for control of critical show lighting introduce a potential failure point and shall not be acceptable.

02 All data and power input for control electronics shall be located on a separately removable/pluggable termination connector on the backplane such that backplane can be replaced without removal and discrete secondary conductor terminations. Systems that do not support tool-less replacement or that require removal of wires connected directly to the control electronics shall not be acceptable.

03 Dimming systems that require discrete termination of DMX, Ethernet, power input, and dimmer control output directly on terminals on the power control or pluggable backplane shall not be acceptable.

04 DMX connections shall be available with option for pluggable screw or punch-down type terminal. Systems that do not allow this option do not support both DMX over CAT5 and mule-strand conductors shall not be acceptable.

05 Ethernet connection shall be available via standard Cat5 RJ45 connection. System requiring punch down direct to rack or controller cannot be Cat5 system certified and shall not be acceptable.

06 Power Control shall provide a convenience Ethernet uplink to the lighting network at the front face of the control module. Network capable 3rd party control and monitoring devices shall be provided full access to control, editing and real time feedback.

07 The following options shall be available to backup all controller setup UL924 Panic configuration, and recorded presets:

a. Automatic backup in non-volatile backplane memory
b. Automatic backup in non-volatile Controller memory
c. 3rd party FTP server
d. USB storage device pluggable on the controller face panel
e. Data shall also be transferable to and from library storage on a personal computer on a per-rack basis

08 Power Controller shall support Class 2 EchoConnect control communications

a. The control network shall utilize unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit). Use of Category 5, or better, control network wiring shall also be supported.
b. The control network wiring may be bus, loop, home run, star or any combination of these

09 The control network wiring may be bus, loop, home run, star or any combination of these

10 The power controller shall directly support the following network protocols:

a. Net3 protocol suite including ANSI E1.31 Streaming ACN (sACN)
b. ANSI E1.17 Architecture for Control Networks (ACN)
c. Systems that do not support the above listed industry standard ACN protocols for Ethernet setup, control, and feedback integrated directly between the power system and control system shall not be deemed

acceptable.

11 The power control shall directly support 2 optically isolated ports of ANSI E1.11 USITT DMX512-A for control input. Minimum 2,500V of optical isolation shall be provided between the DMX512 inputs and the electronics. Systems that do not have optical isolation on a prewired factory plug-in device shall not be acceptable.

D. Power Control Features

01 The power control shall automatically compensate for frequency variations during operation.

02 Dimmer outputs shall exhibit no oscillating or hunting for levels. Dimmers with the same choke type set to the same level shall output within ±1V of each other, regardless of phase or input voltage.

03 Power control shall maintain proper dimming performance for all line feed frequencies from 47-53Hz and 57-63Hz without flicker or misfire. Shifts in frequencies up to 3 Hz shall not result in flicker or loss of dimming timing. Systems that cannot perform to these frequency tolerances and shifts shall not be acceptable.

04 Dimmer output levels shall be regulated for incoming line voltages. The regulation shall adjust for both RMS voltage changes and deformations in the incoming AC waveform. The power control shall monitor and adjust each dimmer's output to maintain a constant power to the load. Regulation shall maintain the desired output voltage ±1V for the entire operating range (91-139V and 181-259 VAC) with the exception that the maximum output will be no greater than the line voltage minus dimmer insulation loss. The regulation shall compensate for dips and anomalies in the AC waveform on a dimmer-by-dimmer basis. There shall be no interaction between dimmers in the system or any other equipment. The output shall be nominally regulated to 115V/230V appropriate for the market, but shall be field adjustable on a dimmer-by-dimmer basis to allow for varying cable length. Systems that cannot maintain perform to the above stated voltage regulation shall not be acceptable.

05 Power control shall support a rack filled with different types and sizes of dimmer modules. The properties of each dimmer shall be configurable, including dimmer name, output curve, dimmer firing mode, and scale voltage values.

a. The output curve selections shall include IES Modified Square, Square, Linear, Modified Linear and a Sensor v2.0 output curve. The power control shall also have the capability of storing up to three custom curves as well as an adjustable preheat level, assignable on a per-dimmer basis.

b. Circuit control modes shall include: Always on, Dimmable, Dimmer Doubled, Switched (unregulated on/off with adjustable on-at level), and Fluorescent with adjustable threshold and Off.

c. Power Control shall support forward or reverse phase firing of appropriate modules.

d. Dimmers set as Dimmer Doubled shall allow a single dimmer to split the output of a single dimmer into two separate signals with different levels on one dimmer circuit by splitting the AC power into positive and negative half cycles with no resultant DC line current.

(i) Both outputs shall be transmitted along the same set of wires from the dimmer modules to the Dimmer Doubler to provide individual levels for Source Four fixtures using a 77v lamp.

(ii) Control consoles equipped with an electronic patch and DMX protocol shall enable each Dimmer Doubled output of a dimmer

to be patched to an individual control channel, increasing the number of available dimming control circuits.

(iii) Systems without the capability for Dimmer Doubling shall not be acceptable

Power Control that does not support all above listed adjustments to dimmers on a per circuit basis shall not be acceptable.

06 User programmable parameters shall support onsite setup via the local interface in the rack. These parameters shall include, but not be limited to, defining module type, scale voltage for each dimmer, firing mode, curve, dimmer numbering, and DMX512/sACN network port assignments. Systems requiring factory programming shall not be acceptable.

07 Hardware settings for rack type, available module types, availability of AF features, and operating voltage shall be configurable at the factory or in the field, and shall not require secondary setup after system commissioning even in the event of power controller replacement.

08 Controller shall support two methods of automatic configuration during controller replacement in a rack.

a. Use backplane configuration: The backplane shall retain full setup and preset data in. In this recovery mode, when a new power control is inserted, the controller shall automatically come on-line fully functional without any manual intervention.
b. Use controller configuration: Override backplane configuration such that replacement modules automatically use the configuration resident in nonvolatile memory of the power control.

09 Controller shall be capable of changing rack setup for multiple shows for an entire system with a single update command from a remote PC.

10 In the event of data loss each rack shall maintain the last level for a user-programmable time (zero to five minutes or indefinitely) or may be programmed to fade out or to play a specific preset. Systems that do not offer this feature shall not be acceptable.

11 The power control shall contain diagnostic routines to allow the user to test and troubleshoot the system. The power control shall also contain a Test/Bypass switch to turn all dimmers on to full for testing. This switch shall bypass all electronics and shall force the fan on. Systems that do not include local control, “all on” control bypass, and diagnostic routines shall not be deemed acceptable.

12 The power control shall be able to record up to 64 presets in a rack. Presets shall be user programmable by recording a snapshot of current dimmer levels (as set by the all control sources), by entering dimmer levels on the power control directly or by a combination of both methods. The system shall have the ability to program and activate group-wide presets from the power control, remote station, console, networked computer or handheld device. Presets shall be activated in the default fade time of 2 seconds but shall be have a user-programmable fade time between 0 and 60 minutes.

13 A system-wide panic (emergency UL924) activation circuit shall be provided. Any dimmer in any rack may be assigned to the panic circuit. The panic closure shall be maintained. Upon activation the system shall:

a. Force all circuits selected to be included in panic to a master level between 80-100%
b. Optionally force all non-panic dimmers to zero
c. Provide configurable fade time to and from “emergency” state
d. Provide configurable delay to and from “emergency” state

14 DMX A and B as well as the Ethernet DMX (EDMX) data may be patched using a rack start address - assigned sequentially from a starting control channel or patched individually on a per-dimmer basis. Priority may be set per universe for the DMX inputs, and set per universe by the control source for Ethernet input. Each dimmer may have up to six network control inputs with either a highest takes precedence or priority patch. Each dimmer may also then be assigned to one of 16 spaces for additional specific preset control. Each preset shall have a separate priority for maximum flexibility of prioritization. Systems that do not support prioritization of multiple Ethernet sources beyond HTP shall not be acceptable. Systems that do not support the above listed flexibility in control source prioritization shall not be acceptable.

15 Power control shall provide the ability to set a single circuit, all circuits or a range of circuits to a level at the control interface in the rack. Systems that cannot locally control dimmers through local control override shall not be acceptable.

16 The power control shall be capable of monitoring and displaying incoming line voltage for all three phases on the LCD. With installed current sensors, the same display shall show amperage on each phase.

17 The power control shall support security protected access. The user shall to able to program passwords that restrict access, preventing unauthorized use of higher-level functions by unauthorized personnel. Systems that do not provide security protected access to features that can render the system unusable shall not be acceptable.

18 Advanced Features (AF) option shall add an additional sensor in the individual dimmer modules. This option shall allow monitoring of current and output voltage on a dimmer-by-dimmer basis and provide information on lamp burnouts, dimmer status and input voltages.

19 Power control shall allow the user to record the loads of all AF dimmers in the system. The power control shall, during operation, test each AF dimmer, determine its load and compare it to the recorded load. Any change from recorded loads of configured tolerance shall display an error on the power control and any monitoring device on the network. If a dimmer is driven on with no load, an optional message shall be available to notify the console operator and electrician that there is no load.

20 Power control shall support a mobile application which allows users to access limited circuit configuration controls via Wi-Fi connection. The mobile application shall be the ThruPower System Reporter (TPSR) app by ETC.

a. Mobile application shall select the circuit to configure either by scanning a QR code label applied to circuit distribution or by manual entry of circuit information
b. Mobile application shall allow users to set the Control Mode of the selected circuit in order to shift a ThruPower module between Dimmable and Switched mode according to the requirement of a connected load
c. Mobile application shall allow users to activate the circuit test function for the selected module
d. Power controls which do not support mobile circuit configuration from the plugin location of a supported load shall not be acceptable

E. Connect to Console Communications

01 The Ethernet network shall provide an integral link to connect all racks in the system for remote rack-to-console and rack-to-network device communication of the below listed features of real-time control, configuration, and status/feedback using industry standard ANSI E1.17 ACN lighting protocol. Power control and dimming systems that do not use this protocol shall not be permitted. Reported

system errors shall be given ACN access to be cleared remotely at the console with exception of system critical errors that require a person to go directly to the rack to manually clear the exiting fault.

02 Control

a. E1.31 sACN control
b. Activate/Deactivate rack presets
c. Set/Unset circuit levels as overrides to Preset, DMX, and sACN control
d. Lock relays into On/Off/Remote switching states without patching to a console.
e. Lock dimmers into non-dim mode with On/Off/Remote switching states without patching to a console.

03 Remote console configuration shall include, but not be limited to, real time reporting and editing the following:

a. Circuit's control mode
   (i) Dimmable
   (ii) Switched
   (iii) Latch-lock
   (iv) Always on
   (v) Off
   (vi) Fluorescent
b. Curves
c. Control threshold
d. Min Scale Voltage
e. Max Scale Voltage
f. Preheat
g. Scale load

04 Standard rack feedback - Rack status messages shall include, but not be limited to, real time reporting of the following:

a. Identification
   (i) Rack type
   (ii) Rack name
   (iii) Rack number
b. State of UL924 panic closure
c. DMX port A or B has an error or has failed
d. Network has an error or has failed
e. Phase A, B or C is below 90 volts
f. Phase A, B or C is above 139 volts
g. Phase A, B or C did not start because it was outside of allowable voltage ranges at power up
h. Phase A, B or C voltage headroom warning
i. Frequency is not 50 or 60 Hz
j. Ambient temperature is below 0 C/32 F
k. Ambient temperature is above 40 C/104 F
l. System Critical-Ambient temperature exceeds 46 C/115 F
m. Configuration memory error
n. Run hours remaining before rack filter needs to be cleaned
o. IP address of the controller in the rack
p. Software version of the controller in the rack

05 Standard branch circuit feedback - Ethernet console access of the following circuit status shall be provided:

a. Module type
b. Circuit location
c. Patched circuit addresses

d. Output level
e. Control Source
f. Overtemp

06 Advanced branch circuit feedback - Dimmer Specific status messages shall include, but not be limited to, the following:

a. Load has dropped below recorded value
b. Load has raised above recorded value
c. DC detected on dimmer output
d. One SCR has failed on/off
e. Dimmer has failed off or circuit breaker has tripped
f. Dimmer has been removed
g. Dimmer load has failed
h. Dimmer has shut down due to over temperature

2.3 DIMMER MODULES

A. General

01 The dimmer modules shall be the Sensor dimmer modules as manufactured by Electronic Theatre Controls, Inc., or equal. Sensor dimmer modules shall be designed for dependable, economical service in theatrical and video applications.

B. Electrical

01 Each dimmer module shall contain two single-pole circuit breakers, a solid-state switching module, associated toroidal filters, and power and control connectors.

02 Modules shall not have any protruding pins subject to physical damage when the module is not installed.

03 Modules shall be keyed so that dimmer modules of different capacity shall not be interchangeable.

04 Circuit breakers shall be fully magnetic so the trip current is not affected by ambient temperature. Circuit breakers shall be rated for tungsten loads having an inrush rating of no less than 20 times normal current. Circuit breakers shall be rated for 100 percent switching duty applications. Dimmers that do not operate continuously at 100% load shall not be acceptable.

C. SCR Assembly

01 Each dimmer module shall use a solid state module (SSM) consisting of two silicon-controlled rectifiers (SCRs) in an inverse parallel configuration, and all required gating circuitry on the high voltage side of an integral, opto-coupled control voltage isolator. Rectifiers, copper leads and a ceramic substrate shall be reflow soldered to an integral heat sink for maximum heat dissipation. The SSM shall also contain a control LED, a thermistor for temperature sensing, and silver-plated control and load contacts. The entire SSM shall be sealed in a plastic housing requiring only a screwdriver to replace. Dimmers employing triac power devices, pulse transformers, or other isolating devices not providing at least 2,500V RMS isolation, shall not be acceptable. Dimmer modules requiring disassembly, heat sink grease or additional tools for repair shall not be acceptable.

02 All electronic components (current/voltage sensors and indicators) shall be contained in a single, field-replaceable housing. Modules requiring discrete wiring of electronic components shall not be acceptable.

03 SCR power switching devices shall have the following minimum ratings:

Module Size:	15 A	20A
Single cycle: Peak surge current	625A	625A
Half cycle: 12T	1,620	1,620
Transient over voltage	600V	600V
Die size (in)	.257	.257

D. Filtering

01 Dimmer modules shall include toroidal filters to reduce the rate of current rise time resulting from switching the SCRs. The filter shall limit objectionable harmonics, reduce lamp filament sing and limit radio frequency interference on line and load conductors. Modules shall offer 350 or 500 uS. filter rise times. Rise time shall be measured at the worst case slew rate (about 50 percent) from 10 to 90 percent of the output wave form with the dimmer operating at full load.

02 All dimmers shall maintain their published rise time and/or fall time regardless of duty cycle or rack temperatures. Dimmers that derate due to increased dimmer temperature caused by full load operation or high phase angles shall not be acceptable.

E. Performance

01 Power efficiency for standard dimmers shall be at least 97 percent at full load with a no-load loss of 3V RMS. The dimmer shall accept hot patching of a cold incandescent load up to the full rated capacity of the dimmer.

F. Physical

01 Dimmer modules shall be fully plug-in and factory wired. Dimmer modules shall consist of a heavy duty, die-cast aluminum chassis with integral face panel. No tools shall be required for module removal and insertion. All parts shall be properly treated, primed and finished in fine-texture, scratch resistant, gray epoxy powder coat. With the exception of the circuit breaker, the module shall contain no moving parts. Each module shall be labeled with the manufacturer's name, catalog number and rating. Modules constructed of molded plastic for structural support are not equivalent and are not acceptable. Dimmer modules shall be UL Recognized.

2.4 THRUPOWER MODULES

A. General

01 The modules shall be Sensor3 ThruPower modules as manufactured by Electronic Theatre Controls, Inc., or equal. Sensor modules shall be designed for complete flexibility of choice for dimmed, non-dim, or hot power on each 20A branch circuit. A single ThruPower module shall provide:

a. Two dimmed outputs with choice of 500 or 350 us rise times, controlled by DMX, or
b. Two air gap relay switched outputs controlled by DMX, or
c. Two manual bypass constant power circuits controlled manually

02 The module may be configured to operate as two dimmers, two relays, or any combination of relay and dimmer from the CEM3 Power Control Module or from an ETC control console connected to a CEM3 system. Any single circuit may be set to bypass the dimmer using a switch on the front of the module.

03 Modules shall be capable of remote setting changes from the control console. Modules that are adjusted only with a direct physical change on the module are not acceptable.

B. Status Reporting

01 The power control system shall report circuit specific errors via the rack control electronics and/or via a lighting control console.

02 Modules shall provide the following status reporting functions:

a. Load dropped below recorded value
b. Load increased over recorded value
c. DC on dimmer output
d. SCR failed on/off
e. Circuit breaker tripped
f. Dimmer error
g. ThruPower module removed
h. Load absent

C. Electrical

01 Each ThruPower module shall contain

a. two circuit breakers
b. SCR solid-state dimming
c. toroid filters
d. power and control connectors
e. 120VAC remotely controllable mechanically latching air gap relay
f. Low voltage dc manual bypass override switch
g. 1 fuse per branch circuit for sufficient short circuit rating

02 Modules that use Triac dimming shall not be acceptable. Modules which utilize an SCR or triac solid state switch as a dimmer bypass may void warranty of products they are powering and shall not be an acceptable means of bypass.

03 Modules shall not have any protruding pins subject to physical damage when the module is not installed.

04 Modules shall be keyed so that modules of different capacity shall not be interchangeable.

05 Circuit breakers shall be fully magnetic so the trip current is not affected by ambient temperature. Circuit breakers shall be rated for tungsten loads having an inrush rating of no less than 20 times normal current. Circuit breakers shall be rated for 100 percent switching duty applications. Dimmers that do not operate continuously at 100% load shall not be acceptable.

D. SCR Assembly

01 Each module shall use a solid state module (SSM) consisting of two silicon-controlled rectifiers (SCRs) in an inverse parallel configuration, and all required gating circuitry on the high voltage side of an integral, opto-coupled control voltage isolator. Rectifiers, copper leads and a ceramic substrate shall be reflow soldered to an integral heat sink for maximum heat dissipation. The SSM shall also contain a control LED, a thermistor for temperature sensing, and silver-plated control and load contacts. The SSM shall include an integral output LED, output voltage sensors and current sensors for feedback to the control module. The SSM shall provide a parallel output connection which completely bypasses all SCR dimming including toroid filters and shall intercept the output prior to connection of the load sensing circuit such that the advanced features are still active during bypass. The entire SSM shall be sealed in a plastic housing requiring only a screwdriver to replace. Dimmers employing triac power devices,

pulse transformers, or other isolating devices not providing at least 2,500V RMS isolation, shall not be acceptable. Modules requiring disassembly, heat sink grease or additional tools for repair shall not be acceptable.

02 All electronic components (current/voltage sensors and indicators) shall be contained in a single, field-replaceable housing. Modules requiring discrete wiring of electronic components shall not be acceptable.

03 SCR power switching devices shall have the following minimum ratings:

Module Size:	20A	50A	100A
Single cycle: Peak surge current	625A	1,200A	2,300A
Half cycle: 12T	1,620	4,150	22,000
Transient over voltage	600V	600V	600V
Die size (in)	.257	.394	.570

E. Filtering

01 Modules shall include toroid filters to reduce the rate of current rise time resulting from switching the SCRs. The filter shall limit objectionable harmonics, reduce lamp filament sing and limit radio frequency interference on line and load conductors. Modules shall offer 350 or 500uS filter rise times. Rise time shall be measured at the worst case slew rate (approximately 50 percent) from 10 to 90 percent of the output wave form with the dimmer operating at full load.

02 All dimmers shall maintain their published rise time and/or fall time regardless of duty cycle or rack temperatures. Dimmers that de-rate due to increased dimmer temperature caused by full load operation or high phase angles shall not be acceptable.

F. Performance

01 Power efficiency for standard dimmers shall be at least 97 percent at full load with a no-load loss of 3V RMS. The dimmer shall accept hot patching of a cold incandescent load up to the full rated capacity of the dimmer.

G. Physical

01 Modules shall be fully plug-in and factory wired. Modules shall consist of a heavy duty, die-cast aluminum chassis with integral face panel. No tools shall be required for module removal and insertion. All parts shall be properly treated, primed and finished in fine-texture, scratch resistant, gray epoxy powder coat. With the exception of the circuit breaker, the module shall contain no moving parts. Each module shall be labeled with the manufacturer's name, catalog number and rating. Modules constructed of molded plastic for structural support are not equivalent and are not acceptable. Modules shall be UL Recognized.

2.5 ADVANCED DIMMER MODULES

A. General

01 The dimmer modules shall be the Sensor Advanced Features dimmer modules as manufactured by Electronic Theatre Controls, Inc., or equal. Sensor dimmer modules shall be designed for dependable, economical service in theatrical and video applications.

B. Electrical

01 Each dimmer module shall contain one or two single-pole circuit breakers, a solid-state switching module, associated toroidal filters, and power and control connectors.

02 Modules shall not have any protruding pins subject to physical damage when the module is not installed.

03 Modules shall be keyed so that dimmer modules of different capacity shall not be interchangeable.

04 Circuit breakers shall be fully magnetic so the trip current is not affected by ambient temperature. Circuit breakers shall be rated for tungsten loads having an inrush rating of no less than 20 times normal current. Circuit breakers shall be rated for 100 percent switching duty applications. Dimmers that do not operate continuously at 100% load shall not be acceptable.

C. SCR Assembly

01 Each dimmer module shall use a solid state module (SSM) consisting of two silicon-controlled rectifiers (SCRs) in an inverse parallel configuration, and all required gating circuitry on the high voltage side of an integral, opto-coupled control voltage isolator. Rectifiers, copper leads and a ceramic substrate shall be reflow soldered to an integral heat sink for maximum heat dissipation. The SSM shall also contain a control LED, a thermistor for temperature sensing, and silver-plated control and load contacts. The SSM shall include an integral output LED, output voltage sensors and current sensors for feedback to the control module. The entire SSM shall be sealed in a plastic housing requiring only a screwdriver to replace. Dimmers employing triac power devices, pulse transformers, or other isolating devices not providing at least 2,500V RMS isolation, shall not be acceptable. Dimmer modules requiring disassembly, heat sink grease or additional tools for repair shall not be acceptable.

02 All electronic components (current/voltage sensors and indicators) shall be contained in a single, field-replaceable housing. Modules requiring discrete wiring of electronic components shall not be acceptable.

03 SCR power switching devices shall have the following minimum ratings:

Module Size:	15/20A	50A	100A
Single cycle: Peak surge current	625A	1,200A	2,300A
Half cycle: 12T	1,620	4,150	22,000
Transient over voltage	600V	600V	600V
Die size (in)	.257	.394	.570

D. Filtering

01 Dimmer modules shall include toroidal filters to reduce the rate of current rise time resulting from switching the SCRs. The filter shall limit objectionable harmonics, reduce lamp filament sing and limit radio frequency interference on line and load conductors. Modules shall offer 500 or 800 uS filter rise times. Rise time shall be measured at the worst case slew rate (about 50 percent) from 10 to 90 percent of the output wave form with the dimmer operating at full load.

02 All dimmers shall maintain their published rise time and/or fall time regardless of duty cycle or rack temperatures. Dimmers that derate due to increased dimmer

temperature caused by full load operation or high phase angles shall not be acceptable.

E. Performance

01 Power efficiency for standard dimmers shall be at least 97 percent at full load with a no-load loss of 3V RMS. The dimmer shall accept hot patching of a cold incandescent load up to the full rated capacity of the dimmer.

F. Status Reporting

01 The dimming system shall report dimmer specific errors via the rack control electronics module and/or via a lighting control console.

02 Dimmer modules shall provide the following status reporting functions.

03 Load dropped below recorded value

04 Load increased over recorded value

05 DC on dimmer output

06 SCR failed on/off

07 Circuit breaker tripped

08 Dimmer error

09 Dimmer module removed

10 Dimmer load absent

G. Physical

01 Dimmer modules shall be fully plug-in and factory wired. Dimmer modules shall consist of a heavy duty, die-cast aluminum chassis with integral face panel. No tools shall be required for module removal and insertion. All parts shall be properly treated, primed and finished in fine-texture, scratch resistant, gray epoxy powder coat. With the exception of the circuit breaker, the module shall contain no moving parts. Each module shall be labeled with the manufacturer's name, catalog number and rating. Modules constructed of molded plastic for structural support are not equivalent and are not acceptable. Dimmer modules shall be UL Recognized.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all new equipment and rewire existing equipment, all in compliance with national and local electrical codes. Auxiliary equipment required making this installation comply with codes, even if not listed in the specification, is the responsibility of the bidder and must be included in the bid price.

B. All wiring shall be done in a craftsman-like manner. When conductors must be spliced to extend length, it shall be done with a terminal strip or suitable type compression fittings.

C. Equipment shall be kept clear of all metal shavings, wire scraps, and miscellaneous trash. Any abandoned holes in the floor shall be patched.

D. Any existing conduit emanating from the floor shall be dressed in such a manner as to eliminate any trip hazard. Conduits shall be re-routed or terminated into wire-ways to insure a neat installation.

E. All equipment shall be installed in compliance with applicable local and national codes. It shall also be installed in accordance with the manufacturer's recommendations. Prior to initial energizing, a factory certified technician shall inspect the system and any errors shall be corrected.

SECTION 27 0000 COMMUNICATIONS GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 PROJECT SUMMARY

A. Scope: Successful bidder shall provide, install, configure, and provide warranty service for technology systems described herein and as required by and as a Subcontractor to the Division 26 Theatrical Lighting Controls Equipment Prime Contractor.

B. The Division 27 scope of work shall include a complete network solution including all copper patch panels, horizontal cabling, patch cords, connectors, etc. for a theatrical lighting controls equipment.

1 Network Hardware, Switches, and Uninterruptible Power Supplies are existing and provided by the Owner.

2 The Division 27 contractor shall provide all connections from the network cabling system installed as part of this project to the Owner's LAN.

C. These documents provide standards of quality, performance guidelines, and project requirements. The proposed system shall be an engineered solution designed to meet these requirements.

1.2 RELATED DOCUMENTS

A. Documents: Provisions of General Conditions, Supplementary Conditions, and the sections included under Procurement & Contract Requirements are included as part of this section as though bound herein.

1.3 RELATED WORK

A. Section 27 0553 – Identification for Communications Systems

B. Section 27 1000 – Structured Cabling General Requirements

C. Section 27 1500 – Communications Horizontal Cabling

D. Section 27 1600 – Communications Connecting Cords, Devices, & Adapters

1.4 DEFINITIONS

A. Approved or Approval: Where approval is called for, only persons with the authorized authority may grant approval. Owner reserves all rights to govern over and grant approval and will appoint authority of agents acting on their behalf.

B. As Required: Contractor shall provide the quantity of said item that is necessary. Owner and Consultant reserve the right to make the final determination of necessary quantities to provide for a complete system.

C. Basis of Design: The documentation of the concepts, calculations, decisions, and product selections used to meet the Owner's project requirements. These Consultant produced documents are not shop drawings. Product selections depict minimum functionality and overall quality and are open to substitution requests.

D. Consultant: Stanton Engineering Group, LLC.

E. Contractor: The qualified party responsible to provide all items and perform services as described within these documents. The Contractor referred to within a specific specification section shall be the successful qualified party contracted to perform and complete that work.

F. Documents: The complete package of Bid and Contract Requirements, General Technology Requirements, related Division 27 sections, drawings, schedules, and addenda that make up this Request for Bid.

G. End-User: Individual(s) who will ultimately operate the completed system.

H. ETR: Existing to Remain. Item is to remain in current location and maintain current functionality.

I. Furnish: To supply and deliver to project site, ready for installation.

J. Install: To place in a position of service or use.

K. NIC: Not in Contract. Item will be the responsibility of others.

L. Notice to Proceed: Formal communication from Owner to Contractor stating the date the Contractor can begin work subject to the conditions of the contract. The performance time of the contract starts from the Notice to Proceed date.

M. OFCI: Owner Furnished Contractor Installed. Item will be provided by Owner and shall be installed by Contractor.

N. OFE: Owner Furnished Equipment. Item will be provided and integrated by Owner.

O. OFOI: Owner Furnished Owner Installed. Item will be provided and installed by Owner.

P. Owner: The party named in the Procurement and Contract Requirements as the advertising party.

Q. Provide: To furnish and install, complete and ready for intended use.

R. Turnkey: Of or involving the provision of a complete product or service that is ready for immediate use.

S. Work: The provision of products and/or services to meet the requirements specified in these documents.

1.5 REFERENCE STANDARDS AND CODES

A. Standards and other procedures referenced by this bid package are as follows:

1 ADA–Americans with Disabilities Act of 2010 www.ada.gov/2010ADAstandards_index.htm

2 AIA – American Institute of Architects www.aia.org

3 ANSI – American National Standards Institute www.ansi.org

4 ASHE – American Society of Healthcare Engineering www.ashe.org

5 ASTM – American Society of Testing and Materials www.astm.org

6 BICSI – Building Industry Consulting Service International, Inc. (RCDD Standards) www.bicsi.org

7 CFR Code of Federal Regulations www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR (Available from the Government Printing Office) (Material is usually first published in the Federal Register)

8 U.S. Copyright Law, December 2011 www.copyright.gov/title17

9 ECIA – Electronic Components Industry Association ESC – EIA Standards Council www.eciaonline.org

10 IACS – International Annealed Copper Standard www.ndt-ed.org/GeneralResources/IACS/IACS.htm

11 IEC – International Electrotechnical Commission www.iec.ch

12 IEEE – Institute of Electrical and Electronics Engineers standards.ieee.org

13 ISO – International Organization for Standardization www.iso.org

14 ITU-T – International Telecommunication Union – Telecommunication www.itu.int

15 NEC – National Electrical Code (NFPA 70)

a. maintained by NFPA – National Fire Protection Association www.nfpa.org

16 NECA – National Electrical Contractors Association www.necanet.org

17 NEMA – National Electrical Manufactures' Association www.nema.org

18 OSHA – Occupational Safety and Health Administration (U.S. Department of Labor, OSHA) www.osha.gov

19 TIA – Telecommunications Industry Association www.tiaonline.org/standards

20 UL – Underwriters' Laboratories www.ul.com

B. Standards: Referenced standards and/or procedures shall be binding on the Contractor and work shall be judged against such standards and procedures unless otherwise stated in writing.

C. Local/State Codes: Contractor shall comply with all local and state code requirements as determined by the authority having jurisdiction (AHJ).

D. Owner Standards: Contractor shall obtain and abide by all published Owner standards as they pertain to the work described herein.

E. Contractor shall use the latest versions of all standards and codes unless otherwise directed by the authority having jurisdiction (AHJ) or expressly noted herein.

1.6 QUALIFICATIONS

A. Refer to related sections for specific requirements.

1.7 PERMITS AND INSPECTIONS

A. Responsibility: Obtain permits and inspections required for the work. Contractor is responsible for all permit and inspection costs.

B. Performance: Perform tests required herein, or as may be reasonably required to demonstrate conformance with the specifications or with the requirements of any legal authority having jurisdiction.

C. Review: Obtain approvals from authorities responsible for enforcement of applicable codes and regulations to establish that the work is in compliance with all requirements of reference codes indicated herein and required by the appropriate jurisdiction. Make corrections, changes or additions as required and deliver certificates of acceptance, operation, and/or compliance with the Operation and Maintenance Manuals described herein.

1.8 DRAWINGS AND BASIS OF DESIGN

A. General: Work, equipment, or material delineated on any drawing in this package is expected to be provided by Contractor unless noted otherwise.

B. Interpretation: Work shall be installed in accordance with the basis of design diagrammatically expressed on the drawings and described in the written specifications and

equipment schedule(s). Contractor shall not make limiting interpretation that provides for incomplete work or a non- functioning system.

1.9 PRODUCT SUBSTITUTION PROCEDURES

A. Requests for Substitutions: Should the Contractor request a change in the material that is to be supplied, from that which was specified in the contract, the Contractor shall provide the Owner and the Consultant with a written request for said change.

B. Substitutions for Non-specified Products: Where no product specification is provided, Contractor may use manufacturer's specification for the identified product as a guide for suggesting appropriate substitutions.

C. Requirements: The Request for Substitution shall include:

1 Reason for substitution.

2 Material data sheets for both the proposed item(s) and the item(s) to be replaced.

3 Any cost impact to the Owner.

D. Changes: Proposed changes to Contract Documents shall be clearly identified in the pre-construction submittals.

E. Approval: The Owner may approve or deny any Requests for Substitution. The Owner reserves the right to govern over and proclaim whether proposed products are equal to the specifications. The Contractor shall not procure any substitute materials until the Owner has approved and signed the Request for Substitution and passed copies to the Contractor and the Consultant. Any procurement or work performed prior to this approval is at the Contractor's own risk.

F. Deviation: Products provided or installed that deviate from the products specified in make, model, color, or other significant characteristic (i.e., non-approved substitutions) shall be removed and replaced with specified products at no additional expense to Owner.

1.10 SOFTWARE

A. Versions: Consultant used the following software versions for this project:

1 Autodesk AutoCAD MEP 2021

1.11 SUBMITTAL CONDITIONS

A. The Contractor shall not consider the Consultant or Owner's review of submittals to be exhaustive or complete in every detail. Approval of shop drawings or submittals including substitutions indicates only the acceptance of the Contractor's apparent intent to comply with general design or method of construction and quality as specified. The finished product shall meet functional requirements, operations, arrangements, and quantities and comply with the contract documents unless specifically approved otherwise.

B. The Contractor shall be held responsible for delivery of systems as specified. Any errors or omissions in the submittals shall not relieve Contractor of responsibility to deliver complete systems as specified.

1.12 PRE-CONSTRUCTION PROCEDURES

A. Pre-Construction Submittal Meeting: Contractor shall schedule web conference (WebEx or similar) with Consultant to review basis of design and submittal expectations.

B. Prior to Work: Pre-construction submittals shall be provided to Consultant with appropriate promptness as to cause no delay to the work.

C. Project Timeline: Project timeline will not be altered due to lateness of submittals. Contractor is bound to deliver a timely, complete, and finished project as stipulated in their contract and specified herein.

D. Format and Distribution: Contractor shall provide one (1) electronic copy in PDF format to Consultant of all pre-construction submittals.

E. Provision: Contractor shall submit pre-construction submittals including any corrections or additions to Consultant prior to the procurement of equipment or commencement of work.

F. Review: Pre-construction submittals shall be received and formally approved by Consultant prior to the procurement of material or the commencement of work. Any procurement or work performed prior to this approval is at Contractor's own risk.

G. Failure to Provide: The failure of Contractor to provide pre-construction submittals as required herein may result in the withholding of payment for work and/or the cancellation of the contract.

1.13 PRE-CONSTRUCTION SUBMITTALS

A. Pre-construction submittals are intended to document the details of installation. Exact copies of original drawings and specifications are not acceptable as pre-construction submittal drawings. Consultant schematic diagrams describe the basis of design as defined herein.

B. Contractor shall provide to Consultant the following pre-construction submittals for approval in addition to specific requirements identified in subsequent sections.

1 Qualifications: Shall include documentation of all required qualifications.

2 Shop Drawings:

a. Title: Each drawing shall have a descriptive title and all subparts of each drawing shall have unique identifiers.

b. Floor Plans: Shall include device locations and installation notes.

c. System Drawings: Shall include functional diagrams for each system detailing system flow including all equipment, routing, inputs/outputs, wiring signal type, cable identification detail, connectors, adapters, intra/inter-rack power distribution, installation notes and any other information required to convey the complete turnkey system design.

d. Equipment Rack and Cabinet Elevations: Shall include placement of all mounted equipment.

e. Structurally Mounted Elements: Shall include both plan view of placement as well as a detail of structural mounting techniques to be used.

3 Product Data:

a. Equipment Schedules: Shall include manufacturers, part numbers, quantities and unit pricing.

b. Product Cut Sheets: Shall identify (highlight, arrow, etc.) actual part numbers to be utilized including but not limited to equipment, mounting hardware, cabling, connectors, software and power distribution equipment.

4 Manufacturer's Recommendations:

a. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, copies of these recommendations shall be provided prior to installation. Installation of the items will not be allowed to proceed until the recommendations are received and approved.

1.14 CONSTRUCTION PROGRESS PROCEDURES

A. Meeting Attendance: Contractor is required to attend job progress meetings in accordance with requirements set by Owner or Consultant.

B. Additional Coordination: Contractor shall request additional job construction coordination meetings it deems to be necessary to ensure coordination of their responsibilities with other parties.

C. Progress Inspection: Consultant may perform periodic progress inspections. At Consultant's request, Contractor shall make Project Manager and/or Lead Technician available.

D. Test Plan: Ten (10) business days prior to the proposed Contractor test date, Contractor shall provide a test plan defining the tests required.

1 The test plan shall be approved by Consultant prior to any testing.

1.15 CONSTRUCTION PROGRESS SUBMITTALS

A. Completion: Contractor shall complete and submit via email all construction progress documentation in PDF format as requested by Owner and Consultant.

B. Contractor shall provide to Consultant the following construction progress submittals in addition to specific requirements identified in subsequent sections.

1 Weekly Report: Weekly written report to be submitted to Consultant through appropriate project channels in PDF format outlining progress from previous week, plans for progress in the current week, and any coordination issues that may require Consultant or Owner attention.

2 Test Plan: Shall ensure the system meets Owner operational and performance specifications and include the following:

a. Identification of the capabilities and functions to be tested.

b. Detailed instructions for the setup and execution of each test.

c. Procedures for evaluation and documentation of the results.

C. Failure to Complete: Failure to complete requested construction progress documentation may result in the withholding of payment by Owner.

1.16 CLOSEOUT PROCEDURES

A. Notification: Contractor shall provide written notification to Consultant and Owner when Contractor is satisfied that the work has reached Substantial Completion and is ready for inspection.

B. Pre-Inspection Submittals: Contractor shall submit an electronic copy of all closeout submittals to Consultant in accordance with the requirements found in these documents no less than ten (10) business days prior to the scheduled Final Inspection.

1 Test Results

2 As-built drawings (full-size sheets)

3 Operation and Maintenance Manuals

4 End User Software

C. Punch List: Work or materials found to be incomplete, of unsatisfactory quality, failing to meet the specifications in these documents, and/or unacceptable to Consultant or Owner shall be documented by Consultant and provided to Contractor to rectify at no additional cost. Contractor shall provide written notification to Consultant and Owner when all punch list items have been completed.

D. Final Inspection: At Consultant's request, Contractor shall make Project Manager and/or Lead Technician available.

E. Re-Inspection: If more than one (1) re-inspection is necessary, the costs of the additional travel, time, and expenses of Owner and Consultant may be deducted by Owner from the contract amount due to the Contractor with a minimum charge of $500 per visit.

F. Punch List Approval: Once all punch list items are complete, the Contractor shall return an initialed punch list to the Consultant and Owner for verification. Punch list shall be considered complete only after having been signed by Owner and Consultant.

G. Closeout Submittals: Upon approval of closeout submittals and prior to final acceptance, Contractor shall provide three (3) electronic copies to Owner and Consultant in format(s) noted below.

1 Record Drawings – AutoCAD 2010 editable .dwg format AND PDF.

2 Operation and Maintenance Manuals – USB Flash Drive, CD, OR DVD.

3 End User Software – USB Flash Drive, CD, OR DVD.

4 Documentation of testing and system certification.

H. Closeout Submittal Format and Distribution: Upon approval of closeout submittals and prior to final acceptance, Contractor shall provide a total of three (3) bound hard copies with labeled dividers of all record drawings (full- size sheets) and operation and maintenance manuals, two (2) copies to Owner and one (1) copy to Consultant. Title on front and spine of binder shall be "Operation and Maintenance Manual – Cloverleaf Elementary Replacement". The following additional items shall be identified on the binder cover:

1 Client Name

2 Contractor Name and Contact Information

3 Consultant Name and Contact Information

4 Date

I. All documentation prepared by the Contractor, including hard copy and electronic forms, shall become the property of the Owner.

J. Payment Authorization: Final payment will be authorized only after all closeout procedures and requirements have been followed and fulfilled by Contractor and approved in writing by Owner and Consultant, including punch list(s) and/or re-inspection(s) and delivery of closeout deliverables.

1.17 CLOSEOUT SUBMITTALS

A. Closeout submittals are intended to document the details of the final installation that substantially conforms to the construction documents and functions as intended to meet the Owner's needs.

B. Contractor shall provide to Consultant the following closeout submittals for approval in addition to specific requirements identified in subsequent sections.

1 As-built drawings: As-built drawings are prepared by the Contractor. They show, in red ink, on-site changes to the Consultant-approved pre-construction submittal documents. As-built drawings shall be submitted to Consultant for approval prior to submitting record drawings and include:

a. Changes made by Addenda, Change Orders, Requests for Information (RFIs), Architect's Supplemental Instruction (ASIs), or Requests for Proposal (RFPs) in addition to any other changes to the original documents.

b. Actual device locations, conduit routing, wiring and relationships as they were constructed.

c. Nomenclature showing as-built wire designations and colors.

d. Room numbers coinciding with Owner space planning numbering.

2 Record drawings are the final drawings prepared by the Contractor and incorporate all as-built drawing changes previously approved by Consultant. Record drawings should be electronically produced without any handwritten, red ink, or clouded changes.

3 Operation and Maintenance Manuals: Notwithstanding requirements specified elsewhere, submit one (1) copy of each of the following per binder:

a. A final Bill of Materials for each system.

b. IP and MAC Addresses for any device that resides on the network.

c. Usernames and passwords by device for all applicable products.

d. Manufacturers Instruction Manuals: Specification sheets, operation manuals and service sheets published by the manufacturers of the components, devices and equipment provided.

e. Information for testing, repair, troubleshooting, assembly, disassembly and recommended maintenance intervals.

f. Replacement parts list with current prices. Include list of recommended spare parts, tools, and instruments for testing and maintenance purpose.

g. Performance, Test and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified herein.

h. Warranties: Provide an executed copy of the Warranty Agreement and copies of all manufacturers' Warranty Registration papers as described herein.

i. Sufficient information, (detailed schematics of subsystems, assemblies and subassemblies to component level) clearly presented, shall be included to determine compliance with drawings and specifications.

j. Any other items defined herein.

4 Local Reference Diagrams: Within each equipment rack, enclosure, or cabinet, the Contractor shall place a functional diagram of the system(s) in a clear plastic sleeve secured to the equipment rack, cabinet, or enclosure.

5 Intellectual Property: Provide all required items and written release as described herein.

6 Training Program: Proposed training materials and program outline.

7 Spare Parts and Remote Controls: Contractor shall submit record of Owner sign-off of turnover of spare parts and remote controls.

1.18 PROJECT MANAGEMENT

A. Project Manager: Contractor shall appoint a Project Manager who will be the main point of contact for Owner and Consultant regarding the project.

B. Responsibility: Project Manager is responsible for the following:

1 Successfully completing the contract in a timely manner.

2 Overseeing work and performance of all employees and Subcontractors who have been hired by Contractor and ensuring compliance with specification.

3 Completing and submitting required documentation.

4 Attending project coordination meetings as required by Owner, Consultant, and

Contractor. Contractor is responsible for taking minutes of these meetings and distributing copies to all participants.

5 Coordinating with Owner, Consultant, Architect, General Contractor, and other Contractors involved in the project to ensure smooth flow of work and on-time project completion.

6 Providing a written weekly progress update to the Owner and Consultant in a PDF format emailed to the project team.

7 Reporting all unexpected conditions and problems that may result in delay or expense to Owner and Consultant immediately upon discovery.

C. Change of Project Manager: If Contractor seeks to change Project Manager during the course of the Project, such change is subject to prior written approval from Owner.

D. The Owner reserves the right to request a change of project manager at any time for any reason.

1.19 EXAMINATION OF EXISTING CONDITIONS

A. Examination: Contractor shall examine the facility and construction documents to the extent necessary to plan for efficient installation strategies prior to the delivery of materials to the site or the commencement of work. Other documents (Architectural Drawings, hardware schedules…) may be made available upon request. Failure to adequately complete the examination shall not result in change order requests.

B. Acceptance of Conditions: Commencement of work by Contractor shall indicate acceptance of existing conditions, unless a written notice of exceptions has been provided to Owner prior to commencement.

C. Observation: If Contractor observes—during preliminary examinations or subsequent work— existing violations of fire stopping, electrical wiring, grounding, or other safety- or code-related issues, Contractor shall report these to Owner in a timely manner.

D. Pre-Existing Damage: If Contractor observes damage to finished surfaces before they begin installation in any area, Contractor shall document by taking digital photos of the damaged area(s) and immediately notifying Construction Manager and Consultant via email, with attached photos.

E. Damage during Installation: Any damage caused by, or reasonably believed by the Construction Manager to be caused by the Contractor shall result in back-charges for said damages. Repairs shall match preexisting color and finish of walls, floors, and ceilings. Any Contractor damaged ceiling tiles, floor, and carpet shall be replaced to match color, size, style, and texture.

1.20 CONTRACT MODIFICATION PROCEDURES

A. Changes: Changes to the contract may be initiated by Owner, Consultant or Contractor.

B. Request for Information (RFI): If a change originates with Contractor, the Contractor shall submit an RFI for Consultant review. If it is deemed a change is necessary, the Consultant shall issue a PR to address the change.

C. Proposal Request (PR): If a change originates with Owner or Consultant, Consultant shall issue a Proposal Request to Contractor.

D. Change Proposal (CP): If a change originates with Contractor, or if Contractor receives a Proposal Request from Consultant, Contractor shall submit a Change Proposal to Consultant to review.

1 References: A Change Proposal shall reference the work to be performed, and shall include the cost change to the Project (if any) and the time change to the

scheduled completion (if any)

E. Cost/Time Changes: A Change Proposal shall reference the work to be performed, and shall include the cost change to the project (if any) and the time change to the scheduled completion (if any).

F. Additional Information: Consultant may request additional information to be supplied with the Change Proposal for consideration.

G. Acceptance: Owner reserves the right to accept or reject Change Proposals.

H. Change Order: A Change Order is a modification of the contract:

1 If a Change Order is approved, Owner will issue a Change Order that references PR and/or CP. Change Order is not valid until it has been signed by Owner.

2 Work performed or equipment supplied outside of contract without a valid Change Order is done at Contractor's own risk.

1.21 PRODUCT STORAGE AND HANDLING REQUIREMENTS

A. Storage: Storage of materials shall remain the full responsibility of Contractor until Acceptance.

B. Protection: Contractor shall take all necessary precautions to protect materials from the following:

1 Theft

2 Vandalism/Tampering

3 Dents

4 Scratches

5 Dust

6 Temperature

7 Weather

8 Cutting

9 Paint

10 Other hazardous conditions

C. Replacement: Contractor shall replace any damaged or lost material as required by Owner or Consultant.

D. Installed Materials: Installed materials remain the responsibility of the Contractor until Acceptance. Contractor shall take necessary precautions to ensure the safety and security of installed materials.

1.22 INTERFERENCE WITH THE FACILITY

A. Transportation and storage of materials at the facility, work involving the facility, and other matters affecting the habitual use by the Owner of the Owner's buildings, shall be conducted to minimize interference, and at times and in a manner acceptable to the Owner.

1.23 ON-SITE CONDUCT

A. Conduct: Any demonstration of rudeness, use of profanity, or lack of respect by Contractor Personnel to a building tenant will be cause for immediate removal from the premises, and such Personnel will not be allowed to return. Contractor and Contractor's Personnel are to

remain in project area.

B. Vandalism: Graffiti or vandalism will not be tolerated. Any Contractor/Personnel caught in the act shall be immediately removed from the premises and will not be allowed to return.

C. Hazardous Conditions: No one shall be allowed to endanger the building, its premises, and its occupants in any manner whatsoever. In the event that a situation occurs which threatens the building or its occupants in any manner, Contractor, Contractor Personnel, Subcontractor, etc. shall take steps to correct hazardous condition. In the event that Contractor's Personnel fail to correct hazardous condition, Owner reserves the right to immediately take steps to correct the situation at Contractor's expense.

1.24 SAFEGUARDS AND PROTECTION

A. Barriers: Provide and maintain suitable barriers, guards, fences and signs where necessary to accommodate the safety of others relative to and/or for the protection of this work.

B. Regulations: Comply with OSHA, Federal, State, Local, and Owner regulations and standards pursuant to this work.

C. Protection: Protect all materials and equipment to prevent the entry or adhesion of any and all foreign material. If necessary, cover equipment with temporary protective material suitable for this purpose.

D. Finishing: Check, clean and remove defects, scratches, fingerprints and smudges if necessary from all equipment and devices immediately prior to Acceptance of the Installation.

E. Damage: Replace all damaged or defective material or work at no additional cost prior to Final Acceptance.

F. Documentation: Provide written description of accidents by workers, staff, and general public of any incident occurring on the project. Report incident in writing to Owner's representative immediately and to the Project Manager for follow up.

1.25 OWNER-FURNISHED PRODUCTS

A. Delivery: Owner is responsible for delivery of Owner-furnished products to the project site, unless otherwise specified in this document.

B. Placement: Contractor is responsible for locating, inspecting, and moving Owner-furnished products to their final installation position.

C. Inspection: Contractor shall report any damage, discrepancies in quantity, type, or function to Owner and Consultant immediately upon discovery.

D. Warranty: Contractor assumes no responsibility for any material warranty for Owner-furnished products. Contractor shall be responsible for integrating, cabling, and installing Owner-furnished products under the same warranty conditions as other products furnished by Contractor.

1.26 QUALITY ASSURANCE

A. Assurance: It is the intent of these specifications to describe and provide for a complete, professional, and reliable installation.

B. Qualifications: Contractor employees who are engaged in installation shall be properly trained in the tasks they are expected to perform.

C. Acceptability: Owner shall determine the acceptability of work.

D. Regulatory Requirements: Contractor shall comply with code requirements that apply to the

work being performed.

E. Certifications: Where manufacturer certifications are required for warranty or for authorized resale, installation personnel shall have received such certification prior to the start of installation of those manufacturers' materials.

1.27 QUALITY CONTROL

A. Installation: During installation period, when connections are made to the Owner's existing infrastructure, Contractor shall use care to ensure that no negative results occur that could reduce or hamper existing systems.

1.28 OWNER'S RIGHT TO USE EQUIPMENT

A. The Owner reserves the right to use equipment, material and services provided as part of this work prior to Acceptance of the Work, without incurring additional charges and without commencement of the Warranty period.

1.29 INTELLECTUAL PROPERTY OWNERSHIP

A. All intellectual property shall remain in escrow for an unlimited period of time. All supporting documentation including but not limited to: software, firmware, programming, uncompiled source code, graphic files, diagrams, written and electronic files, including all latest versions of the documentation and software necessary to edit and adapt the system(s), shall be provided to the Owner on a USB flash drive, CD or DVD for all spaces and all systems. The integrator and/or programmer shall also maintain a current live copy incorporating all system modifications to be provided at the Owner's request and for system restoration upon a failure.

B. A written release shall be given by the Contractor and all other required parties for all programming and configuration done by the Contractor and/or Subcontractors. This release will acknowledge the Owner's ownership and right to modify the intellectual property directly, or to have the intellectual property modified by any party of the Owner's choosing.

PART 2 - PRODUCTS

2.1 BASIC EQUIPMENT AND MATERIALS REQUIREMENTS

A. Standards: Equipment and materials used to accomplish the goals of this project shall meet standards for good engineering practice as defined within this document.

B. Quality: Products specified in these documents are intended to establish a baseline or operational, functional, and performance-based standards that all proposed products shall meet or exceed by functionality and quality.

2.2 FACTORY-ASSEMBLED PRODUCTS

A. Manufacturer: Reference to specific equipment manufacturers does not imply that all products produced by that manufacturer meet the specification requirements.

B. Age of Equipment: Equipment shall be new and unused with full manufacturer's warranties. Contractor shall supplement such warranties as required by the specification. Contractor shall immediately notify Consultant of any product that will be or is expected to be discontinued by the end of the project for resolution.

C. No Modification: Where a product is available from a factory/manufacturer to meet the

needs as outlined, that product shall be used without modification to ensure the full factory warranty is maintained.

D. Like Materials: Like materials used shall be of the same manufacturer, model, and quality unless otherwise specified.

E. Software/Firmware: No software or firmware is to be used unless specifically authorized by Owner or its appointed representative.

2.3 CABLE AND CONNECTORS

A. Cable: Cable shall be selected and applied in a manner defined by signal type, consistent with best industry practices. Highest quality products shall be used with attention given to transmission characteristics, termination methods, resistive and complex impedance at operating frequencies, and insulating material characteristics. Where required by the NEC, substitutions of air handing plenum cable shall exactly match the normally applied product and shall meet the standards of UL Standard #900 and the NEC Articles 800 and 820.

B. Connectors: Highest quality products shall be used with attention given to transmission characteristics, termination methods, resistive and complex impedance at operating frequencies, and insulating material characteristics. Strain reliefs and cable clamps shall be sized for the connector and the cable.

C. Color: Cable and connector color shall be coordinated with Consultant to maintain consistency with cable and connector color schemes used by other trades.

2.4 CABLE MANAGEMENT

A. Plastic Cable Ties: Single use white nylon plastic cable ties, appropriate screw fittings, or mounting clips may be used for AC power cable management within racks and enclosures. Plastic/nylon cable ties shall not be used for signal and DC cables.

B. Velcro Cable Ties: Velcro straps shall be used for all signal and DC cables. Velcro straps shall be black, with no logo or decoration, except as authorized by Consultant.

2.5 ANCILLARY HARDWARE

A. General: Contractor shall provide ancillary and required accessory items necessary to provide a complete and fully functional system to Owner.

B. Interpretation: Exclusion of or limitation in the language used in the drawings or specifications shall not be interpreted as meaning that ancillary or accessory items of work or equipment necessary to complete or make the installed system fully functional can be omitted.

2.6 FIRE STOPPING MATERIALS

A. All penetrations of walls shall be approved by the General Contractor before any penetrations are made. Should the Contractor find it necessary to penetrate any walls extending to the slab, it will be the responsibility of that Contractor to provide satisfactory sleeving and fire caulking both inside and outside of that sleeving. If existing sleeving is to be utilized, it will be the responsibility of the Contractor to fire caulk inside the sleeving.

B. The Contractor is responsible for adhering to the following standards:

1 Conduit penetrations through fire-rated or smoke walls: Completely seal around the conduit penetration with Hilti FS 601 fire-rated sealant Tremco or 3M or equal.

2 Conduit sleeves through fire-rated or smoke wall: Completely seal around the conduit penetration with Hilti FS 601 fire-rated sealant Tremco or 3M or equal.

Completely seal inner opening of the conduit sleeve with fire wool packing and Hilti FS 611A intumescent firestop sealant.

3 Cable bundles through fire-rated or smoke walls (without sleeves): Completely seal openings with Hilti FS 611A intumescent firestop sealant, Tremco or 3M or equal.

C. A submitted response to this specification assumes that all firestopping will be provided as specified. The firestop manufacturer's specifications and instructions shall be submitted with the final documentation.

2.7 COMPATIBILITY OF RELATED EQUIPMENT

A. Existing Equipment: Equipment and systems specified in these documents shall be assumed to be compatible with the systems already installed at Owner site(s) and as identified in this document as related to this project.

B. Installed Equipment: Specified equipment and systems shall be compatible with all other equipment and systems as offered by Contractor, thus placing the responsibility on Contractor to ensure proper interaction.

2.8 LICENSES

A. Any and all licenses required for system functionality shall be provided.

2.9 SPARE PARTS

A. Suggested List: Contractor is requested to submit a list of suggested spare parts with an offered price, allowing Owner to select appropriate parts.

B. Means of Obtainment: Contractor shall state where spare parts can be obtained after the installation.

2.10 MAINTENANCE MANUALS

A. Contractor shall produce a maintenance manual showing interconnection of equipment and any special procedures necessary for proper operation and maintenance of the systems.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall provide, furnish, deliver, transport, erect, install, connect and configure all of the material and equipment described herein or depicted on any bid package document or drawing, as required for a turnkey solution.

3.2 COORDINATION

A. General: Contractor shall cooperate with other Contractors for proper provisioning, anchorage, placement, and execution of all work. Interference between the work of various Contractors shall be resolved before installation. In the event of conflict on space requirements or location of devices, refer the matter to Owner and Consultant for decision.

B. Related Work: References to the following related work do not limit or release Contractor from the responsibility of coordination with other trades or from having the necessary knowledge of other non-referenced work.

1 Work by Prime Contractor.

2 Work by Electrical Contractor, including electrical rough-ins and surface-mounted raceway.

C. Delays: Contractor shall coordinate with all other trades to avoid causing delays in the installation schedule.

D. AC Power: Contractor shall coordinate with Prime Contractor its requirements for proper AC power to service all equipment installed by Contractor.

E. Low Voltage Sleeving: Contractor shall provide openings through walls as necessary, with sleeving and fire-stopping materials installed in a professional manner to meet local and national codes.

F. Grounding and Bonding: Contractor shall coordinate with General Contractor for their requirements for proper grounding and bonding to their equipment.

G. Surface-Mounted Raceway Coordination

1 Prime and Electrical Contractors: Contractor shall coordinate with Prime Contractor and Electrical Contractor the installation of surface-mounted-raceway where not provided but made necessary by non-penetrable wall.

2 Verification: Contractor shall field verify and coordinate the proposed use of surface- mounted raceway at any location with Consultant and Owner.

3.3 BASIC EXECUTION REQUIREMENTS

A. General: Contractor is responsible for following industry standards of good practice for telecommunications and networking equipment.

B. Aesthetic Factors: With the installation of equipment and cables, consideration shall be given not only to operation efficiency but also to overall aesthetic factors. Contractor shall redo, at no cost to Owner, any work deemed by Owner to appear sloppy, hastily done, or unprofessional. Owner shall make final decision over whether work shall be redone.

C. Manufacturers' Recommendations: Manufactured items, materials, and equipment shall be applied, installed, connected, erected, used, and adjusted as recommended by the manufacturers or as indicated in their published literature unless otherwise noted herein.

D. Protection of Work Area: Work shall be properly protected during construction, including the shielding of soft or fragile materials, protecting against dust and dirt, protecting and supporting cable ends off of the floor and from other traffic, protecting floor box lids, and temporarily plugging open conduits during construction. Upon completion, installation shall be thoroughly cleaned and all tools, equipment, obstructions, or debris present as a result of work shall be removed from the premises.

E. Protection of Cable and Equipment: Contractor shall make appropriate preparations to protect all cabling and equipment from foreign material. Foreign material is defined as any substance or material that would void the manufacturer's performance warranty, impact ratings (UL, Plenum, etc.), or cover up markings needed for inspection. Foreign material includes, but is not limited to, paint overspray (intentional or not), fire-stopping material, drywall compound, or any other chemical, liquid, or compound that could come in contact with cables, cable jackets, cable termination points, or other equipment.

1 Cleaning of cables or equipment with harsh chemicals from a failure to comply with Protection of Cable and Equipment clause is unacceptable. Contractor shall replace any affected cable, cable components, or equipment in their entirety at no additional cost to the project.

F. Waste Materials: Contractor shall keep work area neat, orderly, and free from accumulation of waste materials. Remove trash and debris from the building and job site as required to maintain a clean work environment at all times. Rubbish shall be moved to a common trash

point or receptacle on the job site as determined and directed by General Contractor or Owner.

G. Dumpsters: No construction debris shall be placed in building's dumpsters. Contractor shall provide a dumpster for construction waste and debris at own expense. Said dumpster shall be emptied on a regular schedule. Location of dumpster shall be arranged through Building Management.

H. Ceiling Grid: Contractor shall not hang cable supports from ceiling grid wire.

I. Roof Deck: Contractor shall not shoot into the roof deck for mounting cable hangers.

J. Mounting: Equipment and enclosures shall be mounted plumb and square in relation to the structure.

3.4 PREPARATION

A. Existing Equipment: Prior to any installation, the Contractor shall prepare the site by removing any remaining debris, leveling equipment racks (where appropriate), and verifying information and systems stated to be in-place are ready for use.

B. Equipment for Installation: Prior to installation, Contractor shall ensure that required major equipment has been secured and is ready for installation.

3.5 CLEANING

A. Tool Clean-up: Contractor is not permitted to use restrooms for tool clean-up. A slop-sink may be provided in janitorial closet on each floor for cleaning of tools and equipment and as a source of water. Janitorial closet or maintenance area or shop shall be kept clean at all times. Contractor or Contractor's Personnel found using restrooms for clean-up or other similar purposes shall be subject to removal from building.

B. Daily: At the end of each work period or day, Contractor shall remove excess packing, drilling remnants, and other non-equipment related parts, materials, or debris to ensure a clean, safe, and professional working environment.

C. Carpet: Contractor shall ensure that no damage to carpeting occurs as a result of their work. Contractor shall cover carpets in areas of work to prevent wire debris from entering the carpet.

3.6 FIRE STOPPING

A. Contractor is responsible for applying fire-stopping material in and around all openings that it creates or are created for it, whether or not specifically indicated in specifications or project drawings, where code requires the use of fire stopping material.

B. Contractor shall ensure that all fire-stopping materials meet appropriate codes and are installed in a neat and workman like manner.

3.7 WATERPROOFING

A. Contractor is responsible for creating a waterproof seal in and around any openings to the outside environment that are created by Contractor or for systems being installed.

B. Contractor shall ensure that all waterproof materials meet appropriate codes and are applied according to good engineering practice.

3.8 INSTALLATION REQUIREMENTS

A. All cable shall be pulled by hand unless installation conditions require mechanical assistance. Where mechanical assistance is used, care shall be taken to ensure that the maximum tensile load for the cable as defined by the manufacturer is not exceeded. This may be in the form of continuous monitoring of pulling tension, use of a “break-away”, or other approved method.

B. Qualified personnel utilizing state-of-the-art equipment and techniques shall complete all installation work. During pulling operation, an adequate number of workers shall be present to allow cable observation at all points of pathway entry and exit.

C. Cable pulling shall be done in accordance with cable manufacturer’s recommendations and ANSI/IEEE C2 standards. Recommended pulling tensions and pulling bending radius shall not be exceeded. Any cable bent or kinked to radius less than recommended dimension shall not be installed.

D. All cable shall be free of tension at both ends.

E. PLENUM rated cable shall be used in areas used for air handling.

F. Contractor shall replace any cables that have been damaged or abraded during installation.

G. Pulling lubricant may be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the cable jacket and other materials used. Lubricant shall not harden or become adhesive with age.

H. A pull cord (nylon; 1/8” minimum) shall be co-installed with all cable installed in any conduit or surface mount raceway.

3.9 CABLE

A. Cable treatment: Cable shall be stored and handled to assure that it is not stretched, kinked, crushed, or abraded in any way. Bend radiuses shall meet manufacturer specifications and/or recommendations. Cable shall not be installed in ambient temperatures or moisture conditions above or below the rating of the manufacturer.

B. Splicing

1 Voice, data, and other twisted pair cables: No splices shall be installed in any voice, data or twisted pair cables.

2 Technology systems: No splices shall be installed in any cable less than five hundred feet in length.

C. Lengths

1 Variations: Where cables are to be of the same length, variations in the length shall be less than plus or minus ½ inch. Lengths of cables are based on the length of the unterminated signal conductors.

2 Labeling: Cables, regardless of length, shall be marked with a labeling scheme approved by Consultant.

3 Grouping: Cables shall be separated into like groups according to signal or power levels.

4 Power cables: Power cables shall be grouped to one side of the equipment rack while low-level cables to the other side.

5 Equipment Racks: Equipment rack wiring and cabling shall be neatly dressed.

6 Fastening: Rack cabling shall be adequately supported with Velcro wire wraps and horizontal support cable managers fastened to rack frame.

7 Wire Support outside MER/TR Spaces: Wire and cables shall be supported at least every 5 feet from the structure or as required to maintain not more than a 12 inch cable sag between supports and without over tensioning the cables.

8 Support Hardware: Cables shall be supported by J-hooks, cable tray, or ladder rack. Hardware shall be secured to building structure using 3/8" threaded rod supports.

9 Right Angles: Cables are to run at right angles to the structure, placed above ceiling in halls or corridors.

10 Height: Cables shall not run above red iron joist.

D. Concealment: Contractor shall make every effort to conceal wiring and other apparatus into walls, floors, and ceilings, assuming code and good engineering practice allows and suggests. Cabling systems installed in public areas shall be installed within walls, ceiling, or floors or within surface wiring pathways, as dictated by codes and good engineering practice.

E. Velcro Straps for Horizontal Cabling: Straps shall be installed snugly without deforming cable insulation. Straps shall be spaced at uneven intervals not to exceed 4 feet.

F. Cable Ties and Velcro Straps within Equipment Racks and Cabinets: Ties and straps shall be installed snugly without deforming cable insulation at uneven intervals not to exceed 8 inches. Cable ties shall only be used for non-signal carrying cables. No sharp burrs shall remain where excess length of the cable tie has been cut.

G. Obstruction: Contractor shall notify Owner immediately if any obstruction or hazard is discovered in a pathway provided by others.

3.10 CONNECTORS

A. Preparation: Cables shall be carefully prepared and connectors installed as directed by the manufacturer. Proper stripping devices and crimping tools shall be used.

B. Terminations: Connectors shall be carefully fitted to mating devices on equipment to avoid damage to mating contacts, inserts, or bodies. Specialized terminations shall be made in a neat and secure manner suited to the service of the wire and as directed by the manufacturer. Contractor shall use manufacturer specified terminations when those specifications exist.

C. Soldering: A person skilled in that practice shall execute soldered terminations. Any excessive insulation displacement resulting from soldering shall be grounds to require the Contractor to re- terminate the connector.

D. Adapters: Adapters shall be used only where the identity of the necessary type of connector is unknown at the time of installation, such as for Owner-provided equipment or in anticipation of future equipment upgrades, with Consultant's approval.

3.11 EQUIPMENT INSTALLATION

A. General: Contractor shall make system properly operational and physically secure by mounting equipment and related accessories into furniture, consoles, and racks as required. Manufacturer's guidelines for installation shall be followed. Discrepancies in installation procedure or inability to complete a given task due to a shortage of materials or malfunctioning equipment shall be reported to Consultant immediately upon discovery.

B. Equipment Placement: Contractor shall locate equipment as indicated on drawings and as specified herein. Where such information is not provided, follow industry best practices and locate operable devices at convenient positions; heat generating devices at the top and seldom-accessed equipment below.

1 Unless otherwise specified, end user-operable devices shall be positioned within the range of front wheelchair access per ADA standards.

C. Equipment Installation: Equipment shall be installed as directed by the manufacturer using

equipment manufacturer's desktop mounting frames, equipment tubs, installation hardware, and techniques. Contractor shall be responsible for moving equipment from storage and for providing necessary personnel or devices to carry and lift equipment around obstacles and into operating position.

3.12 FIRMWARE

A. Firmware shall be latest version supported by software and/or equipment as of Date of Acceptance.

3.13 ROUGH-IN

A. Scheduling: Contractor shall make every effort to install systems per this specification in a timely manner including rough-in of cabling and other apparatus where appropriate to stay on schedule.

B. Protection of Environment: Where cabling and/or equipment is installed prior to other trades completing their work in an area, Contractor shall take necessary precautions to cover, wrap, or otherwise protect to reduce possible damage due to plastering, painting, cleaning, or other such work.

3.14 CUTTING, DRILLING, PATCHING, AND PAINTING

A. Coordination: Contractor is responsible for coordinating the work when any cutting or drilling is required in the performance of installing the specified systems.

B. Restoration: Contractor is responsible for returning all surfaces (including walls, floors, and ceilings) to their previous condition after any cutting.

3.15 LABELING

A. General: Rack-mounted equipment and hardware shall be labeled as required herein. Connectors, jacks, receptacles, outlets, cables, cable terminations, terminal blocks, rack mounted equipment, active slots of card frame systems, etc. shall be clearly, logically, and permanently labeled in a manner acceptable to Consultant.

B. Approval: Proposed wording and/or numbering schemes for labeling shall be provided to Consultant for review and written approval prior to procurement or installation.

C. Labels used shall be permanent and secure. Provide labeling as follows unless otherwise noted in a specific section:

1 Like Size: Labels shall be sized to match other labels used for same purpose. Similarly, provide engraved labels of like size in other locations.

2 Equipment Racks: For enclosed racks containing equipment, provide labels on each equipment rack rear door or console rear panel reading "No user serviceable parts. Refer service to qualified technician."

3 Installer and Consultant Identification: Position at the front top center section of each equipment rack a label that states the names of system Installer and Consultant.

4 Custom Panels: Custom panel nomenclature shall be engraved, etched, or screened. Markings are to be designed to ensure consistency and clarity within and without of system. Verify markings and placements by submitting label sample layouts to Consultant for approval prior to procurement.

5 Documentation: Labeling information shall appear on the as-built drawings.

3.16 DEMOLITION

A. General: Where demolition is indicated in Project Documents, Contractor shall be responsible for removal, collection, transportation, and recycling of all indicated cabling and components, including the delivery of cable to the recycling center. If material is to remain on site for more than seven days after removal, Contractor shall coordinate with Owner for acceptable storage location.

B. Verification: Contractor shall field-verify existing conditions prior to beginning demolition work. Any discrepancies between existing conditions and Owner's written instructions shall be reported to Owner prior to the start of work in order to prevent disturbance of existing installation(s). Beginning work shall indicate acceptance of existing conditions. Contractor is responsible for immediately restoring any outages caused as a result of removing or damaging adjacent cabling, systems, or services.

C. Cable Removal: Where it is not possible to remove cables without damaging other cables that are to remain, such as in a shared conduit, Contractor shall cut cables at entry and exit point of constriction, leaving a minimum of 24" of cable at each end.

D. Cover Plates: Contractor shall provide and install blank cover plates for any outlets that are to be left in place and from which all cables have been removed. Cover plates shall match the Project standard color and finish.

3.17 FIRE-STOPPING

A. If Contractor removes anything from an opening in a fire-rated wall, Contractor shall restore the fire-rating condition of the wall to the same condition as before Contractor started its work. Depending on the size of the opening, this may involve sheetrock patching, in addition to use of other appropriate fire-stopping materials.

3.18 ADDITIONAL ENGINEERING SERVICES

A. General: Contractor is responsible for securing necessary engineering services where needed to meet the needs of the installation.

B. Change Orders: Only when Contractor can show that additional engineering services are needed as a result of changes to the scope of the services being requested will Owner entertain a Change Order for these services.

3.19 GENERAL TESTING

A. See more specific/detailed testing requirements listed in each system subsection.

B. Supplies: Contractor shall supply testing equipment needed to verify compliance with specifications found in these documents.

C. Program: Contractor shall complete required testing prior to the inspection by Owner and Consultant.

D. Data: Test data shall be properly documented and recorded so that it is available for final inspection.

E. Quality Control: Testing may be repeated during the inspection process at the request of Owner or Consultant.

F. Prior to energizing or testing any active systems, ensure the following:

1 Installation: Products are installed in a proper and safe manner per the manufacturer's instructions.

2 Cleanliness: Products are neat, clean, and unmarred and parts securely attached. Dust, debris, solder, splatter, etc., is removed.

3 Cables and Connections: Cable is dressed, routed, and labeled; connections are consistent with regard to polarity.

4 Grounding: Electronic devices are properly grounded.

5 AC Power: Each AC power receptacle is tested with a circuit checker for proper hot, neutral, and ground connections prior to plugging in equipment.

3.20 WARRANTY AND MAINTENANCE PROGRAM

A. Contractor shall provide the following warranty in addition to specific requirements identified in subsequent sections.

B. As part of the base proposal cost, the Contractor shall include a 1-year, turnkey warranty period with full support costs covering all aspects of the Contractor's work. This warranty shall be in addition to any manufacturer's warranties for the given period of time.

C. The Warranty period shall begin once the system is complete and all punch list items are confirmed as being complete per the construction documents. The Contractor shall receive a letter of completion from the Consultant and Owner once the project is complete starting the warranty period.

D. The warranty and support work included in this contract shall cover the following materials, software and services, without additional cost to the Owner:

1 Inspections, preventative maintenance and testing of equipment and components. The Contractor shall schedule a 10-month on-site preventative system review 10-months into each year of warranty and support including system inspections, preventive maintenance, software upgrades/patches and testing of equipment and components.

2 Regular Service, Emergency Service, and Normal Service.

3 Labor, travel, equipment, materials and transportation cost.

E. Response Time: Response time for service calls.

1 The Owner reserves the right to make the final determination of emergency or normal service calls and the right to coordinate the best times for service of any system failure.

2 Emergency service calls are defined as failures that prohibit the use of a typical system function(s) that pose a life safety concern or such failures that create a major impact to the Owner's daily operations.

a. The Contractor shall provide remote service diagnosing the impact within two (2) hours after notification by the Owner.

b. If remote service does not correct the reported issue, the Contractor shall provide on-site service correcting the impact within four (4) hours after notification by the Owner.

3 Normal service calls are defined as failures that prohibit the use of typical system function(s) that do not inhibit critical system usage, do not pose life safety concerns and do not create a major impact to Owner's daily operations.

a. The Contractor shall provide remote service correcting the impact within twenty-four (24) hours after notification by the Owner.

b. If remote service does not correct the reported issue, the Contractor shall provide on-site service correcting the impact within forty-eight (48) hours after notification by the Owner.

4 The Contractor shall supply Service Request forms and or proper contact procedure to the Owner with instructions for proper notification of the Contractor for warranty service. By following said instructions, the Owner shall constitute proper

notification for any need warranty service

F. Repair Time: Contractor shall locally stock critical parts in sufficient quantities such that emergency repair or replacement shall be guaranteed within 12-hours. Temporary replacements within this time period shall be acceptable, provided temporary replacements do not compromise system functionality, and provided permanent replacement is achieved within 96 hours. Contractor may contact the Owner for use of Owner supplied spare parts where delay of system repair will have negative impact on system performance.

G. Transmittal: A copy of this Warranty shall be delivered to, and signed for by the Owner's representative whose primary responsibility is the operation and care of these systems. A copy of the signed Warranty document shall be delivered for review as part of the Final Submittals.

H. Registration: Register Warranty papers for all equipment and software in the name of the Owner. Furnish reproductions of all equipment Warranty papers to the Owner with the Final Submittals.

I. Subcontracting: Warranty service work may not be subcontracted except with specific permission and approval by the Owner.

1 Service/Warranty Procedures: With project close-out submittals, the Contractor shall submit a warranty service plan with all contact information and Owner service call directions for Owner review.

J. Resolution of Conflicts

1 The Owner retains the right to resolve unsatisfactory warranty service performance at any time by declaring the work unsatisfactory, stating specific areas of dissatisfaction in writing.

K. If the Contractor or his approved Subcontractor does not resolve such stated areas of dissatisfaction within ninety-six (96) hours, the Owner may appoint an alternative service agency or person to fulfill the terms of the Warranty at the expense of the Contractor. This action may be taken repeatedly until the Owner is satisfied that Warranty service performance is satisfactory. Satisfactory resolution of a malfunction shall be considered adequate when the device, equipment, system or component which is chronically malfunctioning is brought into compliance with the standards of performance as contained herein and published by the manufacturers of the equipment installed.

END OF SECTION

SECTION 27 0553 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. This section describes the products and execution requirements relating to labeling of telecommunications cabling, termination components, and related subsystems. Covered systems include the following:

1 Equipment room backboards and equipment racks

2 Station cable and terminating equipment

1.2 RELATED WORK

A. Section 27 0000 – Communications General Requirements

B. Section 27 1000 – Structured Cabling General Requirements

C. Section 27 1100 – Communications Equipment Room Fittings

D. Section 27 1500 – Communications Horizontal Cabling

E. Section 27 1600 – Communications Connecting Cords, Devices, & Adapters

1.3 REFERENCE

A. In addition to any requirements below, Contractor shall abide by requirements delineated in 27 0000 including but not limited to:

1 General: Definitions, reference standards and codes, qualifications, pre-construction submittals, construction progress submittals, closeout submittals, and correction period.

2 Products: Substitutions, product specifications, miscellaneous material, cable, connectors, power devices, and interface panels.

3 Execution: Coordination, testing, training, warranty, and cable management.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 0000.

2.2 LABELS

A. All labels shall be permanent and be machine generated (e.g., Brady or Panduit). No handwritten or non-permanent labels shall be allowed. Labels shall be Brady “I.D. Pro” or XC-Plus or equivalent.

B. Characters on all labels shall be black printed on a white background.

C. Label size shall be appropriate to the cable size(s), outlet faceplate layout, patch panel

design, or other related equipment sizes and layouts.

D. All labels to be used on cables shall be self-laminating, white/transparent vinyl, and be wrapped around the cable sheath. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminated over the full extent of the printed area of the label.

E. Labels used to identify innerduct carrying fiber optic cable shall be labeled with a durable yellow polyethylene tag that reads “CAUTION Fiber Optic Cable” and includes blank spaces for adding fiber count and (2) destination information. An example of a compliant product is VIP Products’ “Caution Write-On Coverall Tag.”

PART 3 - EXECUTION

3.1 WARRANTY

A. Refer to Section 27 0000 for additional requirements.

B. Clean surfaces before attaching labels.

C. Install all labels firmly. Labels attached to terminating equipment such as backboards, faceplates, 110 blocks, and patch panels shall be installed plumb and neatly on all equipment.

3.2 LABELING OF CABLING AND TERMINATION COMPONENTS

A. Cabling

1 Horizontal cables shall have a machine generated wrap around cable label within 4” of each end of the cable. Label shall be clearly legible and meet TIA-EIA 606 standards. Character height shall be .25” (minimum).

2 Voice/data/video backbone cables shall have a machine generated wrap around cable label within 10” of each end of the cable. Label shall be clearly legible and meet TIA- EIA 606 standard. Character height shall be .5” (minimum).

B. Patch panels:

1 Each patch panel port shall be labeled with the end device connection

2 Each panel shall have 24 ports numbered 01-24

C. All patch panel port labels shall match the label at the workstation/outlet side and the cable label.

3.3 STANDARD INFORMATION OUTLET (SIO) FACEPLATES

A. All faceplates shall be clearly labeled indicating the destination of the cable(s) (telecommunication room number), the data patch panel(s) letter designation, the data port number(s) on the data patch panel(s), and the voice cable number(s).

B. Telecommunications outlets are to be labeled (1) on the cover of the assembly and (2) on each cable terminated at that location.

C. Station cables shall be labeled within two inches of the cable end.

D. Category 6 horizontal cables shall be labeled as directed by the Owner.

END OF SECTION

SECTION 27 1000 STRUCTURED CABLING GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. Refer to Section 27 0000 for additional project scope information. (Note to specifier: Add specific scope requirements by section on project by project basis.)

B. This section describes the products and execution requirements related to furnishing and installing Category 6 Cabling and Termination Components and related subsystems as part of a Structured Cabling System.

C. Others will provide the network electronics for the LAN within the Telecom Rooms (TRs). The contractor shall be responsible for connecting the new cabling infrastructure to the LAN. This Contractor, however, shall supply the Category 6 patch cords. The Contractor shall be available on site during the crossover to assist with any cabling issues that may occur during the connection.

D. The Division 26 Electrical Contractor shall install conduits and surface raceway for new technology outlet locations unless otherwise noted. Division 27 Structured Cabling Contractor shall coordinate on site project walk thru(s) with Electrical Contractor to coordinate details of installation and pathway requirements.

E. The Structured Cabling Contractor shall provide and install all sleeves through the wall penetrations as required whether or not specifically marked on Project Drawings, unless otherwise noted.

F. All cables and related terminations support, and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Contractor, as detailed in the following section(s).

G. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the TX Electrical Code, and present manufacturing standards.

H. All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

1.2 RELATED WORK

A. Section 27 0000 – Communications General Requirements

B. Section 27 0553 – Identification for Communications Systems

C. Section 27 1100 – Communications Equipment Room Fittings

D. Section 27 1500 – Communications Horizontal Cabling

E. Section 27 1600 – Communications Connecting Cords, Devices, & Adapters

1.3 REFERENCE

A. In addition to any requirements below, Contractor shall abide by requirements delineated in 27 0000 including but not limited to:

1 General: Definitions, reference standards and codes, qualifications, pre-

construction submittals, construction progress submittals, closeout submittals, and correction period.

2 Products: Substitutions, product specifications, miscellaneous material, cable, connectors, power devices, and interface panels.

3 Execution: Coordination, testing, training, warranty, and cable management.

1.4 REFERENCE STANDARDS AND CODES

A. All references relate to the current version adopted by the city/county according to the authority having jurisdiction (AHJ). If the city/county has not adopted a version the latest version shall be utilized.

B. ASTM B633: Specification for Electrodeposited Coatings of Zinc on Iron and Steel

C. ASTM A653: Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process

D. ASTM A123: Specification for Zinc (Hot Galvanized) Coatings on Iron and Steel

E. ASTM A510: Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

F. ANSI/TIA 569-C: Telecommunications Pathways and Spaces

G. ANSI/TIA 568-C.0, 1, 2, 3, 4: Commercial Building Telecommunications Standard

H. ANSI/TIA-598-C-2005 – Optical Fiber Cable Color Coding

I. ANSI/TIA 606-B: Administration Standard for Telecommunications Infrastructure

J. ANSI/TIA 942-A: Telecommunications Infrastructure Standard for Data Centers

K. ANSI/TIA 607-B: Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises

L. IEEE: National Electrical Safety Code® (NESC®) standards.ieee.org/about/nesc

1.5 QUALIFICATIONS

A. Premises Distribution System: Written certification that the premises distribution system complies with the EIA ANSI/TIA/EIA-568-C.0,1, 2, 3, EIA ANSI/TIA/EIA-569-B, and ANSI/TIA/EIA- 606-A.

B. Materials and Equipment: Where materials or equipment are specified to conform, be constructed, or be tested to meet specific requirements, certification that the items provided conforms to such requirements. Certification by a nationally recognized testing laboratory that a representative sample has been tested to meet the requirements, or a published catalog specification statement to the effect that the item meets the referenced standard, will be acceptable as evidence that the item conforms. Compliance with these requirements does not relieve the Contractor from compliance with other requirements of the specifications.

C. Installers

1 The Contractor shall have an RCDD (Registered Communication Distribution Designer) on staff assigned to manage this Project; documented proof shall accompany the proposal response.

2 All installing personnel shall have completed and be certified in manufacturer training or BICSI (Building Industry Consulting Service International) installation training for UTP infrastructure systems, or the Contractor shall contract with manufacturer for installation of all proposed components. Company Certifications shall accompany the proposal response.

3 The Contractor's technicians shall be certified and trained in the connectivity hardware that is being installed.

4 The Contractor shall submit certification that installers are factory certified to install and test the provided products. No less than half of the crew to be used for the telecommunications installation shall be trained by that manufacturer for the work.

1.6 PRE-CONSTRUCTION SUBMITTALS

A. Equipment and materials cutsheets.

1.7 CLOSEOUT SUBMITTALS

A. Provide three (3) sets of the following:

1 Data cable test results

2 USB drive containing:

a. As-built drawings (CAD format)

b. As-built drawings (PDF format)

c. Detailed test results in original tester format (Fluke Linkware)

d. Detailed cable test results in PDF format

e. Final rack elevation diagrams

f. Pictures of each TR including front and back of rack/cabinet elevations

3 Warranty certification from connectivity manufacturer

1.8 DELIVERY, STORAGE, AND HANDLING

A. Vendor shall be responsible for all materials until completion of Project.

B. Cable shall be stored according to manufacturer's recommendations at minimum. In addition, cable shall be stored in a location protected from vandalism and weather.

C. If cable is stored outside, it shall be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees Fahrenheit, the cable shall be moved to a heated (minimum 50 degrees Fahrenheit) location. If necessary, cable shall be stored off site at the Contractor's expense.

D. If the Contractor wishes to have a trailer on site for storage of materials, arrangements shall be made with the Owner.

E. Commercial off-the-shelf manuals shall be furnished for operation, installation, configuration, and maintenance for all products provided as a part of the premises distribution system. Specification sheets for all cable, connectors, and other equipment shall be provided.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Unless noted otherwise, products in this section are intended as a basis of design and

are open to substitutions per the product substitution procedures defined in Section 27 0000.

PART 3 - EXECUTION

3.1 WARRANTY

A. The Contractor shall provide to the Owner a manufacturer's 15 year minimum warranty certificate for all materials, equipment, etc. Upon successful completion of the installation and subsequent inspection, the Owner shall receive a numbered certificate, from the manufacturing connectivity hardware (patch panels, jacks, parch cords 110 blocks, etc.) company, registering the installation. This warranty shall include all labor, materials, and travel time.

B. The warranty shall ensure against product defects and guarantee that all approved cabling components exceed the specifications of TIA/EIA-568-C, and ISO/IEC IS 11801 for cabling links/channels, and that the installation will exceed the loss and bandwidth requirements of TIA/EIA 568-C ISO/IEC IS 11801 for fiber links/channels, for a fifteen (15) year period. The warranty shall apply to all passive structure cabling system components.

C. The warranty shall cover the failure of the wiring system to support the application that it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use the TIA/EIA 568-C or ISO/IEC IS 11801 component and link/channel specifications for cabling, for a minimum of a fifteen (15) year period.

D. The warranty shall cover the replacement or repair of defective product(s) and labor for the replacement or repair of such defective products(s), labeling of the new components, and testing of the circuit(s) at no cost to the Owner.

3.2 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper and timely completion.

B. Verify cable lengths comply with published standards.

C. Notify Owner of installation that would exceed maximum lengths prior to installation of cable.

D. Contactor shall consult with Owner regarding alternative routing or location of cable.

E. Do not proceed until unsatisfactory conditions have been corrected.

3.3 SPARE PARTS AND UNIT PRICES

A. None.

3.4 INSTALLATION REQUIREMENTS

A. Contractor shall furnish all required installation tools to facilitate cable pulling without damage to the cable jacket. Such equipment shall include, but not be limited to, sheaves, winches, cable reels, cable reel jacks, duct entrance tunnels, pulling tension gauge, and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices that may move or wear in a manner to pose a hazard to the cable shall not be used.

B. Service Loops: A surplus of cable, typically located at or near the point of termination to facilitate potential future changes. Cables shall have a minimum cable slack of 10ft (3m) at the telecommunication room(s) and 3.28ft (1m) at each telecommunications outlet in the suspended ceiling unless noted otherwise. Service loops shall be stored in an extended loop or in a figure- eight configuration, not in bundled loops.

C. Cable Support (TIA 569-C.9.7):

1 Non-continuous supports shall be located at intervals not to exceed 1.5 m (5 ft). Non- continuous supports shall be selected to accommodate the immediate and anticipated quantity, weight, and performance requirements of cables.

2 It is recommended not to make long runs exactly 5 ft apart due to “harmonics” issues per cable manufacturers

3 Non-continuous pathways do not need to be bonded together or grounded (see 2011 NEC 250.92.A.1

D. Maximum pulling tension (TIA 568-C.5.3.1):

1 The pulling tension for a 4-pair balanced twisted pair cable shall not exceed 110 N (25 lbf) during installation. For multipair cable (12-pair and above), manufacturer’s pulling tension guidelines shall be followed.

2 Sags between supports shall be a maximum of 300 mm (12 inches).

3.5 COOPERATION

A. The Contractor shall cooperate with other trades and General Contractor’s personnel in locating work in a proper manner.

B. Should it be necessary to raise, lower, or move longitudinally any part of the work to better fit the general installation, such work shall be done at no extra cost to the Owner, provided such decision is reached prior to actual installation. The Contractor shall check location of electrical outlets with respect to other installations before installing.

3.6 TESTING AND ACCEPTANCE

A. The Contractor shall perform acceptance tests as indicated below for each subsystem (backbone, station, etc.) as it is completed.

B. The Contractor shall supply all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor shall provide a summary of the proposed test plan for each cable type, including equipment to use, setup, test frequencies or wavelengths, results format, etc. The Consultant will approve the method of testing.

C. The Contractor shall visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. The Contractor shall provide the Consultant with a written certification that this inspection has been made.

D. The Contractor shall conduct acceptance testing according to a schedule coordinated with the Consultant. Representatives of the Owner may be in attendance to witness the test procedures. The Contractor shall provide a minimum of one (1) week advance notice to the Consultant and Owner to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.

E. Tests related to connected equipment of others shall be done only with the permission and presence of Contractor involved. The Contractor shall ascertain that testing only as required to prove the wiring connections are correct.

F. The Contractor shall provide test results and describe the conduct of the tests, including the date of the tests, the equipment used, and the procedures followed. At the request of the Consultant, the Contractor shall provide copies of the original test results.

G. All cabling shall be 100% fault free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the Contractor's expense. The applicable tests shall then be repeated.

H. Backbone voice cables shall be free of shorts within the pairs and be verified for continuity, pair validity and polarity, and conductor position on the termination blocks (e.g., 110). Any mispositioned pairs shall be identified and corrected. The percentage of "bad" pairs shall not exceed 1% in any backbone (riser or tie) cable based on total pair count. All bad pairs shall be identified and documented.

I. The Consultant or Owner may request that a 10% random field re-test be conducted on the cable system to verify documented findings.

1 If requested, the Contractor shall test up to 10% of cable links at no cost to the Owner.

2 Tests shall be a repeat of those defined above and under Testing and Acceptance. If findings contradict the documentation submitted by the Contractor, additional testing shall be performed to the extent determined necessary by the Consultant, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

3.7 FIRE STOPPING

A. Contractor shall seal any openings created for cable pass-through between floors or through fire rated walls. Sealing material and application of this material shall be accomplished in such a manner that is acceptable to the local fire and building authorities having jurisdiction over this work.

B. Creation of such openings as are necessary for cable passage between locations as shown on the Drawings shall be the responsibility of the Contractor. Any openings created by or for the Contractor and left unused shall also be sealed as part of this work.

END OF SECTION

SECTION 27 1500 COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SCOPE

A. This section describes the products and execution requirements relating to telecommunications voice, data and video horizontal (station) cabling and termination components.

B. Horizontal cabling is the cabling between the work area telecommunications outlet and the telecommunications room (TR). Horizontal cabling is often referred to as “station cabling”.

C. The horizontal cabling system will consist of the following:

1 Unshielded Twisted Pair (UTP) Cable

2 Outlet Termination Modules (jacks)

3 Outlet Termination Plates

4 Above Ceiling Cable Support Systems

5 Horizontal Cable Testing Requirements

6 Cable Pathway/Sleeve Requirements

1.2 RELATED WORK

A. Section 27 0000 – Communications General Requirements

B. Section 27 0553 – Identification for Communications Systems

C. Section 27 1000 – Structured Cabling General Requirements

D. Section 27 1500 – Communications Horizontal Cabling

E. Section 27 1600 – Communications Connecting Cords, Devices, & Adapters

1.3 REFERENCE

A. In addition to any requirements below, Contractor shall abide by requirements delineated in 27 0000 including but not limited to:

1 General: Definitions, reference standards and codes, qualifications, pre-construction submittals, construction progress submittals, closeout submittals, and correction period.

2 Products: Substitutions, product specifications, miscellaneous material, cable, connectors, power devices, and interface panels.

3 Execution: Coordination, testing, training, warranty, and cable management.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Unless noted otherwise, products in this section are intended as a basis of design and are

open to substitutions per the product substitution procedures defined in Section 27 0000.

2.2 CATEGORY 6 HORIZONTAL COPPER CABLES

A. This specification defines the requirements for commercially available high performance category cables.

B. Horizontal cabling for data shall be 23 AWG, 4-pair U/UTP, NEC/NFPA CMP rated and be independently verified for compliance. This cable shall be suitable for installation in free-air, in building risers, in conduit, and/or in cable tray and shall carry CMP plenum rating.

C. The cable design described herein shall exceed transmission performance of category cables. Cable performance shall be independently verified by ETL and meet the ANSI/TIA/EIA-568-C.2 Category 6 and IEEE 802.3af (POE) requirements.

1 Cat6 Bandwidth beyond 500MHz

D. Cable shall be Underwriters Laboratory (UL) listed, independently verified for flammability by UL, and shall comply with NEC article 800 and NFPA 70.

E. Cables shall meet the specifications of NEMA (low loss), UL 444, and ICEA. Conductor shall also conform to the requirements for solid annealed copper wire in accordance with ASTM B 3.

F. Cable shall be packaged on a 1000ft spool.

G. All cables and equipment shall be furnished, tested, installed and wired by the Contractor.

H. All horizontal data cables shall terminate on patch panels in the telecommunications cabinet as specified in these documents.

I. All cables, termination components, and support hardware shall be furnished, tested, installed, and wired by the Contractor.

J. Jacket color:

1 **BLUE – GENERAL DATA**

K. IMPORTANT: Cable and termination components (jack, patch panel, wiring blocks) are specified to function as a system. The compatibility of the cable to be installed with the proposed termination components shall be recognized and documented by the termination component manufacturer.

L. Approved Manufacturers:

1 Cat 6 Plenum Rated

a. Hubbell HC6RPExx

2 Other equivalent products by Panduit or Commscope that meet these specifications and warranty.

2.3 INFORMATION OUTLET

A. General

1 Station cables shall each be terminated at their designated workstation location in the connector types described in the subsections below. Included are modular jacks, faceplates, and surface mount raceway. The combined assembly is referred to as the Standard Information Outlet (SIO). These connector assemblies shall snap into a mounting frame.

2 SIOs shall be mounted (1) where existing boxes are in place, (2) on surface mount raceway typically in surface raceway with barrier, (3) on floor mount interface boxes, or (4) on power poles either currently owned or new.

3 The telecommunications outlet frame shall accommodate or incorporate the following:

a. A minimum of four (4) modular jacks, when installed on a wall-mounted assembly.

b. A mechanism for adjusting the surface plate to a plumb position.

4 Multiple jacks are identified in close proximity on the Drawings. The Contractor shall determine the optimum compliant configuration based on the products proposed.

5 The same orientation and positioning of jacks and connectors shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each SIO type for review by the Consultant.

B. Modular Jack

1 Data jacks shall be non-keyed 8-pin modular jacks.

2 Termination components shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.

3 Jacks shall utilize a four-layer printed circuit board to control NEXT.

4 Jack housings shall fully encase and protect printed circuit boards and IDC fields.

5 Modular jack contacts shall accept 2500 plug insertions.

6 Modular jack contacts shall be formed flat for increased surface contact with mated plugs. These contacts shall be arranged on the PC board in two staggered arrays of four to maximize contact spacing and minimize crosstalk.

7 Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.

8 Contact Plating shall be a minimum of 50 micro inches of gold in the contact area over 50 micro-inch of nickel, compliant with FCC part 68.5.

9 Jack termination shall be110 IDC, integral to the jack housing, laid out in two arrays of four contacts.

10 Jacks shall utilize a paired punch down sequence. Cable pairs shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.

11 Jacks shall utilize tin lead plated (60% tin/40%lead) phosphor bronze 110 insulation displacement contacts.

12 Jacks shall terminate 22-26 AWG stranded or solid conductors.

13 Jacks shall terminate insulated conductors with outside diameters up to .050".

14 Jacks shall be compatible with single conductor 110 impact termination tools.

15 Jacks shall be compatible with EIA/TIA 606 color code labeling and accept snap on icons for identification or designation of applications.

C. Jack color:

1 **BLUE – GENERAL DATA**

D. Jacks shall be marked as either T568A or T568B wiring.

1 Approved Manufacturers:

a. Cat6

1) Hubbell HXJ6xx

b. Other equivalent products by Panduit or Commscope that meet these specifications and warranty.

E. Outlet Faceplates

1 Faceplates shall be stainless steel with minimum 4-ports and incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.

2 Any unused jack positions shall be fitted with a removable blank inserted into the opening.

3 Modular jacks shall have capability to incorporate a dust cover that fits over and/or into the jack opening. The dust cover shall be designed to remain with the jack assembly when the jack is in use. No damage to the jack pinning shall result from insertion or removal of these covers. Dust covers that result in deformation of the jack pinning shall not be accepted.

4 Contractor shall coordinate with prime contractor to match faceplates finish with Electrical outlets finish.

5 Faceplates shall be manufactured by modular jack manufacturer.

6 Approved Manufacturers:

a. Hubbell

1) 4-port SSFL14

2) 6-port SSFL16

b. Other equivalent products by Panduit or Commscope that meet these specifications and warranty.

F. Surface Mount Interface Box

1 Low profile, 2-port, surface mount boxes shall incorporate recessed designation strips at the top for identifying labels. Designation strips shall be fitted with clear plastic covers.

2 The box shall feature built-in cable management for both fiber and copper applications.

3 Any unused jack positions shall be fitted with a removable blank inserted into the opening.

4 Modular jacks shall have capability to incorporate spring-loaded shutter door for added protection from dust and other airborne contaminants. The dust cover shall be designed to remain with the jack assembly when the jack is in use.

5 The box shall have the capability to incorporate optional magnets that can be internally mounted.

6 Surface mount box shall be manufactured by modular jack manufacturer.

7 Approved Manufacturers:

a. Hubbell HSB2W

b. Other equivalent products by Panduit or Commscope that meet these specifications and warranty.

2.4 CABLE HOOK SYSTEMS

A. None.

B. All horizontal cabling shall be installed in conduit end-to-end supported from the building structure or walls.

PART 3 - EXECUTION

3.1 TWISTED PAIR TEST EQUIPMENT

A. Test equipment used under this contract shall be from a manufacturer who has a minimum of five years' experience in producing field test equipment. Manufacturers shall be ISO 9001 certified.

B. All test tools of a given type shall be from the same manufacturer and have compatible electronic results output. Test adapter cable shall be approved by the manufacturer of the test equipment. Baseline accuracy of the test equipment shall exceed TIA Level III, as indicated by independent laboratory testing.

C. Test equipment shall:

1 Be capable of certifying Category 5E, 6 and 6A permanent links.

2 Have a dynamic range of at least 100dB to minimize measurement uncertainty.

3 Be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.

4 Include S-band time domain diagnostics for NEXT and return loss.

5 Be capable of running individual NEXT, return loss, etc., measurements in addition to AutoText.

6 Include a library of cable types, stored by major manufacturer.

7 Store at least 1000 Category 5e, 6 or 6A auto tests in internal memory.

D. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurements.

E. The approved manufacturer of the test equipment is Fluke.

3.2 CABLE SUPPORT

A. All horizontal cabling shall be installed in conduit end-to-end supported from the building structure or walls.

3.3 STATION CABLING

A. Information outlet cables with copper media (data UTP) shall be located as detailed in the Project Documents.

B. The Contractor shall utilize these documents in determining materials quantities and routing.

C. Station cables shall be run to the information outlet from the MER/TR serving each area in conduit.

D. The maximum station cable drop length for UTP cables shall not exceed 295 feet (90 meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and shall include any slack required for the installation and termination. The Contractor shall install station cabling in a fashion to avoid unnecessarily long runs.

E. Contractor shall verify cable lengths comply with published standards; prior to installation of any horizontal cabling, this Contractor shall verify cable paths and confirm no horizontal cable will exceed 295 total feet. If it is determined that the cable will exceed 295', this Contractor shall route the cabling to another MER/TR or determine shorter path so cables are under 295'. If this is not possible, the Contractor shall notify the Consultant prior to

installation. Failure to do this step will not result in a change order from the Contractor.

F. All cables shall be installed splice-free unless otherwise specified.

G. During pulling operation, an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as the feed cable and operate pulling machinery.

H. Avoid abrasion and other damage to cables during installation.

I. All cable shall be free of tension at both ends. In cases where the cable shall bear some stress, Kellem grips may be used to spread the strain over a longer length of cable.

J. Manufacturers' minimum bend radius specifications shall be observed in all instances. Use of plastic cable ties is not acceptable. Cable bundles shall be neatly dressed with use of Velcro type straps.

K. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.

L. A coil of one foot in each cable shall be placed in the ceiling at the last support (e.g., J-box) before the cables enter a fishable wall, conduit, surface raceway, or box.

M. To reduce or eliminate EMI, the following minimum separation distances from 480V power lines shall be adhered to:

1 Twelve (12) inches from power lines of 5-kV

2 Eighteen (18) inches from high voltage lighting (including fluorescent)

3 Thirty-nine (39) inches from power lines of 5-kV or greater

4 Thirty-nine (39) inches from transformers and motors

N. All openings shall be sleeved and fire stopped per prevailing code requirements upon completion of cable installation.

3.4 INFORMATION OUTLET

A. Information outlets shall be flush mounted on wall-mounted boxes, in floor-mounted boxes, on surface raceway, or on modular furniture.

B. Any outlets to be added where these conditions are not met shall be positioned at a height matching that of existing services or as directed otherwise by the Site Coordinator and the Consultant. Nominal height (from finished floor to center line of outlet) in new installation shall be as follows:

1 Standard Voice & Data Outlet (SIO) shall match adjacent electrical outlets.

C. The Contractor shall coordinate the style of the telecommunication outlets to be installed in the floor mount boxes and surface mount raceways with the Owner.

3.5 CABLE TERMINATION

A. At the telecommunication closet, all data and voice cables shall be positioned on termination hardware in sequence of the outlet ID, starting with the lowest number.

B. Termination hardware (blocks and patch panels) positioning and layout will be reviewed and approved by the Consultant prior to construction. The review does not exempt the Contractor from meeting any of the requirements stated in this document.

C. Cable Termination – Data/Voice UTP

1 Data/voice patch panels shall be designed and installed in a fashion as to allow future station cabling to be terminated on the panel without disruption to existing connections.

2 Data patch panels shall be sized to accommodate a minimum of 20% growth in the quantity of stations relative to the initial installation.

3 At information outlets and data/voice patch panels, the installer shall ensure that the twists in each cable pair are preserved to within 0.5 inch of the termination for data/voice cables. The cable jacket shall be removed only to the extent required to make the termination.

3.6 TEST DATA – COPPER MEDIA

A. The test result records saved by the tester shall be transferred into a Windows-based database utility that allows for the maintenance, inspection, and archiving of these test records. A guarantee shall be made that these results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test. Comma separated value (CSV) format is not acceptable.

B. The database for the completed job – including twisted-pair copper cabling links, if applicable – shall be stored and delivered on CD-ROM. This CD-ROM shall include the software tools required to view, inspect, and print any selection of test reports.

C. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information:

1 The identification of the link in accordance with the naming convention defined in the overall system documentation.

2 The overall Pass/Fail evaluation of the copper channel-under-test, including the NEXT worst-case margin (margin is defined as the difference between the measured value and the test limit value).

3 The overall Pass/Fail evaluation of the fiber link-under-test, including the Attenuation worst-case margin (margin is defined as the difference between the measured value and the test limit value).

4 The date and time the test results were saved in the memory of the tester.

3.7 COPPER STATION CABLES

A. Station cabling testing shall be from the jack at the outlet in the work area to the termination block on which the cables are terminated at the MDF or IDF.

B. Testing shall be of the permanent link. Contractor shall warrant performance, however, based on channel performance and provide patch cords that meet channel performance criteria. All cabling not tested strictly in accordance with these procedures shall be retested at no cost to the Owner.

C. Testing shall be from the jack at the SIO to the patch panel on which the cables are terminated at the wiring hub.

D. Horizontal “station” cables shall be free of shorts within the pairs and shall be verified for continuity, pair validity and polarity, and wire map (conductor position on the modular jack). Any defective, split, or mispositioned pairs shall be identified and corrected.

E. Testing of the cabling systems rated at TIA Category 5e/6/6a and above shall be performed to confirm proper functioning and performance.

F. Testing of the transmission performance of station cables (Category 5e/6/6a) shall include the following:

1 Length

2 Attenuation

3 Pair to Pair NEXT

4 ACR

5 PSNEXT Loss

6 Return Loss

7 Pair to Pair ELFEXT Loss or ACRF

8 PSEFEXT Loss or PS-ACRF

9 Propagation Delay

10 Delay Skew

11 Return Loss

G. The maximum length of station cable shall not exceed 90 meters, which allows 10 meters for equipment and patch cables.

H. Worst case performance at 20°C, based on a horizontal cable length of 90 meters and equipment cord length of 4 meters, shall be as follows:

CATEGORY 6 (Permanent LINK)					
Freq (MHz)	Insertion Loss	NEXT Loss Pair to Pair	PS-Next Loss (DB; Worst Case)	ELFEXT Loss Pair to Pair (dB)	PSELFEXT Loss (dB
1	1.9	65.0	62.0	64.2	61.2
4	3.5	64.1	61.8	52.1	49.1
8	5.0	59.4	57.0	46.1	43.1
10	5.5	57.8	55.5	44.2	41.2
16	7.0	54.6	52.2	40.1	37.1
20	7.8	53.1	50.7	38.2	35.2
25	8.8	51.5	49.1	36.2	33.2
31.25	9.8	50.0	47.5	34.3	31.3
62.5	14.1	45.1	42.7	28.3	25.3
100	18	41.8	39.3	24.2	21.2
200	26.1	36.9	34.3	18.2	15.2
250	29.5	35.3	32.7	16.2	13.2

I. In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation method. The Contractor shall make additional tests as the Consultant deems necessary at no additional expense to the Owner or Consultant.

J. All data shall indicate the worst-case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combination and in both directions when required by the appropriate standards.

K. Cables shall be tested to the maximum frequency defined by the standards covering that performance category. Transmission Performance Testing shall be performed using a test instrument designed for testing to the specified frequencies. Test records shall verify

“PASS” on each cable and display the specified parameters—comparing test values with standards-based “templates” integral to the unit.

END OF SECTION

SECTION 27 1600 COMMUNICATIONS CONNECTING CORDS, DEVICES, & ADAPTERS

PART 1 - GENERAL

1.01 SCOPE

A. This section describes the products relating to high quality Category 6 voice and data patch cords.

B. In this section the term patch cords refers to the cords that connect data network electronics to the horizontal cable infrastructure.

C. It is important that the horizontal cable system and the provided patch cords work as one complete system for guaranteed channel performance. Patch cords shall be manufactured by the same manufacturer as the jack and patch panels.

D. The Contractor shall provide and deliver all cords as listed in this section. The Contractor will be responsible for installation of cords.

1.02 RELATED WORK

A. Section 27 0000 – Communications General Requirements

B. Section 27 0553 – Identification for Communications Systems

C. Section 27 1000 – Structured Cabling General Requirements

D. Section 27 1500 – Communications Horizontal Cabling

1.03 REFERENCE

A. In addition to any requirements below, Contractor shall abide by requirements delineated in 27 0000 including but not limited to:

1 General: Definitions, reference standards and codes, qualifications, pre-construction submittals, construction progress submittals, closeout submittals, and correction period.

2 Products: Substitutions, product specifications, miscellaneous material, cable, connectors, power devices, and interface panels.

3 Execution: Coordination, testing, training, warranty, and cable management.

PART 2 - PRODUCTS

2.01 SUBSTITUTIONS

A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 0000.

2.02 CATEGORY 6 PATCH CORDS

A. The Owner has the right to determine the final length of the patch cords after the contract is awarded.

B. All Category 6 UTP patch cords shall be round and consist of eight insulated 28 AWG, stranded copper conductors, arranged in four color-coded twisted pairs within a flame retardant jacket and be backwards compatible with lower performing categories. Modular patch cords shall utilize ISO termination method that is designed to reduce and control near-end cross talk (NEXT) and far end cross talk (FEXT) without compromising signal impedance.

C. Both ends of the cord shall be equipped with modular 8-position (RJ45 style) plugs wired straight through with standards compliant wiring. All modular plugs shall exceed FCC CFR 47 part 68 subpart F and IEC 603.7 specifications, and have 50 micro inches of gold plating over nickel contacts. Cable shall be label-verifiable. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Category 6 cords shall have color-coded insert molded strain relief boot with a latch guard to protect against snagging. Additional color- coding shall be available by the use of snap-in icons.

D. Patch cords shall be wired straight through. Pin numbers shall be identical at each end and shall be paired to match T568B patch panel jack wiring per ANSI/TIA/EIA-568-B. Patch cords shall be unkeyed.

E. The manufacturer of the cords shall be the same as the manufacturer for UTP termination hardware (jacks & patch panels). Cords shall be highest quality cords available by connectivity manufacturer.

F. Jacket color:

1 **BLUE – GENERAL DATA**

G. Approved Manufacturers:

1 Cat6 UTP Low Diameter

a. Hubbell HCL6Rxxyy (where yy is the length)

2 Other equivalent products by Panduit or Commscope that meet these specifications and warranty.

H. This Contractor shall provide the following copper patch cords (for pricing purposes only; see section 3.2 below):

Qty	Color	Length	Type	Notes
xx	Blue	7 feet	Cat6	1 Cord for horizontal cable installed
xx	Blue	1 foot	Cat6	2 Cords for every horizontal cable installed (use at Data Cabinet and Theatrical Lighting Controls Equipment for patching to the equipment)

PART 3 - EXECUTION

3.01 INSTALLATION

A. The installing contractor shall be responsible for providing and installing all patch cords as required for a complete end to end turnkey installation.

B. All patch cords connecting the new video surveillance network equipment to the Owner's network equipment shall be made by the installing contractor in collaboration with the Owner's technology department.

3.02 ORDERING AND DELIVERY

A. Prior to ordering patch cords the Contractor shall schedule meeting with Owner and Consultant to verify patch cord lengths, colors, connectors, and quantities.

B. Contractor shall coordinate delivery of spare patch cords with Owner. Contractor shall have list of delivered cords and shall have Owner sign delivery sheet at time of delivery.

END OF SECTION