ADDENDUM NO. 2 April 11, 2024
New Castle County Vocational Technical School District
Hodgson Vo-Tech High School
Bid Package D.1 – Building Envelope and Fitout
Page 1

The Bid Due Date and Bid Opening date is
Wednesday, April 17, 2024 @ 3:00 PM.

NOTICE: Attach this addendum to the project manual for this project. It modifies and becomes a part of the contract documents. Work or materials not specifically mentioned herein are to be described in the main body of the specifications and as shown in the drawings. Bidders shall acknowledge receipt of this addendum on the space provided on the Bid Form. Failure to do so may subject the bidder to disqualification.

Whenever this Addendum modifies a portion of the Project Manual added information is shown as **Bold** and deleted information is shown as ~~strikethrough~~.

The contract documents for the above referenced project, Project Manual dated March 11, 2024, are amended as follows:

GENERAL CLARIFICATIONS:

1. Bid Documents may be viewed and downloaded at EDiS' FTP site. To obtain access to the FTP site, please submit your request via email to Jackie McKee at jmckee@ediscompany.com.

2. Physical copies of bids will be received at the office of New Castle County Vo-Tech School District, 1417 Newport Road, Wilmington, DE 19804 until **3:00 PM local time on Wednesday, April 17, 2024.** The outer envelope should clearly indicate: "NEW CASTLE COUNTY VOCATIONAL TECHNICAL SCHOOL DISTRICT - HODGSON VO-TECH BUILDING ENVELOPE AND FITOUT BP-D.1 _____ SEALED BID – DO NOT OPEN." Bids may be hand delivered or mailed/shipped. Electronic bids will not be accepted. Bidder assumes full responsibility for timely delivery at location designated for receipt of bids. Any bids received after the stated time will be returned unopened.

3. Pre-bid RFI log is attached for your use.

MODIFICATIONS TO SPECIFICATIONS:

1. SECTION 011100 – SUMMARY OF WORK – DELETE this section in its entirety and INSERT revised section, annotated Addendum No 2 and dated April 11, 2024.

2. ADD the following specifications for reference:
   Project Manual Volume 5, Division 26 – Electrical dated February 16, 2024
   - 26 05 00 Common Work Results for Electrical
   - 26 05 13 Medium-Voltage Cables
   - 26 05 19 Low-Voltage Electrical Power Conductors and Cabling
   - 26 05 26 Grounding and Bonding for Electrical Systems
   - 26 05 29 Hangers and Supports for Electrical Systems
   - 26 05 33 Raceways and Boxes for Electrical Systems
   - 26 05 43 Underground Ductbanks
   - 26 05 53 Identification for Electrical Systems
   - 26 05 73 Short Circuit Analysis, Coordination Study, and Arc Flash Hazard Analysis
   - 26 09 23 Lighting Control Devices
   - 26 09 43 Network Lighting Controls
   - 26 09 61 Performance Lighting Systems
   - 26 09 63 Performance Lighting Systems Installation
   - 26 09 73 Audio Video Systems Installation
   - 26 11 20 Utility Incoming Service Provisions
   - 26 22 00 Low-Voltage Transformers
   - 26 24 13 Switchboards
   - 26 24 16 Panelboards
   - 26 25 50 Manual Transfer Switch/Generator Docking Station
   - 26 27 16 Commercial Pedestals
   - 26 27 26 Wiring Devices
   - 26 28 13 Fuses
   - 26 28 16 Enclosed Switches and Circuit Breakers
   - 26 29 13 Enclosed Controllers
   - 26 32 13 Engine Generators
   - 26 36 00 Transfer Switches
   - 26 41 13 Lightening Protection System
   - 26 43 13 Surge Protection Devices
   - 26 51 00 Interior Lighting
   - 26 56 00 Exterior Lighting
   - 26 60 10 Rigging Systems Electrical Work

LIST OF ATTACHMENTS:

Pre-Bid RFI Log
011100 - Summary of Work
Project Manual Volume 5, Division 26 – Electrical dated February 16, 2024

End of Addendum No. 2

RFI No.	Date	Submitted By	Sheet No.	Detail/Section	Question	Response	Addendum
001	4/3/24	MDavis		011100, item 9	In the 'scope of work' for BPD.1-38 in the project manual, item 9 states to "coordinate and provide a complete grounding system…" (see attached). Can you clarify this? I haven't seen any grounding specific to this ductbank.	See Addendum #1 for response.	2
002	4/5/24	MDavis			Is this scope to include the conduit stubs from the Utility Sectionalizing Cabinet towards the street (drawing E004)?	Yes, we would consider the stub outs from the cabinet to be part of this scope.	2
003	4/5/24	MDavis			The concrete pads or vaults for the Sectionalizing Cabinet and transformers are by others and we would just own the 2 manholes, correct?	That is correct.	2
004	4/5/24	MDavis			Addendum 1 attachment C shows the under the road concrete encasement sections, but only shows 2 places. Should we also include concrete encasement between the manhole and transformer T2 where it goes under the parking lot?	We added Attachment C to identify concrete encasement under the temporary stone roadway because its going to be utilized well after this goes in. The section from the manhole to T2 should be included as well but is covered in the original ductbank detail noted.	2
005	4/5/24	AU Power			Who is responsible for providing the Primary cable from the switch to the transformers?	Contract D.1-38 Primary Electrical Ductbank provides all cable (F&I) to transformers T-2 and T-1. Final connections by Delmarva	2
006	4/5/24	AU Power			Who is responsible for proving the sing-phase transformers also?	Delmarva power provide the T-2 and T-1 transformers and transformer pads.	2
007	4/9/24	Preferred Electric		261120	Specification 26 11 20 section 2.2-E calls out for the manholes to be purchased from the Utility Company. DP&L has advised they will not be providing pricing. Please provide details for size and type manholes that are to be provided.	Two electric manholes are indicated on E004. Manhole details are on E702 with specifications for manholes included in Section 26 05 43 Underground Ductbanks. They do not have to be purchased from the utility if not a utility requirement.	2
008	4/9/24	Preferred Electric			Please confirm the concrete pads for the DP&L switch and the transformers will be furnished and installed by others.	See question #3.	2
009	4/9/24	Preferred Electric			Please provide a specification for the #1/O solid aluminum 25kV cable.	Section 26 05 13 Medium Voltage Cables is included in the bid set. Concentric neutral is required per the description on Dwg. E501.	2

SECTION 011100 - SUMMARY OF WORK

1. RELATED DOCUMENTS

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

2. CONTRACTS

   A. The work will be performed under separate prime contracts managed by the Construction Manager.

3. ALTERATIONS & COORDINATION

   A. Contractor shall be responsible to coordinate their work with the work of others, including, but not limited to, the preparation of general coordination drawings, diagrams and schedules, and control of site utilization, from the beginning of activity, through project close-out and warranty periods.

4. KNOWLEDGE OF CONTRACT REQUIREMENTS

   A. The Contractor and his Subcontractors, Sub-subcontractors and material men shall consult in detail the Contract Documents for instructions and requirements pertaining to the Work, and at his and their cost, shall provide all labor, materials, equipment and services necessary to furnish, install and complete the work in strict conformance with all provisions thereof.

   B. The Contractor will be held to have examined the site of the Work prior to submitting his proposal and informed himself, his Subcontractors, Sub-subcontractors and material men of all existing conditions affecting the execution of the Work.

   C. The Contractor will be held to have examined the Contract Documents and modifications thereto, as they may affect subdivisions of the Work and informed himself, his Subcontractors, Sub-subcontractors and material men of all conditions thereof affecting the execution of the Work.

   D. The Scope of Work for the Contract is not necessarily limited to the description of each section of the Specifications and the illustrations shown on the Drawings. Include all minor items not expressly indicated in the Contract Documents, or as might be found necessary as a result of field conditions, in order to complete the Work as it is intended, without any gaps between the various subdivisions of work.

   E. The Contractor will be held to be thoroughly familiar with all conditions affecting labor in the area of the Project including, but not limited to, Unions, incentive pay, procurements, living, parking and commuting conditions and to have informed his Subcontractors and Sub-subcontractors thereof.

5. CONTRACT DOCUMENTS INFORMATION

   A. The Contract Documents are prepared in accordance with available information as to existing conditions and locations. If, during construction, conditions are revealed at variance with the

Contract Documents, notify the Construction Manager immediately, but no more than three (3) days from the day the variance is first known. Failure to give timely notice shall operate to waive any claim Contractor might otherwise have for an adjustment to Contract Time or Sum as a consequence of such variance.

B. The Specifications determine the kinds and methods of installation of the various materials, the Drawings establish the quantities, dimensions and details of materials, the schedules on the Drawings give the location, type and extent of the materials.

C. Dimensions given on the Drawings govern scale measurements and large scale drawings govern small scale drawings, except as to anything omitted unless such omission is expressly noted on the large scale drawings.

D. The techniques or methods of specifying to record requirements varies throughout text, and may include "prescriptive", "open generic/descriptive", "compliance with standards", "performance", "proprietary", or a combination of these. The methods used for specifying one unit of work has no bearing on requirements for another unit of work.

E. Whenever a material, article or piece of equipment is referred to in the singular number in the Contract Documents, it shall be the same as referring to it in the plural. As many such materials, articles or pieces of equipment shall be provided as are required to complete the Work.

F. Whenever a material, article or piece of equipment is specified by reference to a governmental, trade association of similar standard, it shall comply with the requirements of the latest publication thereof and amendments thereto in effect on the bid date.

G. In addition to the requirements of the Contract Documents, Contractor's work shall also comply with applicable standards of the construction industry and those industry standards are made a part of Contract Documents by reference, as if copied directly into Contract Documents, or as if published copies were bound herein.

H. Where compliance with two (2) or more industry standards, contract requirements, or sets of requirements is specified, and overlapping of those different standards or requirements establishes different or conflicting minimums or levels of quality, then the most stringent requirements, which are generally recognized to be also the most costly, is intended and will be enforced, unless specifically detailed language written into the Contract Documents clearly indicates that a less stringent requirement is to be fulfilled. Refer apparently equal but different requirements, and uncertainties as to which level of quality is more stringent, to Architect for decision before proceeding.

I. Reference standards referenced directly in Contract Documents or by governing regulations have precedence over non-reference standards which are recognized in industry for applicability of work.

J. Contractor's bid is based on the complete set of Contract Documents including documents not specifically issued as part of the bid pack but referenced in same.

6. SCOPE OF WORK/GENERAL INFORMATION

A. A Scope of Work for each contract to be awarded on the project follows in this section. When a Contract has been awarded to a Contractor, the successful Contractor will be listed after the title of the Contract. When no Contract has yet been awarded, no Contractor's name will be listed. Previous Scopes of Work include addendum changes.

B. Contractor is responsible for performing the work listed in the Summary of Work for his contract. Contractor is also responsible for knowing the work that has been assigned to preceding contracts. No additional compensation or extension of time will be allowed a Contractor due to his ignorance of the work assigned to his Contract or to other contracts which may affect his work. The Contractor is responsible, however, for all items which are covered in the Specifications and Drawings relating to their Contract if not specifically mentioned in the Summary of Work.

C. The Construction Manager will provide on-site a source for temporary electric, temporary water and portable sanitation facilities only. It is each Contractor's responsibility to make the necessary connections, including all material for temporary electric and water. Please note that utility charges for office trailers will be the responsibility of the individual Contractors.

D. A dumpster will be provided on site for free use by Contractors to dispose of non-hazardous, common, work-related refuse. Clean-up is the responsibility of each Contractor. Clean up shall be performed on a daily basis. Contractors not complying will be advised in writing and back charged for all costs associated with the cleanup of their work.

E. Contractors are reminded that there are limited storage areas available on site. Off-site storage will be the responsibility of each individual Contractor.

F. Office trailer permits off site will be the responsibility of each individual Contractor. On site Contractor's field offices, one (1) per Contractor, if required, will be located as directed by the Construction Manager.

G. Contractor will be prepared to discuss and submit a detailed project schedule seven (7) days after receipt of Notice to Proceed and to begin its submittal process. The Project Schedule is an integral part of this contract. Certain construction sequences and priorities must take place in order to meet the target dates. Concentrated work periods will occur and each Contractor is responsible to staff the project as required by the current Construction Schedule or as directed by the Construction Manager. Contractor will cooperate with the Construction Manager in planning and meeting the required sequences of work and Project Schedule as periodically updated by the Construction Manager.

H. All bids must include insurance limits in accordance with Article 11 of the Section 007300 SUPPLEMENTARY CONDITIONS.

I. Hoisting, scaffolding and material handling is the responsibility of each Contractor, unless otherwise noted.

J. Contractor will be responsible for layout of its own work. The Construction Manager will provide benchmark and layout of the building line.

K. Contractor will be responsible to keep clean public roadways soiled by construction traffic on a daily basis. If cleaning is not done, the Construction Manager may perform the cleaning on an

overtime basis and backcharge the Contractor responsible.

L. Contractor Scopes of Work and Schedule are interrelated. Familiarity with each is required.

M. The Construction Manager will provide testing services for soil, concrete and steel. Other testing as required by the Contract Documents will be in accordance with the technical specifications and/or the individual scope of work. Refer to Specification Section 004500 - QUALITY CONTROL.

N. Safety is the responsibility of each individual Contractor. The project will be governed under the guidelines of OSHA.

O. Inter-Contractor shop drawing distribution will be performed by the Construction Manager. Contractor is individually responsible for either coordinating his work with these distributed drawings or notifying the Construction Manager, in writing, of any discrepancies.

P. Coordination with other trades will be required. The Contractor will be required to attend periodic coordination meetings with other trades where requirements, conflicts and coordination issues will be discussed and resolved. Attendance when requested will be mandatory. If inter-Contractor coordination is not satisfactorily performed, the conflicting Contractors shall mutually share the cost to relocate and/or reinstall their work.

Q. Contractor shall submit a schedule of values to the Construction Manager prior to the submission of their first invoice for approval through Building Blok.

R. Contractor is expected to review and coordinate its Work with the complete set of Contract Documents, including all items noted as by his trade whether or not shown on that particular set of drawings. Documents are available at the site for review.

S. Contractor is responsible for obtaining all necessary permits required for his work, including street permits. Unless otherwise noted, building permit shall be secured by the Construction Manager. Any subcontractor who will be restricting access to street, right of way or adjacent property must notify the Construction Manager 48 hours in advance.

T. Contractor's License: Submit a copy of all business licenses required by local and state agencies.

U. Contractor shall absorb, without additional compensation, any and all costs of working beyond normal hours to maintain job progress in accordance with the current construction schedule.

V. No asbestos or PCB's in or on any material or equipment will be accepted or allowed on this project. All hazardous materials will be treated in accordance with all State and Federal regulations.

W. Daily cleanup of the work is the responsibility of each individual Contractor which includes broom cleaning of their debris as required. Contractor will be individually back charged by the Construction Manager for cleanup not satisfactorily performed by the Contractor.

X. In the event asbestos is uncovered, the Contractor shall notify the Construction Manager of the areas requiring removal of asbestos. The Construction Manager shall then coordinate the removal

with the Owner.

Y. This project is to be constructed adjacent to existing buildings. Contractor shall exercise all due precautions to minimize noise, air pollution and any other construction hazards which in any way would cause discomfort or danger to the occupants of the existing building in the area.

Z. The Safety Cable System shall not be altered or removed without a written request submitted to the Project Manager with a copy to the Field Manager. It shall be the responsibility of each and every Contractor that is removing or altering the Safety Cable System to maintain the fall protection safety provided by the safety cable and not leave the area unprotected. Each and every Contractor shall be responsible to re-install the Safety Cable System immediately after work is completed. Each and every Contractor shall be responsible to re-install the Safety Cable System in accordance to OSHA standards.

AA. Normal work hours for this project are from 7:00 a.m. to 3:30 p.m. Any work to be performed outside of these hours must receive prior approval from the Construction Manager. Requests to work beyond normal work hours shall be submitted at least 48 hours prior.

AB. Contractor is responsible for having a competent project superintendent/foreman on-site during all work performed under its contract.

AC. In the event the Contractor has non-English speaking employees or subcontractors on the project, they shall have a superintendent or foreman on site, at all times, who speaks English and can communicate with Contractor's employees. Should the Contractor fail to meet this requirement, at any time, Construction Manager may direct all Work to stop until the proper supervision is on site. The Contractor will be responsible for maintaining the project work schedule and make up at its own expense, any delay to the Schedule resulting from the work stoppage.

AD. Punch List Procedures: Contractor shall be given a copy of the punch list with his appropriate work identified. Contractor shall have nine (9) calendar work days to complete its punch list work. On the 10th day or as determined by the Construction Manager, the Construction Manager shall employ other contractors, as required, to complete any incomplete punch list work and retain from the appropriate Contractors retainage all costs incurred.

AE. Contractor shall provide the necessary safety barricades and railings required to complete their work and comply with all OSHA, local code and contract specifications.

AF. **Prohibition of Using Photographs on EDiS Projects**: The Contractor and all associated subcontractors agrees to not issue any news release or advertising pertaining to the Work or the Project, including references to the Project on the Contractor's/subcontractor website or other social media outlets, without obtaining EDiS' prior written approval, in each instance. The Contractor, for itself, its employees, vendors and subcontractors, agrees to not use the name of the Owner, the Project, EDiS or any photographs, videos, or other images of the Project in connection with any of Contractor's business promotion activities, advertising, website, social media outlets, or operations, without EDiS' prior written approval in each instance.

AG. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

AH. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

AI. All contractors must provide a silica exposure plan that meets or exceeds the new 2017silica OSHA requirements before any work can commence. At a minimum, it must be implemented into the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

AJ. All contractors shall be responsible to protect all non-metallic piping within the building envelope from overspray of the Applied Fireproofing, intumescent coatings, fire caulking and fire safing as it pertains to the scope of your course of work. The contractor shall be familiar with and comply with the NFPA regulations, including but not limited to the following 6.3.7.5 Firestopping materials intended for use on nonmetallic piping penetrations shall be investigated for compatibility with the nonmetallic pipe materials. 6.3.7.5 Protection plan shall be submitted and reviewed with the CM prior to implementation.

AK. For all contracts which include allocations for COOP hours with NCCVT students, any unutilized COOP hours shall be returned to the district at the rates published in the documents, as a credit change order.

CONTRACT NO. D.1-02 - MISCELLANEOUS METALS, STAIRS, AND RAILS

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 055000	Metal Fabrications
Section 055100	Metal Stairs
Section 055133	Metal Ladders
Section 055213	Pipe and Tube Railings
Section 057300	Decorative Metal Railing

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide stairs, loose lintels, misc. metal angles, plates, handrails, railings, metal ladders and accessories.

2. Furnish loose steel lintels, angles, plates and embedded items to the Concrete and Masonry contractors.

3. This contract shall provide to Contract D37 Misc. Concrete the Mechanical yard pipe rack anchors bolts and leveling plates referenced on drawing M315 (typical.)

4. Review Alternates as per the Bid Form and Alternate section for work related to Stair #5.

5. Review Alternates as per the Bid Form and Alternate section for work related Alternate No.3 CTE expansion. This contract shall provide all Misc. Metals items related to this work. The structural steel, joists and decking is provided by Contract C-03

6. This contractor will be required to coordinate work of this contract with the Structural Steel, Joist and Deck contract which is part of BP-C. Review and understand the BP-C contract as it relates to your work.

7. This is not a secure site. All contractors are responsible for concealing, locking and/or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

8. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

9. Provide miscellaneous rough hardware, iron shapes, framing and support angles.

10. **This contractor shall provide all H&B partition top supports at the masonry walls as shown on drawing S004. (Addendum No. 1)**

11. Provide powder coated downspout boots per section 055000-10. **Per previously issued BP-D Addendums, this item refers only to downspout boots on the exterior. (Addendum No. 2)**

12. Provide stair nosing's.

13. Provide gratings.

14. Overhead door frames, furnished and installed.

15. Elevator hoist beams, provide and coordinate installation with BP-C masonry contractor.

16. Elevator sill angles, provide and coordinate anchoring systems, bolts etc. and installation with other trades.

17. Toilet partition supports, if not part of the manufactured toilet partition frame shall be supplied by this contractor. **Spec section 102113.19-2 calls out a floor mounted Toilet Partition system, additional support is only required by this contract if specifically called for on the contract drawings. (Addendum No. 2)**

18. Provide ships ladder, access ladders and related fastening devices and accessories.

19. Galvanizing and other special coatings as required.

20. Anchoring devices, fasteners, inserts and other related items associated with the installation of the above items.

21. Field touch-up paint.

22. No electrical power for welders will be provided.

23. Verify all field dimensions prior to fabrication.

24. No electrical power for this contractor's equipment or welders will be provided. Electrical power to be provided as needed by this contractor.

25. This contractor must provide a silica exposure plan that meets or exceeds the new 2017silica OSHA requirements before any work can commence. At a minimum, it must be implemented into the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

26. Include within this contracts base bid an allocation of $20,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner.

CONTRACT NO. D.1-05 - EXTERIOR METAL PANELS

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 054000	Cold-Formed Metal Framing
Section 055000	Metal Fabrications
Section 074213.13	Metal Wall and Roof Panels
Section 074213.23	Metal Composite Material Wall Panels
Section 076200	Sheet Metal Flashing and Trim
Section 079100	Preformed Joint Sealants
Section 079200	Joint Sealants

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide all metal panels, framing, sub girts, Z furring, insulation and all other components to provide a complete metal panel system.

2. Provide Flashing and complete "engineered and sealed" (Delegated Design) as shown in detail D1/A612. Include all flashing, closures, jamb reveal detail, self-adhered flashing tape etc. to provide a complete system at all locations. This contractor must work with and in conjunction with the spray foam system installation and sealing.

3. This contractor shall provide the MCM metal column enclosures color 2 as indicated on A-202, A-203 and A-207. Provide a complete and sealed systems.

4. The spray installation system will be provided by the Masonry contractor, however this contractor is responsible to coordination. Specifically for installation durations and the completeness of the installation of the Z furring system this contract is providing. Timely installation to not impact the spray foam installation is required by this scope of work.

5. Provide all composite metal panel return systems as identified in detail A1/A612, A7/A612 and similar details as indicated. Jamb return needs to be coordinated with the window installation.

6. Provide all fascia's, soffits, overhangs etc. as required for a complete system.

7. Flashing of panels integral with the panel system.

8. Coordinating, cutting and fitting around the work of other trades is required by this contract and should be part of your base bid work.

9. Caulking of panels as required to provide a complete system. Vertical joints where metal panels meet adjacent materials shall be caulked by the Caulking and Salant contractor.

10. Miscellaneous metal items necessary to support panels other than required structural steel.

11. Furnish anchorage items for embedding into other construction for support of panels.

12. Touch up of all welding.

13. No electrical power for this contractor's equipment or welders will be provided. Electrical power to be provided as needed by this contractor.

14. Galvanized, epoxy or stainless steel, etc. anchors as specified.

15. Metal fascias and copings related to the panel system.

16. This Contractor shall coordinate his shop drawings with the Window Contractor's shop drawings and the overall construction schedule.

17. Coordinate all work of this contract with the Carpentry contractor for the installation, flashing and complete installation of the louvers into the metal panel system. Close coordination of shop drawings is required by these two contracts.

18. All material handling, lifts, cranes etc. are the responsibility of this contractor.

19. Verification of field dimensions is the responsibility of this Contractor. Coordination and review window openings, door openings and others during the shop drawing process is required so materials can be ordered to accommodate schedule. Material may be required to be ordered in advance of the ability to field measure. This coordination is the responsibility of this contractor.

20. Provide all flashing as identified with the metal panel installation. Provide all hat channels and sub-girts for the panel installation. Coordinate with the work of other contractors related to the spry foam installation.

21. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

22. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. NCCVT and EDiS will not be responsible for any lost tools, materials or equipment.

23. This contractor must provide a silica exposure plan that meets or exceeds the new 2017silica OSHA requirements before any work can commence. At a minimum, it must be implemented into the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

24. Include within this contracts base bid an allocation of $30,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner.

CONTRACT NO. D.1-38 – ELECTRICAL SERVICE PRIMARY DUCTBANK

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Division 26	Electrical
Section 033000	Cast in Place Concrete
Section 260543	Underground Ductbanks
Section 261120	Utility Incoming Service Provisions
Section 312300	Excavation and Backfill for Pipelines and Structures

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. This contractor shall provide the work associated with the incoming electrical service from the Delmarva switch at Glasgow Avenue to the main transformer in the service yard at the building. This course of work shall include but not be limited to the layout, excavation, installation of conduits within the ductbank, concrete encasement where indicated, all electric power cables, pull strings, racks and backfilling of trench and restoration of areas disturbed back to original condition.

2. The power cabling shall be pulled to the transformer pad area and left coiled up for use by others once the transformers are set.

3. Excavation and backfill for underground electrical work as required below is the responsibility of this Contractor. Soil types shall be in accordance with project specifications and the Geo-Tech report. Geo-Tech reports included for review and acceptance.

4. Backfilling is the responsibility of this Contractor. Soil types shall be in accordance with project documents. It is the intent to use on-site material and not imported fill. The use of this on-site material shall conform to the compaction requirements identified in Section 312300. Excavated materials shall be covered immediately and protected from moisture mitigation. If Materials become unusable, this contractor shall own purchasing acceptable off-site materials.

5. Include requirements of New Castle County, State, and local codes for concrete encasement.

6. The onsite testing and inspection agency provided the owner will monitor the excavation and backfilling operation.

7. All guarantees and warranties to begin at the substantial completion of the entire project.

8. Hoisting, rigging, and material handling required to perform your scope of work shall be provided by this contractor.

9. Coordinate and provide a complete grounding system as it relates to the incoming Primary incoming electrical service, wiring and ductbank**. Only required if specifically identified in the drawings or specifications. (Addendum No. 1)**

10. As-built drawings in both hard copy and electronic format including As-Built drawings.

11. Perform certification testing for all wiring and systems supplied by this contract scope.

12. Coordinate all work with the requirements of Delmarva Power and their standards and requirements. A pre-Con meeting with this contractor and Delmarva Power shall be scheduled and held before any work starts on the electrical service to the transformer.

13. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. NCCVT and EDiS will not be responsible for any lost tools, materials or equipment.

14. No electrical power for this contractor's equipment or welders will be provided. Electrical power to be provided as needed by this contractor.

15. This contractor must provide a silica exposure plan that meets or exceeds the new 2017silica OSHA requirements before any work can commence. At a minimum, it must be implemented into the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

16. Include within this contract's base bid an allocation of $10,000 for work to be determined by the owner and construction manager. Unused allocation funds to be returned to the owner.

"FOR REFERENCE ONLY"

CONTRACT NO. D-01 - UNIT MASONRY

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 033000	Concrete (coordination)
Section 042000	Unit Masonry
Section 044316	Stone Fabrications
Section 047200	Cast Stone Masonry
Section 321413.13	Interlocking Concrete Unit Paving
Section 070553	Fire and Smoke Assembly Identification
Section 072100	Insulation
Section 072640	Sprayed Polyurethane Foam Insulating Air Barrier
Section 072500	Weather Barriers
Section 076200	Sheet Metal Flashing and Trim
Section 078400	Firestopping
Section 079100	Preformed Joint Sealers
Section 007900	Joint Sealers

This contract provides and includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide masonry units, cast stone, reinforcing, accessories and related work. This contract includes all masonry work except the work provided by BP-C Foundation Masonry contract. This contractor owns coordination with the BP-C contractor and must review and understand the BP-C scope of work.

2. Provide all concrete interlocking pavers, grading, subbase, concrete substrate, grouting and cleaning as required to provide a complete brick pavers system.

3. This contractor to provide Detail F2 sheet A106 complete for all areas. Including concrete subbase and 8" thick concrete slab section.

4. This contractor to provide the colored concrete medallion in the courtyard complete.

5. Provide work specified in Section 044316 Stone Fabrications.

6. Provide all special shape, cast stone masonry and custom masonry units as defined in the construction documents.

7. This contract shall provide all Sprayed Polyurethane Foam Insulating Air Barrier with intumescent coatings, special paint layer per NFPA 285, and all "Self-Adhering Flashing Tape" at all locations (vertical and horizontal) behind vertical brick, block, metal panels, canopies and overhangs. The Flashing tape shall be applied to seal all exterior openings, including but not limited to doors, louvers,

windows, curtain walls, storefronts etc. This includes all exterior sheathed areas, and block back up areas, whether behind masonry or not. Include spray insulation termination angles as needed for the spray foam insulation installation Coordination of work with other trades shall be required and final installation work to be coordinated with project schedule and CM. Provide a "complete system" in its entirety for this project.

8. This contractor shall include multiple mobilizations within their base bid amount to accommodate the exposure time recommendation for the sprayed insulation, special coatings and self-adhering flashing tape in all areas per the construction schedule and project phasing.

9. This contractor shall provide installation and coordination of sleeves required to go through any masonry walls above finished floor elev. 0.00. Coordinate with the MEP contractors for sleeves (to be provided by MEP contractor) and coordinated/installed by the Masonry contractor.

10. Provide Fire and Smoke Identify markings on all masonry walls that require marking per governing jurisdictions. Coordinate marking walls with pant.\/stencils with the CM on site.

11. Masonry to dissimilar materials provided by Caulking contractor. Masonry to Masonry Caulking to be provided by Caulking Contractor D-10.

12. Integral masonry flashings, expansion joints, insulation and other related items as required.

13. Mock up as required. Provide a complete mockup of all masonry items within a sample wall to be coordinated by the CM. This contractor to provide and install the concrete footing required for the mock up. Include demolition, removal and clean up of the mock up area.

14. This contractor shall include within their bid the incorporation of **2000 hours of COOP participation** by a NCCVT student. Contractor to comply with project documents and requirements set forth in 19 del. C.ch.5.

15. Grouting of door frames at all masonry openings. Include grouting of HM vision panels in CMU and grouting of after-set frames in stair towers built by BP-C masonry contractor.

16. Weather protection and temporary heat as required to perform the work and maintain the project schedule. This would include tenting, tarping, heating (providing fuel and equipment), installation, maintenance and removal. Kerosene is not an acceptable fuel for work within the interior spaces.

17. Layout of the work including responsibility for all elevations and dimensions as they affect other Contractor's work.

18. Lintels either required by this Contract or install loose lintels furnished by others. Include bolting or welding of lintels as per details.

19. Provide mixing stations as required to perform your work. The station locations shall be coordinated with the CM (include 5 separate locations and the remobilization of the station 5 times) The mixing area shall be protect as required by DNREC and it shall be this contractors responsibility to maintain the station area at all times. Remove all components and restore area when work of this contract complete.

20. Concrete fill/grout at all masonry units as identified.

21. Purchasing and installing reinforcing steel in block walls.

22. Provide all fire safing/fire stopping, and continuous fire sealant at top and bottom of masonry walls as shown on the contract documents. Also include these sealants at all steel penetrations through the provided masonry.

23. Silicone waterproofing/sealant if specified.

24. This contractor shall provide the required firewall/smoke wall assembly identification for work of this contract. (labelling of the walls with fire rating)

25. Interior exposed masonry walls shall be cleaned and scraped thoroughly; a second pass of scraping and refining the cleaning shall be included in the base bid. CM to review and coordinate second pass with the masonry foreman in the field.

26. Temporary protection for final wash down/cleaning of masonry. This includes covering and protecting the curtain wall, storefronts, Kalwall and all door window openings.

27. This contractor shall supply and install straw at the base of wall when work of this contract has been completed to stop splashing of mud and water on completed walls.

28. Flashing at locations indicated on drawings for your work.

    a) Thru wall and cavity flashing below the roof line shall be by the Masonry Contractor.
    b) Thru wall and cavity flashing above the roof line shall be by the Roofing Contractor.
    c) Flashings at rising wall conditions shall be provided by this contractor.

29. Cutting, fitting and building into masonry work, embedments provided by others. Coordinate all work with other trades as required.

30. Provide all firesafing and fire caulking as required for your course of work.

31. Provide masonry veneer anchors as required for your course of work.

32. Bond beams including supplying and installing reinforcing and fill.

33. Elevator shaft masonry block in BP-C contractors scope. All veneer and finish masonry shall be provided by this contractor. Include the final infill toothing of the block around the elevator door frames at each level in this contract. Include sealing and fire safing as required at top of shaft wall.

34. Furnish and install all masonry veneer anchors where required. Welding of anchors that are not shown to be fabricated with the structural steel shall be welded in place as needed by this contractor.

35. Masonry contractor shall supply and manage dumpsters for use in removal of masonry debris. The project dumpsters may not be used for masonry debris.

36. Mock up as required. Provide your portion of a complete mock-up of the exterior wall assembly for areas of masonry, metal panel, translucent panels and others as detailed. within a sample wall to be coordinated by the CM.

37. Provide generators and services as required to provide temp power, water etc. as needed for your course of work.

38. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

39. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

40. This contract includes all Division 0 and Division 1 General Requirements. All commissioning requirements are identified in Division 1 and are a requirement of this contract.

41. This contractor must provide a silica exposure plan that meets or exceeds the new 2017silica OSHA requirements before any work can commence. At a minimum, it must be implemented into the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

42. Include within this contracts base bid an allocation of $40,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner.

"FOR REFERENCE ONLY"

CONTRACT NO. D-03 - EXTERIOR STRUCTURAL STUD ASSEMBLY

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 054000	Cold-Formed Metal Framing
Section 070553	Fire and Smoke Assembly Identification
Section 072100	Thermal Insulation
Section 072129	Sprayed Acoustical Insulation (coordination)
Section 072640	Spray Polyurethane Foam Insulating Air barrier (coordination)
Section 072500	Weather Barriers (coordination with mason contractor)
Section 079100	Preformed Joint Sealants
Section 079200	Joint Sealants
Section 078400	Firestopping
Section 092116	Gypsum Board Assemblies

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide structural stud assembly for the exterior skin of the building. Including but not limited to Metal Studs, gyp sheathing, Fire safing and delegated design on the exterior wall assembly.

2. Provide rock wool thermal insulation at area where exterior walls create parapets and at edge of floor slab connections.

3. This contractor shall be responsible to coordinate with the masonry contractor as related to the exterior wall assembly and the installation of the spray foam insulation system.

4. Steel stud construction as related to the roof parapet construction.

5. Steel stud construction related to framing out for openings in exterior walls.

6. Provide secondary support framing as required.

7. Clips, anchors, supports and other accessories that interface between steel framing and steel studding and steel studding with masonry interaction.

8. Expansion systems as required for performance of your course of work.

9. Scaffolding, lifts, and all necessary equipment required for your contract's course of work.

10. Provide engineered drawings (delegated design requirements.)

11. This contractor shall be responsible for coordinating with other trades for exterior openings and layout of design features.

12. Comebacks and out-of-sequence work may be required and as such should be included in your base bid proposal.

13. No power for welding equipment will be provided. This contractor shall provide portable generators, fuel, etc.to power equipment required for their scope of work.

14. Coordinate Self Sealing Flashing installation at base of wall assemblies and flashed areas. with Masonry contractor who is providing. This contract (D-30 Ext Wall) to provide any required metal flashings for your course of work.

15. This contractor shall supply and install any access panels in the exterior wall assembly that are required by the contract documents. In addition the contractor shall install (40) 2'X2' Access panels provided by other. (exterior walls only)

16. Provide fire resistant joint sealants, fire safing, fire stopping, as it relates the work of your contract.

17. Bidders are advised to pay particular attention to top of wall conditions, fire and smoke safing of slabs and acoustical sealants.

18. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

19. This contractor must provide a silica exposure plan that meets or exceeds the new 2017silica OSHA requirements before any work can commence. At a minimum, it must be implemented into the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

20. Layout of the work including responsibility for all elevations and dimensions as they affect other Contractor's work.

21. Mock up as required. Provide your portion of a complete mock-up of the exterior wall assembly for areas of masonry, metal panel, translucent panels and others as detailed. within a sample wall to be coordinated by the CM.

22. This contractor shall include within their bid the incorporation of **750 hours of COOP participation** by a NCCVT student. Contractor to comply with project documents and requirements set forth in 19 del. C.ch.5.

23. This contract shall include in their bid the necessary crews to complete the work as per the project schedule. Provide additional crews as required to maintain schedule at no additional cost to the project.

24. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

25. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

26. Include within this contracts base bid an allocation of $40,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner.

"FOR REFERENCE ONLY"

CONTRACT NO. D-04 - CARPENTRY AND GENERAL WORK

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 055800	Architectural Metal Column Covers
Section 06100	Rough Carpentry
Section 06200	Finish Carpentry
Section 079200	Joint Sealants
Section 081113	Hollow Metal Doors and Frames (coordination, handing, installation)
Section 081416	Flush Wood Doors (coordination, handing, installation)
Section 081613	Integrated Door Opening Assemblies (coordination, handling, installation)
Section 083100	Access Doors and Panels
Section 087100	Door Hardware (coordination, handing, installation)
Section 080671	Door Hardware Schedule (coordination, handing, installation)
Section 089100	Louvers
Section 101101	Visual Display Boards and Display Cases (coordinate blocking and supports)
Section 102113	Plastic Toilet Compartments (coordinate blocking and supports)
Section 102123	Cubicle Curtains and Track (coordinate blocking and supports)
Section 102601	Door and Wall Protection (coordinate blocking and supports)
Section 102800	Toilet Accessories (coordinate blocking and supports)
Section 104400	Fire Protection Specialties (coordinate blocking and supports)
Section 129300	Site Furnishings
Section 116625	Gymnasium Equipment
Section 116653	Gymnasium Dividers
Section 323119	Decorative Metal Fences and Gates

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide labor and materials to perform the work related to all carpentry and general work.

2. All rough carpentry related to the exterior skin of the building and roof areas, including wood nailers and blocking, roof blocking, curb blocking, MEP blocking coordinated with MEP trade, fire shutter blocking etc. as required. Include blocking for roller shades.

3. All rough carpentry related to the interior of the building including blocking, wood nailers, etc. for the installation of fire extinguishers, doors, windows, toilet accessories, cabinets, toilet partitions, casework, millwork, AED's, gas and air cabinets, rollup doors, coiling doors, kitchen equipment and accessory blocking, etc. including fire treating as required.

4. Provide interior architectural metal column covers as required. (Note the MCM exterior column enclosures are provided by the Metal Panel contractor)

5. Provide all decorative metal fencing and gates as per contract documents. Include complete installation and coordination with electrical and special systems contractor for the locking interface and card access.

6. Provide and install plywood back boards on all wall areas, floor to ceiling in all electric, MDF and IDF rooms. Backboards to be ¾ inch plywood, painted one side with white Fire Proof paint and fire caulked to the walls tightly.

7. This contract shall provide all bollards complete as indicated on the contract documents,. This includes the bollards that are shown and detailed on the MEP documents as well as the architectural other documents.

8. This contractor shall include the installation of the key box system and all required blocking and anchoring systems.

9. Provide blocking and anchoring for all roof ladders, TV and monitor mounts, Smart Board displays, Visual display boards, chalk, tack and white board assemblies. Coordinate with other trades for locations and installation direction.

10. Provide blocking for door hold opens, wall mounted closers, and wall door stops. Hold open hardware is to be provided by Contract D-11 HM, Doors and Hardware and installation provided by this contract.

11. This contractor shall install the interactive displays as furnished by the owner. Work shall be coordinated with Contract D-35 Special Systems.

12. Provide all Gymnasium equipment and Gymnasium dividers as part of this contract.

13. This contract shall provide all Mseal expansion joints required on the interior wall systems of the building. This includes but is not limited to Masonry to masonry, Masonry to drywall etc.) For chase walls and enclosure walls this contract shall supply the Mseal Expansions as well. Detail A6/A512A identifies Expansion Joint Covers, This contract to provide the covers in this detail and all other interior details identifying these types of expansion cover. (typical)

14. Install metal and wood doors and frames, including receipt of doors and frames at the curb side. Contractor shall receive the doors, frames and hardware and inventory immediately. This contractor responsible for safe keeping of all materials and shall provide written documentation that all materials were received. All hardware shall be secured in a fully locked and protected area. By this contractor.

15. Install finish hardware related to all doors (hollow metal, wood and coordinate keying with aluminum hardware) including receipt of hardware at the curb side. This contractor is responsible for coordinating door hardware with their work to ensure each opening is properly prepped for hardware being supplied by others. All low voltage wiring within the doors and frames to be installed by this contractor. Conduits and raceways will be provided by the electrical contractor, as well as installation of the electrical supply power and the final power connections to equipment. Final connections of low voltage wiring to hardware to be provided by the Special Systems contractor. This contractor to work with the electrical contractor and Special Systems contractor to provide a complete installation.

16. This contractor shall advise the hardware supply contractor of any deficiencies or missing item immediately after initial inventory (in writing) as installation takes place. Reporting and tracking is the

responsibility of this contractor.

17. All field trimming required to adjust to the existing in place conditions shall be part of this contractors scope of work. Field measuring and verification is to be included.

18. Anchoring devices, fasteners, inserts and other related items associated with the installation of the above items.

19. Provide all architectural louvers, including insulated panels etc. All louvers are to be included within this contract, they are shown on the architectural drawings and specs and referenced by MEP documents. Provide 'custom" color costs in the base bid. Coordinate the louvers provided within the Kalwall System for custom color, sizing, design or other integrated features. This contractor shall coordinate with other trades for integration of the louvers into their course of work. All material handling and on site protection of the louvers is this contractors responsibility.

20. Provide blocking and support for the Visual Display Boards and Display Cases.

21. Provide all blocking as required for Toilet Partitions, Cubicle Curtains, Door and Wall Protection, Toilet Accessories and Fire Protection Specialties. Coordinate with the BP-D contract for "Specialties" on all required blocking. Volleyball sleeves and installation shall be coordinated and installed by this contractor,

22. This contractor shall provide and install all Gymnasium Equipment a per contract documents, to include blocking, supports, material handling etc. 100% protection of the gym floor while performing your work is required by this contract. Floor protection shall be as provided by the wood floor manufacturers recommendations.

23. This contractor shall provide al Gymnasium scoreboards as indicated on A-111 (3 scoreboards in total)

24. This contractor shall provide and install all Site Furnishings as detailed in the contract documents. Include all work related to this course of work, concrete pads, anchoring, touch up paint etc.

25. This contractor to coordinate all card reader blocking requirements with Special Systems contractor.

26. Provide protection at Elevator door openings at each floor. Include the required mesh protection fabric and the necessary wooden framing that allow easy access by other trades. Include maintenance for a period of 30 months from initial installation. Once elevator is installed, provide ¾" blue board foam insulation on all surfaces taped and secured so as not to damage finishes of elevator. Provide maintenance of this protection until substantial completion of project.

27. Provide and maintain temporary wood railings and handrails at stairs. Provide wood infill of stair pans and landing pans. Each tread to have abrasive edge tape applied immediately after installation of infill.

28. This Contractor shall include in the base bid 600 hours of Journeyman carpenter time and 250 hours of common labor time for work to be directed by the Construction Manager.

29. This Subcontractor shall at a minimum provided, maintained, and inspect for the length of the project, one temporary fire extinguisher for each 3,000 sq. ft of the protected building area. Travel distance from any point of the protected area to the nearest fire extinguisher shall not exceed 100 feet. In

multistory buildings, at least one fire extinguisher shall be located adjacent to stairway. Fire extinguishers shall be at least 10lb, Multi-Purpose (ABC) dry chemical, UL labeled, with a rating of 3a:40bc. Maintain for the duration of the project until substantial completion to insure coverage and compliance.

30. Coordinate electrical requirements with any automatic door operations. This contractor owns all controls, switches and wiring as required for a complete system. Power to be supplied by Electrical contractor.

31. Gate hardware provided and installed by this contractor , Contract D-04 Carpentry.

32. Provide three Knox Boxes coordinated with the local fire company for installation at locations identified by the owner/CM.

33. Coordinate and install hold open closers with fire alarm interface. Power wiring by Electrical Contractor. Fire alarm ties in by Electrical Contractor.

34. This contractor will work with the Special Systems contract to allow the installation of harnesses, whips and connections while installing frames, doors, hardware and access controls.

35. Provide (2) separate scaffold stairways, each must be erected to accommodate access to the roof area from the exterior of the building. The scaffold must provide a landing with stairs at the roof area. Each scaffold leg should have adjustable base plates to accommodate the installation of roofing material without the disassembly of the unit. An 8 foot plywood "wall" must surround the bottom of the stairway with a hinged plywood door installed with a hasp to accept a lock. The scaffold must be installed per OSHA regulations, inspected and tagged for use. Include for a period of 18 months.

36. Provide and maintain perimeter netting at each floor level including all floor openings. Perimeter rail or cable to be provided by the steel contractor. This work shall include toe boards at all location. Netting to be included as detailed on the "Perimeter Safety Netting at Leading Edge Conditions" sketch included as part of this scope of work.

37. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

38. This contractor must provide a silica exposure plan that meets or exceeds the new 2017silica OSHA requirements before any work can commence. At a minimum, it must be implemented into the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

39. Layout of the work including responsibility for all elevations and dimensions as they affect other Contractor's work.

40. Provide all work related to the building mock up, blocking, installation of door frame, doors, hardware, flashings, fasteners etc. as it relates to mocking up of the systems included in the Carpentry Scope. Contract D-04 shall install the doors and hardware for the project mock up. Contract D-11 shall provide the door, frame and hardware for the mock up.

41. This contractor shall include within their bid the incorporation of **2000 hours of COOP participation** by a NCCVT student. Contractor to comply with project documents and requirements set forth in 19 del. C.ch.5.

42. Provide and maintain temporary handrails per OSHA standards at all stair assemblies. The below section is a guideline and doesn't replace the OSHA regulations Stairs having two or more risers or rising more than 30 inches (76 cm), whichever is less, shall be equipped with: At least one handrail; and one stairrail system along each unprotected side or edge. The height of stairrails shall be not less than 36 inches from the upper surface of the stairrail system to the surface of the tread, in line with the face of the riser at the forward edge of the tread. Handrails shall provide an adequate handhold for employees grasping them to avoid falling. Handrails that will not be a permanent part of the structure being built shall have a minimum clearance of 3 inches (8 cm) between the handrail and walls, stairrail systems, and other objects. Midrails, and intermediate vertical members, or equivalent intermediate structural members, shall be provided between the top rail of the stairrail system and the stairway steps. Midrails, when used, shall be located at a height midway between the top edge of the stairrail system and the stairway steps. When intermediate vertical members, such as balusters, are used between posts, they shall not be more than 19 inches (48 cm) apart.

43. This contractor shall provide temporary rails at all exterior opening on the building until permanent window/doors/curtainwall etc. installed.

44. This contractor shall include protective wooden covers and marking for any floor openings, holes, shafts etc. Include labelling of the covers with clear ad readable markings or stickers.

45. Provide temporary protective handrails at stage front, steps, stairs and ramp locations.

46. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

47. Provide **fall** protection at Elevator door openings at each floor. Include the required mesh protection fabric and the necessary wooden framing that allow easy access by other trades. Include maintenance for a period of 30 months from initial installation. Meeting the minimum requirements provided by the elevator vendor.

48. This contractor shall provide within the base bid, (8) sets of exterior steps to be constructed to create safe and easy access to the building first floor from the exterior grade. The step assemblies shall be figured to manage a 24" rise from grade to the first floor elevation, be 40" wide and shall have no-slip tread tape applied to each tread.

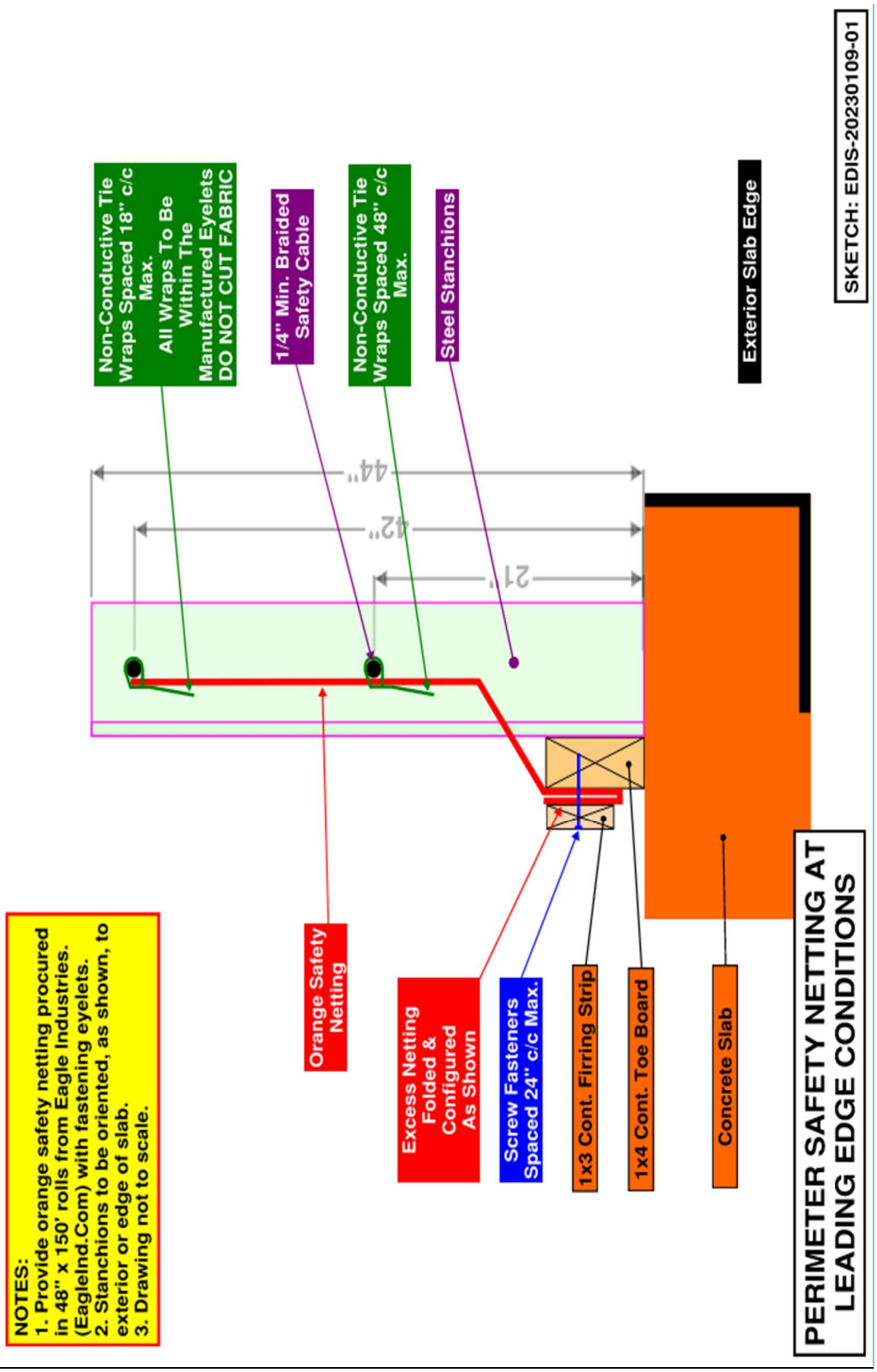
49. Provide, maintain and remove a prefabricated manufactured trash chute from the second floor to the dumpster below for a period of 24 months. This chute shall be maintained and all safety barriers, restraints etc. managed until substantial completion of the project.

50. This contractor shall provide and include all costs associated with installing temporary doors at the exterior of the building (all openings) and a cattle chute on the 2nd floor for accepting deliveries to the second floor. Safety equipment, gates, railings and tie-offs as required by OSHA safety standards shall be included.

51. This contractor shall include within their base bid an allowance of $100,000 for work relate to temporary enclosures at window, storefront and curtainwall areas as directed by the Owner and CM.

52. Provide wood safety barricades to extend top of roof parapets to OSHA required height during construction. Coordinate removal and replacement of wood safety barricades with metal wall cap installation.

53. Provide within this contracts base bid an allocation of $40,000 for work to be directed by the owner and CM. Unused portions of the allocation shall be returned to the owner.


SKETCH: EDIS-20230109-01
Non-Conductive Tie Wraps Spaced 18" c/c Max. All Wraps To Be Within The Manufactured Eyelets DO NOT CUT FABRIC
1/4" Min. Braided Safety Cable
Non-Conductive Tie Wraps Spaced 48" c/c Max.
Steel Stanchions
Exterior Slab Edge
44"
42"
21"
Orange Safety Netting
Excess Netting Folded & Configured As Shown
Screw Fasteners Spaced 24" c/c Max.
1x3 Cont. Firring Strip
1x4 Cont. Toe Board
Concrete Slab
NOTES:
1. Provide orange safety netting procured in 48" x 150' rolls from Eagle Industries. (EagleInd.Com) with fastening eyelets.
2. Stanchions to be oriented, as shown, to exterior or edge of slab.
3. Drawing not to scale.
PERIMETER SAFETY NETTING AT LEADING EDGE CONDITIONS

"FOR REFERENCE ONLY"

CONTRACT NO. D-06 – DRYWALL AND INTERIOR METAL FRAMING

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 051200	Structural Steel (related work)
Section 055000	Metal Fabrications (related work)
Section 054000	Cold-Formed Metal Framing
Section 061000	Rough Carpentry
Section 070553	Fire and Smoke Assembly
Section 072100	Thermal Insulation
Section 078400	Firestopping
Section 079200	Joint Sealers
Section 092116	Gypsum Board Assemblies
Division 15	Mechanical (coordination)
Division 16	Electrical (coordination)

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide metal studs, framing, insulation, gypsum wallboard, taping, spackling and specified wall finishes. (Level 5 where identified) Include all trims and finish pieces for a complete installation.

2. This contract shall provide Ceiling Type Acoustical Gyp Board (Gyp-2) as defined by the contract documents.

3. This contract shall provide all insulation in the exterior walls of the building system. Coordinate all insulation work and interior drywall work with the exterior Metal Framing contractor.

4. Provide secondary support framing and fastening devices as required. If Misc. metals are required by your installation and not identified in the documents this contractor shall provide and install.

5. Provide Fireproofing at the exterior wall and the edge of slab as shown in the typical wall sections. (A1/A312 example and all related details) Sealants required to complete this system shall be provided by this contractor.

6. Provide all interior metal framing at required for back up of other materials.

7. Provide batt insulation, both thermal and acoustical and related work.

8. Acoustical sealants, fire safing and fire caulking as required for penetrations and top of wall conditions.

9. Removal of spray fireproofing to expose points of attachment to structural steel is to be performed in a

workmanlike manner. Removal of spray fireproofing in excess of 3" greater than the attached item will require repatching which will be back charged to this Contractor.

10. This contractor shall coordinate with the other trades for all box outs, penetrations, framed openings etc. as required.

11. This contractor shall provide cleaning of the floor areas of all drywall spackle, mud, finishes etc. that are used by this contractor. Review and acceptance by the CM will be required.

12. Access panel installation (assume 100 total). Assume panels to be 30"x 30" for framing purposes.

13. Coordinate work of this contract with the Carpentry contract for wood blocking and support installation.

14. Coordination of door and interior framed openings with the Carpentry contractor who will install the door and lite frames.

15. Coordinate interior louver extensions and incorporation of louver installation with Carpentry contractor as necessary.

16. Include fire taping and sealing at perimeter edge and as shown or indicated in the contract documents.

17. Provide architectural expansion joint systems, including joint covers materials at concrete slab, drywall and masonry construction (interior only).

18. Scaffolding, lifts and material handling equipment for the course of your work.

19. Comebacks and out-of-sequence work may be required and as such should be included. Include (4) additional mobilization/return trips for touch up and repairs. Each trip shall include 16 hours of carpenter/finisher time as well as materials required for general patching. Comebacks and out-of-sequence work may be required by this contract and as such should be included. This shall include but not be limited to, mobilization for topping out of the drywall partitions including utilizing "paperless drywall" to accommodate environmental conditions and ratings to allow the mechanical systems to be roughed in. Additionally sequencing of the exterior drywall system with the temporary opening protection and the final blocking, door/window returns and the window system installation shall be considered and additional mobilizations included as needed.

20. Include all necessary field measurements.

21. Include three (3) passes per floor to "touch-up" mechanical penetrations to ensure ratings required. The first pass will be required prior to ceiling grid installation and the second pass will be required prior to final inspection for Certificate of Occupancy.

22. Bidders are advised to pay particular attention to top of wall conditions, fire and smoke safing of slabs and acoustical sealants. This work is include within the scope of this contract.

23. This contractor to provide caulking at the base and top of drywall partitions, furred walls and all drywall conditions.

24. This contractor shall work with other trades to install openings that are in wall assemblies being constructed.

25. Provide metal furring as required.

26. Provide all backing board (cement board) for tile areas and as directed by the contract documents. Coordinate with the Tiling contractor for requirements of this work.

27. Engineered shop and installation drawings. (delegated design)

28. This Contractor shall include a $175,000 allocation in his contract to supply, install, inspect and maintain a complete scaffold system to accommodate the construction of the Auditorium framing, ceiling systems, clouds, MEP installation etc. This contractor shall be the responsible contractor for this scaffolding system throughout construction until all work is completed and the CM authorized the removal of the system. All contractors shall provide signed waiver forms to the controlling contractor (this contractor) before they may access the scaffold system.

29. This contractor shall include within their bid the incorporation of **1000 hours of COOP participation** by an NCCVT student. Contractor to comply with project documents and requirements set forth in 19 del. C.ch.5

30. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

31. This contractor must provide a silica exposure plan that meets or exceeds the new 2017silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

32. Provide trash and debris removal daily. This means everything leaves the building and goes to the dumpsters. No piling of trash inside building will be permitted.

33. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

34. Include within this contracts base bid an allocation of $30,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner by means of a credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-07 – GENERAL LABOR AND CLEAN-UP

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Procurement and Contract Requirements
Division 1	General Requirements

This contract also includes, but is not necessarily limited to, all labor, materials, and equipment for the following:

1. This contractor shall provide General labor to the project the direction of the owner and project manager.

2. Include within the Base Bid for this contract $7,500 worth of material handling tools. To include but not limited to, wheeled bins for trash removal, shovels, brooms, trash bags etc. purchased materials shall be tracked with receipts and verified. Any funds left unspent will be returned to the owner via credit change order. (all tools purchased under this allocation shall be organized and turned over to the owner at completion of the work)

3. The contract shall include a total of 6,000 manhours of general labor to be scheduled by the Construction Manager. The work will start Feb 15 2024 and the duration of the coverage could extend to 15 May 2026. This work may be scheduled anytime within the scheduled date range without penalty or additional costs to NCCVT or the CM.

4. A unit price will be provided by this contractor that will pertain to any hours that may be deducted or added to this contract.

5. Pay Applications each month will be backed up with daily tickets and a complete accounting of the monthly hours utilized. Field Superintendent or hid designated representative shall sign all daily tickets.

6. The owner and CM have the right to request replacement of any personnel provide to service this contract, without out obligation or explanation.

7. Include within this contracts base bid an allocation of $7,500 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner by means of a credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-08 - ROOFING

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 072100	Thermal Insulation
Section 075300	Elastomeric Membrane Roofing
Section 076200	Sheet Metal Flashing and Trim
Section 077100	Roof Specialties
Section 077123	Manufactured Gutters and Downspouts
Section 077200	Roof Accessories
Section 079100	Preformed Joint Sealants
Section 07900	Joint Sealants
Division 23	HVAC (controls coordination)
Division 26	Electrical (power, fire alarm, lightning protection)

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide single ply flexible roofing system, including rigid and tapered insulation and all related accessories.

2. This contractor shall carefully review the edge of roof details to determine if the roof can be placed before the exterior wall assembly is complete. This contractor shall include all costs associated with returning to the jobsite to complete the roof perimeter after wall assembly is complete.

3. Provide caulking and joint assemblies related to roofing, flashing and roof accessories.

4. Roof drains and associated plumbing shall be provided by the Mechanical Contractor. Flashing of the roof drains shall be by the Roofing Contractor. Openings for the roof drains in the roofing materials shall be cut by the Roofing Contractor. Openings in the metal deck shall be cut by others. This contractor shall be responsible to coordinate the roof drain locations as needed by the steel contractor and plumbing contractor so reinforcing of the decking and roof support frames may be installed in accordance with the sequence of work.

5. Metal parapet coping, receiver system and all components required for a complete coping assembly. Caulking and sealing of all copings is the responsibility of this contractor.

6. Provide boot for piping and conduits that penetrate the roofing assembly. Coordinate with other trades.

7. Coordinate the roofing installation and flashing required for line sets, piping, electric and control penetrations. Coordinate with MEP contractors.

8. Roof hatches, smoke vents, smoke hatches, access covers etc. are to be provided by this contractor. Coordination of this work with other trades and the MEP vendors are required by this contract. Rail systems and curbs to be provided by this contract. The smoke hatches are not accessible shall be provided with remote controllers to test and re-set.

9. Walk pads and walk pad layout shop drawings are required by this contract.

10. Metal drip edges, complete including all caulking and sealants.

11. Gravel stops, complete including all caulking and sealants.

12. Roof curbs to be installed by this contractor, provided by the MEP trades as identified in the contract documents. Coordination with the Carpentry contractor on the roof blocking thickness is required by this contractor. Provide detail shop drawings identifying the insulation thickness so blocking can be installed accordingly.

13. This contactor shall coordinate with the carpentry contractor on location of wood blocking, curbing, etc. to facilitate the installation of the tapered insulation, crickets etc.

14. Provide expansion joints that are integral to the roof. Including but not limited to edge of wall Details E3/A590 and B1/A590.

15. Gutters, downspouts, splash pans, splash blocks. This contractor shall be responsible to coordinate with the plumbing contractor for the connection to the RW system. Provide membrane flashing, metal flashings, sealants, drip edge, gutters , drain covers etc. as related the gutter systems for this course of work.

16. Metal scuppers, over flows, drains etc. as required by the contract documents are this contractors responsibility.

17. Provide a means to lift materials to the roof for materials not stored on the roof at initial time of delivery. All costs shall be the responsibility of the roofing contractor.

18. This contractor shall manage, handle, lift and install the insulation materials supplied by the steel contractor for the areas of acoustical decking. Lifting of these materials to the roof when needed is the responsibility of the roofing contractor. At areas of Acoustical Decking below, fasteners for the first layer of roof insulation shall be installed so they “do not “penetrate the bottom surface of the decking. All layers of insulation above are to be imbedded into full bed od adhesive in accordance with roofing and insulation manufacturer’s instructions.

19. This contractor shall provide waterproof seals around lightning protection system as required by roof manufacturer requirements. If location of lightning protection conduits are not clearly shown on the roof plan, include within your base bid an additional; cost to seal one penetration for every 1000 sf of roof area.

20. This contractor shall review the schedule for the roofing scope of work and include within the base bid considerations (costs) for cold weather roofing installations. This shall include but is not limited to providing a warming hut/enclosure to keep material warm and allow the roof installation to continue in cold temperatures. All costs related to cold weather roof installation shall be the responsibility of this

contractor.

21. The owner may at any time select to have a third party roof inspector review and inspect the roofing installation and finished roof system. This contractor shall work with and allow access to this third party inspector as needed.

22. All trash shall be removed from this contractors work area daily to the dumpsters. No trash may be stored on the roof area.

23. Flashing and sheet metal systems related to the scope of this contract work.

24. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

25. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

26. This contractor shall include within the base bid proposal (2) additional roofing inspections of the entire roofing assembly to facilitate any damage or overuse repairs that may be required. These inspections will be schedule by the CM within the duration of the construction schedule. These inspections do not in any way take the place of the final warranty inspections as required by the contract documents.

21. Flashing Summary:
    a. Thru wall and cavity flashing below the roof line shall be by the Masonry Contractor.
    b. Thru wall and cavity flashing above the roof line shall be by the Roofing Contractor.

22. Include within this contracts base bid an allocation of $35,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner by means of credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-09 - FIREPROOFING

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 072129	Sprayed Acoustical Insulation
Section 078100	Applied Fireproofing
Section 078400	Firestopping

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide all fireproofing, both exposed and concealed as required by the contract documents.

2. Provide all intumescent and special coatings required by the code documents, identified in contract drawings, plans and details.

3. Provide Sprayed Acoustical Insulation as required by the contract documents. The Alternates apply to this area of work.

4. Clean up on a daily basis, all over spray materials. Remove all excessive water from spraying operation.

5. This contractor shall be responsible to protect all non-metallic piping within the building envelope from over spray of the Applied Fireproofing, intumescent coatings, fire caulking and fire safing as it pertains to the scope of your course of work. The contractor shall be familiar with and comply with the NFPA regulations, including but not limited to the following
   6.3.7.5 Firestopping materials intended for use on nonmetallic piping penetrations shall be investigated for compatibility with the nonmetallic pipe materials.
   6.3.7.5
   Protection plan shall be submitted and reviewed with the CM prior to implementation.

6. Inspection of the fireproofing for compliance will be provided by a third party inspector provided by the owner.

7. Protect fireproofing according to advice of fireproofing manufacturer and installer from damage resulting from construction operations or other causes so that fireproofing will be without damage or deterioration at time of Substantial Completion.

8. Coordinate installation of fireproofing with other work in order to minimize the need for other trades to cut or remove fireproofing. As other trades successively complete installation of their work, maintain protection of structure afforded by fireproofing by patching any areas which have been removed or damaged prior to concealment of fireproofing by other work.

9. This contractor to include and submit as a shop drawing for review a detailed mshop drawing of all areas of fireproofing and the required coatings on floor plans and elevations, to clearly illustrate where the fireproofing materials and special coatings will be applied.

10. This shop drawing will be shared with the Steel contractor for review and incorporation into their steel and joist preparation plan. (no primer, coatings, primers etc.)

11. Repair or replace work which has not been successfully protected.

12. Prepare all surfaces including priming of substrate if required.

13. Provide all required steel frame fireproofing whether clearly shown or not on the drawings. Do not include concrete fire proofing.

14. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

15. Provide Alternate pricing as required by the contract documents. (k-12 Sprayed Insulation at Shop Areas)

16. Include within you base bid 80 hours of labor and $20,000 of materials required to touch up fireproofing systems as required by the governing agencies (FM) or the construction manager.

"FOR REFERENCE ONLY"

CONTRACT NO. D-10 – JOINT SEALANTS AND PREFORMED JOINT ASSEMBLIES

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials, and equipment for:

Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 078400	Firestopping
Section 079100	Preformed Joint sealants
Section 079200	Joint Sealants

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide required caulking at control and construction joints.
2. Provide all preformed joint sealant products including but not limited to Emseal expansion joint as required. This contract shall provide all Mseal expansion joints as it relates to the exterior of the building.
3. Provide caulking of masonry to masonry.
4. Provide within your Base Bid proposal (240) man hours and $7,500 in materials to be utilized for Misc. fire safing and Fire sealants that may be required due to agency walk throughs and inspections. This work shall only be authorized by NCCVT or EDiS. Any remaining funds shall be returned to the owner via credit change order.
5. Provide caulking of vertical joints on exterior metal panels to adjacent materials (Metal Panel contractor to provide sealants and caulking between panels and as required to seal their assembly, including where metal panels sit on masonry.)
6. Provide caulking related to interior glazing. Caulking of interior perimeter of new aluminum windows, storefront and curtainwall to finished surfaces to be provided by this contract.
7. Provide caulking of exterior perimeter of hollow metal door frames. (including overhead doors)
8. Provide caulking of interior perimeter of hollow metal door frames to masonry. (HM frames to drywall shall be provided by the Painting contractor)
9. Provide caulking of all hollow metal frames to the floor. Coordinate caulking with flooring materials.
10. Provide caulking of all interior exposed drywall to masonry and metal wall panels.

11. Provide caulking at the tops and bottoms of all exterior and interior column covers.

12. Provide caulking of all interior exposed concrete slab control joints, expansion joints and perimeter slab to walls.

13. Provide caulking for interior perimeter of sinks, urinals, toilets, bath accessories, toilet partitions, fire extinguisher cabinets, hose reel cabinets, gas cabinets and any other accessories identified on the contract documents. (work as indicated on contract documents)

14. Provide caulking of joints in ceramic tile areas, including and ceilings.

15. Provide caulking of the top and sides of all finished stair stringers to adjacent materials. Include caulking of all stair stringers and bottom riser to floor.

16. Examine areas and conditions where joint sealers are to be installed and correct any conditions detrimental to the proper and timely completion of this scope of work. Do not proceed with work until unsatisfactory conditions are corrected to permit proper installation.

17. Provide mock ups of all products and adhesion tests for exterior caulking.

18. Provide custom colors or all caulks and sealants.

19. Protection and cleaning of adjacent surfaces to be the responsibility of this contractor.

20. This contractor shall include the Pollution Insurance coverage as specified in the contract documents.

21. This is not a secure site, the contractor is responsible for the safe storage of all of their materials. NCCVT and EDiS will not be responsible for lost or stolen materials

22. All subbase preparation, priming etc. to be performed before caulking is applied.

23. Include within this contracts base bid an allocation of $15,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner by means of a credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-11 - HOLLOW METAL, WOOD DOORS, AND FINISH HARDWARE

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 081113	Hollow Metal Doors and Frames
Section 081416	Flush Wood Doors
Section 081700	Integrated Door Opening Assemblies
Section 087100	Door Hardware
Section 080671	Door Hardware Schedule
Section 088000	Glass and Glazing (coordinate with glazing contractor)
Section 084313	Aluminum Framed Storefronts (coordination of keying)
Section 089100	Louvers (as related to doors)
Division 26	Electrical (coordination)
Division 27	Communications (coordination)
Division 28	Electronic Safety and Security (Coordination)

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Furnish only hollow metal doors, frames, vision panels, wood doors and finish hardware.

2. This contract shall furnish and deliver the Integrated Door Opening Assemblies Section 081613.

3. Furnish all work related to the building mock up of doors frames, hardware for each type of door on the project. Contract D-04 shall install the doors and hardware for the project mock up. Contract D-11 shall provide the door, frame and hardware for the mock up.

4. Keying for Aluminum Entrance doors to be coordinated and provided by this contract.

5. Keying. All lock sets. Provide Owner with a complete schedule of all keying and pin schedules as required.

6. Provide hex keys or flat keys for hardware not keyed to building hardware.

7. Provide cylinders and keying for elevator, light switches, panic bar dogging and door openers.

8. Construction door cylinders shall be provided by this contractor to the Carpentry contractor for use during construction. Plan and include the cost of providing (3) three separate levels of cylinders (green, red, blue) to allow areas to be secured separately as required by the CM. Provide (25) keys per color system.

9. All exterior Hollow Metal frames shall include a box and raceway built into the door frame for locations

at the latch and hinge as required. Provide a box and raceway at the head of the frames for door contact access and installation.

10. This contractor shall pay close attention to the Alternate section of the specifications as they relate to the scope of this contracts scope of work. (Access Control System- Salto Alternate)

11. This contractor shall coordinate the hardware and door materials with the Carpentry contractor prior to ordering materials. Including but not limited to all coordination meetings with the Owner, CM Carpentry contractor and Special Systems contractor as required to properly coordinate all doors, frames, hardware and connections, prior to ordering of materials.

12. This contractor shall deliver all materials as coordinated with the installer to the project site in an orderly organized manner. Deliveries will not be received unless the Carpentry contractor is notified and the delivery is coordinated. The Owner and EDiS will receive any materials. Additionally provide 48 hour notice prior to delivery. All deliveries are to be between 7:00 AM and 3:30 PM (allow time for check in of all hardware when scheduling)

13. Provide field assistance to Electrical and Carpentry Contractor as required to facilitate the installation of the materials supplied by your course of work.

14. This contractor to coordinate with the Special Systems contractor and Electrical contractor to ensure that all cut outs, plates, receiver etc. that are required to be built into your doors and frames are fully coordinated. In person attendance at review and coordination meetings for the doors, hardware, special systems, raceway and electrical connections shall be the responsibility of this contractor.

15. As changes are made to the hardware schedule, whether due to issued ASI's, RFI's, architectural changes etc., this contractor shall make updates to the hardware schedule and re-issue so the schedule is always updated and submitted to EDiS.

16. Coordinate electrical requirements with any automatic door operations.

17. Provide harness lengths to reach above accessible ceilings. Coordination of this work and the lengths required is the responsibility of this contractor. Provide any harness adapters and connectors required allow hardware to have a splice free system.

18. This contractor shall provide all magnetic hold open hardware, including extensions as required.

19. Provide a key box system to hold up to 25% over the amount of keys being supplied.

20. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

"FOR REFERENCE ONLY"

CONTRACT NO. D-12: OVERHEAD COILING DOORS

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials, and equipment for:

Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 055000	Metal Fabrications
Section 083313	Overhead Counter Doors
Section 083323	Overhead Coiling Doors
Division 26	Electrical (coordination)
Division 28	Electronic Safety and Security (coordination)

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide all overhead coiling doors as required by the contract documents. To include but not limited to exterior and interior coiling doors systems. Hardware, openers, buttons and controllers required for a complete system shall be provided by this contractor.

2. Provide all overhead coiling grilles.

3. Provide all overhead counter doors.

4. Include all wall framed openings and openings including trims, flashings, and sealants as required to perform your course of work.

5. Provide additional supports for overhead coiling doors. Structural members identified on the structural drawings are not part of this contract scope. Provide ancillary steel, connectors, all thread and other misc. items as required. Coordinate all electrical and special systems requirements for work of this contract with the appropriate contractors. Provide keyed switches for both electric and low voltage to match building keying.

6. Keying coordination for all lock sets. (coordinate with same hardware system as Dor Hardware supply contract..

7. Coordinate electrical requirements with any automatic overhead door operations.

8. Provide low-voltage wiring required for overhead doors automatic door operations. Include all raceways, boxes and switches required for a complete installation.

9. Ensure that all garage doors fully open the entire height of the door opening and close with the bottom edge touching the ground. Garage doors will fit square in the openings with no gaps along the top, bottom or sides when the door is closed.

10. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

11. Provide all sensing and safety devices as specified for each assembly to provide a complete assembly.

12. Exterior overhead doors and grilles shall have the appropriate specified seals, and weatherstripping at all edges. Top, sides and bottom. Seals shall maintain water tightness when installed.

13. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

14. Include within this contracts base bid an allocation of $10,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner.

"FOR REFERENCE ONLY"

CONTRACT NO. D-13 - CURTAIN WALL/GLAZING/STOREFRONTS

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 054000	Cold Formed Metal Framing (coordination)
Section 055000	Metal Fabrication (as required for work)
Section 072500	Weather Barriers
Section 079100	Preformed Joint Sealants
Section 079200	Joint Sealers
Section 089100	Louvers
Section 084313	Aluminum Framed Storefronts
Section 084333	Folding Glass Storefronts
Section 084413	Glazed Aluminum Curtain Walls
Section 084523	Translucent Wall Assemblies
Section 008710	Door Hardware
Section 088000	Glazing
Section 088723	Safety and Security Films
Division 26	Electrical (coordination)
Division 28	Electronic Safety and Security (coordination)

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide curtain wall, storefront, glass and glazing systems, Fiberglass Sandwich Panel Systems, complete.

2. Provide all Safety and Security Films required by Section 088723 and the contract documents.

3. Provide aluminum door systems and handling.

4. Provide automatic aluminum door systems, including hardware, low voltage wiring, coordination of power and all hardware. Coordinate with Division 26 and Division 28 for access of their work in to your framing system.

5. All work of this contract shall be coordinated thoroughly with Division 26 Electrical and Division 28 Electronic Safety and Security.

6. Curtain wall systems complete, including all Delegated Design requirements required to provide a complete system. Coordinate your work with the envelope systems and contractors to insure sealing of the units for a tight seal. (pressure caps and Blueskin seals)

7. Furnish hardware for aluminum doors only. (all other finish hardware by Door and Hardware contract.

(coordinate the keying and keying systems, including card reader systems)

8. All glass and glazing at exterior of building.

9. Caulking related to storefront doors and curtain wall systems.

10. Mock-ups as required by the Drawings and Specifications.

11. Custom breakmetal trim and infill.

12. Hoisting/scaffolding/cranes and all other material handling or access equipment. This contractor owns all material and manpower handling.

13. Coordinate edge of slab tolerances and field verify all rough openings. Field verification of edge of slab details is required by this contractor.

14. Provide all caulking and sealants, including any Preformed Sealants, required for your systems. All exterior caulking of your system and caulking to adjacent exterior surfaces by this contractor. The caulking and Sealant contractor shall caulk interior surfaces to your Alum frames.

15. Provide interior glass and glazing systems. Coordinate with the door and frame contractor and carpentry contractor.

16. Interior door, partition, vision panel and window glass.

17. Caulking and sealants related to interior glazing.

18. Do not provide interior hollow metal or hardware. These items will be provided by the Door and Hardware contractor.

19. Any openings that are missing glass (due to this contractors issues) during construction shall have plywood installed to secure and weatherproof the building by this contractor.

20. Clean up of all trash and debris related to this contract shall performed daily and removed to the dumpsters. All material shall always be stored neatly and orderly.

21. Coordinate glass types with partition and door fire ratings. Contact Construction Manager with any discrepancies. Shop drawings, samples and product data must be submitted within 3 weeks after award of contract.

22. This contract shall coordinate and work with the Special Systems contractor to allow the installation of harnesses, whips and connections while installing frames and hardware.

23. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

24. Include within this contracts base bid an allocation of $35,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner by means of a credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-14 – TILING

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 090561	Common Work Results for Flooring Preparation
Section 093000	Tiling

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide ceramic tile, marble tile, quarry tile, base material and thresholds as required by the contract documents, complete.

2. Provide all mortar bed installations as directed by the specifications and drawings.

3. Grout, including Epoxy grout and custom colors as specified.

4. Cutting and fitting around work installed by others.

5. Provide waterproofing and crack-isolation systems as required by contract documents.

6. Precast mop receptors as per contract documents.

7. Patching and leveling of "new" concrete system to be included in this contracts base bid. Contractor to review concrete floor installations and report any deficiencies in tolerance prior to mobilizing for any tile installation. Float inconsistent defects as needed to bridge tile for wall assemblies receiving wall tile.

8. Provide protection of finished products until acceptance by Construction Manager. This contract shall include the material and labor to cover all ceramic tile areas with Ramboard panels (not roll material or corrugated plastic panels. Seams to be taped and sealed for effective protection.

9. Attic stock, delivered and unloaded into owner storage room.

10. Provide crack suppression membrane for this set tile installation.

11. This contractor to coordinate work of this contract with contractor installing cement backer boards to receive your tile.

12. Provide metal strips and Schluter strips installed as part of the tile installation.

13. This contractor must provide a silica exposure plan that meets or exceeds the new 2017silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the

company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

14. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

15. Include within this contracts base bid an allocation of $15,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner.

"FOR REFERENCE ONLY"

CONTRACT NO. D-15 - ACOUSTICAL CEILINGS AND SPECIALTY CEILINGS

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 072100	Thermal Insulation
Section 079200	Joint Sealants
Section 095100	Acoustical Ceilings
Section 095420	Specialty Ceiling Systems
Section 098400	Acoustical Room Components

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide complete acoustical ceiling systems to include suspension system, hangers and all required components for a complete system.

2. Provide specialty ceiling systems complete, including framing, supports and necessary components.

3. Provide acoustical wall treatments and acoustical room components complete.

4. This contract includes all Sound Reflecting Tiles, Sound Diffusing tiles, Suspension grids, struts, metal panel ceiling systems and architectural metal wall panel systems. Provide cutting, fitting and coordination with MEP trades for outlets, grilles, cable access etc.

5. This contract to provide Decorative Metal panels shown on A441, A442, and A443.

6. Acoustical lay in insulation blankets and rigid panels above ceilings and behind wall grid systems as identified in the contract documents.

7. Supplemental suspension hangers at large ducts above ceilings and at openings for lighting fixtures shall be provided and coordinated to minimize exposed clips, anchors, and wires.

8. Continuous acoustical sealant on back of vertical leg before installing moldings as indicated.

9. Furnish and install hold down clips where required by governing regulations for fire resistant ratings.

10. Provide all material handling, scaffolds, lifts, Spyder cranes, access to work etc. as required for the scope of this contracts work.

11. Expansion joints for all acoustical ceilings, specialty ceilings and acoustical systems.

12. Provide ceiling grid layout on floor for cassette and duct placement in ceiling grid system.

13. This contractor shall review all documents, shop drawings, plans, and drawing model for ceiling height issues. All issues shall be reported to the EDiS prior to installing wall angles.

14. Reflected ceiling layout plans and shop drawings for approval and installation must be provided for all ceiling systems, clouds, acoustical panels, metal wall systems, etc.

15. This Contractor shall cut openings in ceilings for sprinkler heads, lights, mechanical diffusers and grilles, etc. Coordinate work with other trades.

16. Coordinate with other trades for layout and install of their materials into the grid system provided by this contract.

17. Attic stock as per the contract documents, delivered, inventoried, and moved to a storage area within the building at the owner's direction.

18. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

19. Include within this contracts base bid an allocation of $20,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner via credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-16 - FLOORING

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 090561	Common Work Results for Flooring Preparation
Section 096500	Resilient Flooring
Section 096813	Tile Carpeting
Section 096816	Sheet Carpeting
Section 096933	Low-Profile Fixed Height Access Flooring

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide flooring in accordance with the contract documents.

2. Prepare subfloor for finished flooring including leveling and patching. Base bid shall include all flashing patching and surface preparation required to perform the work of this Contractor.

3. Provide all Resilient flooring, LVT, Sheet vinyl, rubber tile, rubber treads, rubber base, resilient base, carpeting, carpet tile complete.

4. Provide Low-Profile fixed height access flooring system, complete.

5. Provide all moldings, transitions and edge strips as required.

6. Provide recessed flooring systems at specified areas, to include a shop drawings for approval, recessed floor system, carpet inset and required attic stock materials.

7. Resilient transition and reducer strips at edges of resilient flooring and at edges of carpeting.

8. Cleaning and protection of floors after installation shall be required by the cope of this contract.

9. Seaming diagrams are required to be submitted for approval.

10. Provide mock up's as defined by the contract documents.

11. Attic stock to be delivered to the site, inventoried and then moved to a storge are within the building at the direction of the owner.

12. This contractor shall own all material handling and means to unload, move and lift materials to second floor locations.

13. Provide entrance mat systems complete.

14. Provide finish floor material in elevator cab as specified.

15. Provide cutting and fitting around work of others.

16. This contractor shall protect the adjacent work of other trades while performing the scope of this contract.

17. Include within this contracts base bid an allocation of **$25,000** for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner by means of a credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-17: RESILIENT ATHLETIC FLOORING

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials, and equipment for:

Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 090561	Common Work Results for Flooring Preparation
Section 096566	Resilient Athletic Flooring

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide flooring in accordance with the finish schedule and specifications.

2. Provide resilient athletic flooring, base, and associated striping, logos, sealants etc.

3. Provide moisture level testing and reporting as part of this contract scope.

4. This contract includes removal of curing and sealing coatings that may be incompatible with the flooring adhesives of your product. Shot blasting, grinding or any required floor preparation is the responsibility of this contractor.

5. Prepare subfloor for finished flooring including leveling and patching. Base bid shall include all flashing patching and surface preparation required to perform the work of this Contractor. This shall include within the base bid the cost required to prepare and provide 10,000 sf of the Remedial Floor Coating Material specified in Section 090561 Part 2 Products, item 2.01 Remedial Floor Coating Materials.

6. Provide required flashing and transitions to adjacent materials. This include ramping of existing concrete floor if required for the fit and completeness of the Resilient Athletic Flooring system.

7. Provide cleaning, sealing and protection. Protection will be with Ramboard Pro panels with taped seams or Masonite with taped seams. Cover floor immediately after installation.

8. Seeming diagrams, and shop drawings for approval/installation.

9. Include within this contracts base bid an allocation of $15,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner via credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-18 - RESINOUS MATRIX TERRAZZO FLOORING

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials, and equipment for:

Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 090561	Common Work Results for Flooring Preparation
Section 096623	Resinous Matrix Terrazzo Flooring
Section 096616	Precast Cement Terrazzo Treads and Landings

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide vapor retarding sealer prior to terrazzo application' include required cost in this contracts base bid.

2. Provide all thresholds, reducers etc. as required to perform the work of this contract.

3. Provide all Precast Cement Terrazzo Treads and landings as defined by the contract documents.

4. Prepare subfloor for finished flooring including leveling and patching. Include in the base bid, leveling and patching as per the manufacturer's recommendations for the resinous terrazzo flooring. Include shot blasting, grinding, and moisture barriers as required for a complete installation.

5. Provide moisture vapor treatment on all slabs on grade.

6. Provide crack suppression membrane as required. Crack suppression, control joints and expansion joints shall be clearly identified in a shop drawing of all Terrazzo areas for design team approval.

7. Provide standard and custom samples for approval. Include three (3) in-field mock ups for final selection and approval.

8. Prep all floors for terrazzo application per manufacture and industry standard.

9. Cutting and fitting around work installed by others.

10. Provide protection of finished products until acceptance by Construction Manager. Protection shall RamBoard pro Sheets with Ram tape.

11. Attic stock, delivered, unloaded and moved to owners storage area within building.

12. Protection of surrounding surfaces and work of others.

13. Provide joint sealants required for Terrazzo installation.

14. Protect materials from damage and contamination in storage or delivery, including moisture, heat, cold, direct sunlight, etc.

15. Maintain temperature of storage area between 60 and 80 degrees F (15 and 26 degrees C).

16. Keep containers sealed until ready for use.

17. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with Resinous Terrazzo materials. Include all bead blasting required to perform the work of this contract.

18. Close spaces to traffic during Terrazzo application. Coordinate traffic on unpolished Terrazzo with CM and construction schedule.

19. Maintain proper ventilation of the area during application and curing time period.

20. Provide at least a 48 hour notice prior to any delivery. All deliveries are to be between 7:00 AM and 3:30 PM.

21. This is not a secure site. All contractors are responsible for concealing, locking and/or removing any materials on a daily basis. NCCVT and EDiS will not be responsible for any lost tools, materials or equipment.

22. This contractor must provide a silica exposure plan that meets or exceeds the new 2017 silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

23. Contractor must provide additional crews as needed to maintain the project schedule.

24. Provide pricing for all alternates as described in Section 012300-Alternates.

25. Include within this contracts base bid an allocation of $10,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner.

"FOR REFERENCE ONLY"

CONTRACT NO. D-19 - FLUID-APPLIED FLOORING

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials, and equipment for:

Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 079200	Joint Sealants
Section 090561	Common Work Results for Flooring Preparation
Section 096700	Fluid Applied Flooring

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide fluid-applied flooring and integral base.

2. Provide mock-ups as required by plans and specifications.

3. Provide standard and custom color samples for review and approval.

4. Provide vapor retarding sealer prior to resinous application, as required by specifications or manufacturer's installation instructions.

5. Provide protection of work of others as well as cutting and fitting around work installed by others.

6. Patching and leveling of areas to receive resinous flooring to be included in the base bid of this contract.

7. Provide cleaning, finishes and protection. Protection shall be RamBoard Pro sheets with Ram tape. Provide protection of finished products until acceptance by Construction Manager.

8. Provide crack suppression membrane required for the work of this contract. The submitted shop drawing for the Resinous Flooring areas shall reflect all control joints, expansion joints and crack suppression locations for review and approval.

9. Provide at least a 48 hour notice prior to any delivery. All deliveries are to be between 7:00 AM and 3:30 PM.

10. This is not a secure site. All contractors are responsible for concealing, locking and/or removing any materials on a daily basis. NCCVT and EDiS will not be responsible for any lost tools, materials or equipment.

11. This contractor must provide a silica exposure plan that meets or exceeds the new 2017 silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or

equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

12. Contractor must provide additional crews as needed to maintain the project schedule.

13. Provide multiple out of sequence installations. Each area shall be considered a separate mobilization and all costs shall be included in the base bid.

14. Provide pricing for all alternates as described in Section 012300-Alternates.

15. Include within this contracts base bid an allocation of $10,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner.

"FOR REFERENCE ONLY"

CONTRACT NO. D-20 - PAINT AND VWC

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 079200	Joint Sealants
Section 099113	Exterior Painting
Section 099123	Interior Painting

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide all painting and vinyl or fabric wall covering (all walls and ceilings indicated on the finish schedule) include all preparation of surfaces, trims and finish wood locations.

2. Provide sealing of all interior joints between dissimilar materials that require sealants before painting.

3. This contractor shall provide "all" interior and exterior painting complete.

4. Paint all exposed block work and concrete work as shown on the room finish schedule and contract documents. Include painting of the elevator shaft from F.F. down to the bottom of pit (white)

5. Prime, stain or seal, all wood trim and doors as required by the contract documents.

6. Paint exposed piping (sprinkler, plumbing, gas piping, electrical) and ductwork in accordance with the contract documents. Include preparation work for all items specified. Review and coordinate any color requirements specified in the contract documents or as required by code. Pay close attention to MEP documents for specific locations of piping colors.

7. Provide supplementary ventilation as required in enclosed spaces.

8. Paint and caulk all hollow metal frames and doors as shown on the door schedule.

9. Paint metal stairs and railings.

10. Prefinished items will not be painted by this Contractor.

11. Paint all semi-exposed wood blocking as indicated on the drawing.

12. Include "preparation" of all surfaces and items required to be covered by the scope of this contract.

13. This contractor shall allow a touch up pass from drywall contractor/mason contractor between prime coat and first coat of finish.

14. Protection of adjacent surfaces required by this contractor.

15. Minor patching prior to application of finishes shall be included in the base bid.

16. This contractor shall provide sealing/hardener of concrete floors, including scraping, brushing, removal of markings, grease, foreign materials and thoroughly cleaning all the floors prior to installation of the sealer/hardener materials. Coordination with other finishes will require multiple mobilizations for the sealer/hardener preparation and installation. Include within your base bid a (6) additional mobilizations for this work.

17. Installation of rated wall identification to be provided by this contractor. Access, lifts, ladders etc. to be provided by this contractor.

18. Provide painting of all exterior bollards and gates that are not prefinished.

19. Paint gas lines at both the interior and exterior of the building.

20. All lintels shall be painted by this contractor.

21. Paint all railings and handrails that are not prefinished.

22. Provide cleanup of your work areas and storage areas on a daily basis. Removal of spent paint cans and buckets is the responsibility of this contractor.

23. This contractor shall protect all areas, materials and work of others from over-spray from the work of this contract.

24. This Contractor to allow 240 man hours and all required paint materials for these man hours to be used as directed by the Construction Manager.

25. Provide at least a 48 hour notice prior to any delivery. All deliveries are to be between 7:00 AM and 3:30 PM.

26. This is not a secure site. All contractors are responsible for concealing, locking and/or removing any materials on a daily basis. NCCVT and EDiS will not be responsible for any lost tools, materials or equipment.

27. This contractor must provide a silica exposure plan that meets or exceeds the new 2017 silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

28. Contractor must provide additional crews as needed to maintain the project schedule.

29. Provide pricing for all alternates as described in Section 012300-Alternates

30. Include within this contracts base bid an allocation of $20,000 for work to be determined by owner and

construction manager. Unused allocation funds to be returned to the owner by means of a credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-21 - WOOD STRIP FLOORING - GYM FLOORING

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials, and equipment for:

Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 062000	Finish Carpentry (coordination of work)
Section 079200	Joint Sealants
Section 090561	Common Work Results for Flooring Preparation
Section 096429	Wood Strip Flooring

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide complete gymnasium floor system including sleepers, base, plywood, finishes, transitions, and striping (including logos). Flooring installation shall be coordinated and installed so the integrity of the concrete floor is not impacted. Include within your base bid a penetrating water/vapor sealer application prior to starting the Gym floor assembly.

2. Provide underfloor ventilation fan as required by the specification or manufacturer's requirements. Power connection provided by the electrical contractor, all interconnection wiring or low voltage work to complete work shall be provided by this contractor.

3. Provide wood strip flooring, hardboard floors in, and accessories at all areas indicated by the contract documents. This contract to provide all stage flooring and the required painting.

4. Provide wall base and trims associated with wood strip flooring.

5. Coordination with the bleacher contractor and other trades with the installation of the wood floor.

6. This contractor shall include patching and leveling of low areas identified after the slab floor analysis. The high areas will be reviewed and the concrete contractor will be responsible to adjust.

7. Sealants and caulking associated with your course of work shall be provided by this contractor.

8. Provide thresholds as required to finish your course of work. Threshold locations and types shall be submitted for Owner/Design Team approval.

9. Provide at least a 48 hour notice prior to any delivery. All deliveries are to be between 7:00 AM and 3:30 PM.

10. This is not a secure site. All contractors are responsible for concealing, locking and/or removing any materials on a daily basis. NCCVT and EDiS will not be responsible for any lost tools, materials or equipment.

11. This contractor must provide a silica exposure plan that meets or exceeds the new 2017 silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

12. Moisture and humidity readings are the responsibility of this contractor, monitoring and reporting results will be required. Results shall be provided each day in your daily reports, with photos of measuring device and reading. In addition provide the CM with a separate set of humidity sensors and a testing device for concrete floor moisture content.

13. All work to be coordinated with the carpentry contractor installing the gym equipment. Sequencing and timing shall be discussed and agreed to by this contractor.

14. Contractor must provide additional crews as needed to maintain the project schedule.

15. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

16. Provide pricing for all alternates as described in Section 012300-Alternates.

17. Include within this contracts base bid an allocation of $10,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner.

"FOR REFERENCE ONLY"

CONTRACT NO. D-22 - SPECIALTIES

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 061000	Rough Carpentry
Section 062000	Finish Carpentry
Section 079200	Joint Sealers
Section 101101	Visual Display Boards and Display Cases
Section 102113.19	Plastic Toilet Compartments
Section 102123	Cubicle Curtains and Track
Section 102600	Wall Protection
Section 102800	Toilet Accessories
Section 104400	Fire Protection Specialties
Section 105100	Metal Lockers
Section 107316.13	Metal Canopies

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following: (provide ad install)

1. Provide an install all specialties listed within this contract specification sections and scope.

2. Provide White boards, Markerboards (including glass markerboards), Chalk boards, tack boards, and tack strips.

3. Provide display boards and display cases.

4. This contractor shall own providing, engineering and installation of the Metal Canopies Section 107316.13. Coordinate all work with other trades.

5. Provide Projection screens if identified on documents. Electric service is the responsibility of the Electrical Contractor. All other control wiring, raceways and special boxes as specified will be the responsibility of this Contractor.

6. Provide Lockers including lockers bases that are not identified as "concrete bases"(concrete locker bases provided by the Misc. Concrete and Grouting contract.)

7. Provide Toilet partitions. Coordinate any structural requirements with the structural steel and blocking requirements with the Carpentry contractor.

8. Provide toilet and bath accessories, complete. This contract shall include installing all owner supplied toilet accessories and specialties.

9. Provide all accessories as indicated on the contract documents.
10. Provide Fire extinguishers, cabinets and accessories. Include labeling of extinguishers and cabinets. Coordinate with other trades for opening size and placement.

11. Provide wall and corner protection. Including FRP Paneling.

12. Provide Mirrors (both framed and frameless.)

13. Verification of field dimensions is the responsibility of this Contractor.

14. Anchoring devices, fasteners, inserts and other related items associated with the installation of the above items.

15. All blocking and bracing requirements for all work of this contract shall be coordinated with the Carpentry contractor for correct installation of blocking etc. Include any blocking not specified to be provided by the carpentry contractor.

16. Provide at least a 48 hour notice prior to any delivery. All deliveries are to be between 7:00 AM and 3:30 PM.

17. This is not a secure site. All contractors are responsible for concealing, locking and/or removing any materials on a daily basis. NCCVT and EDiS will not be responsible for any lost tools, materials or equipment.

18. This contractor must provide a silica exposure plan that meets or exceeds the new 2017 silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

19. Provide hand dryers and installation, electrical power connection by electrical contractor.

20. Contractor must provide additional crews as needed to maintain the project schedule.

21. This contractor shall include within their bid the incorporation of **500 hours of COOP participation** by a NCCVT student. Contractor to comply with project documents and requirements set forth in 19 del. C.ch.5

22. Provide pricing for all alternates as described in contract documents.

23. This contractor must provide a silica exposure plan that meets or exceeds the new 2017silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

24. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

25. This contract includes all Division 0 and Division 1 General Requirements. All commissioning requirements are identified in Division 1 and are a requirement of this contract.

26. This contractor shall be on site to coordinate when walls are being installed for penetrations and sleeve installations. If penetrations and sleeves are missed, this will be the responsibility of this contractor to cover associated costs of fixing.

27. Provide $20,000 allowance to be used as directed by the owner and CM. All funds not expended will be returned to the owner via a credit change order by means of a credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-23 - FOOD SERVICE EQUIPMENT

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 11400	Food Service Equipment
Division 22	Plumbing
Division 24	HVAC
Division 26	Electrical

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide food service equipment, hoods, connective ductwork and accessories All final connections shall be made by the Electrical and Mechanical Contractors.

2. Any discrepancies between the Drawings, Specifications and site conditions or ambiguities in the documents shall immediately be reported to the Construction Manager in writing. Inconsistencies shall be corrected in writing or by reissuing the drawings. If the Contract Documents disagree with the quality or quantity of work required, the better quality or greater quantity shall be supplied unless otherwise instructed in writing by the Construction Manager. Any work performed by the Contractor at locations in question after his discovery of discrepancies, inconsistencies, ambiguities, or errors, without securing resolution, shall be at the Contractor's risk.

3. This Contractor shall verify all measurements at the site and assume full responsibility for their correctness before proceeding with his work. No extra compensation will be allowed because of differences between site conditions and those indicated on the drawings.

4. Manufactured articles, materials, and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned as directed by the manufacturer and shall be protected from damage until acceptance. Prefinished products which are damaged before or after installation shall be replaced with new and perfect materials. Materials finished after installation which are damaged shall be refinished or replaced as the Construction Manager may direct. No additional charge will be honored by the Construction Manager for repair or replacement of finished materials.

5. Should this Contractor feel that the Contract Documents call for work which he cannot guarantee, he shall so state, in writing, prior to bidding. Proceeding with any operation shall be construed as acceptance of all guarantee conditions.

6. Secure certificates of inspection and occupancy required by authorities having jurisdiction. Deliver copies of certificates to the Construction Manager prior to filing application for final payment.

7. Supply and install any pedestals, curbs or doghouses required for equipment on the roof in this contract.

This should be a finished product so the roofer can flash to the system complete.

8. Any penetrations for work of this contract are the responsibility of this contractor whether through walls, floors or roof areas. Sealing of all penetrations (sealant, fire sealant or otherwise) and coordination with others is part of this contract.

9. This contractor shall include any blocking requirements required on a drawing that shall be coordinate with the carpentry contractor for blocking installation.

10. This contractor is responsible to make field visits to review rough in of underground utilities/piping/electric conduit, for placement in relationship to equipment locations.

11. This contractor to provide complete hood assemblies, including the hood fire protection assembly (Ansul) complete.

12. Provide licensed electrician to make all interconnections within equipment furnished by this contract. This includes, but is not limited to power and control wiring interconnecting the kitchen hoods and make up air units provided by the mechanical contractor.

13. This contractor shall coordinate and provide assistance to the electrical, fire alarm and controls contractor for interconnection into your hood assemblies and attached equipment.

14. Provide technicians on site to test all systems, hoods, equipment in advance of any required inspections.

15. This contractor is to accept delivery of their equipment and supplies, CM will not receive and unload equipment. Provide any and all material handling and unloading equipment and man power.

16. It is this Contractor's responsibility to make certain statutes, building codes, and regulations including those of the appropriate health agencies having jurisdiction over this type of facility are met.

17. Any items furnished as part of this Scope of Work that require mechanical or electrical rough ins or services that are different from those shown on the Contract Drawings shall be so noted at the time of bid. Failure to do so shall make this Contractor liable for costs of any changes required by same.

18. Provide all caulking and sealants for proper installation and in accordance with public health regulations. This contractor provides caulking and sealants for your own course of work.

19. Start, test and demonstrate all equipment installed under this category of work. Provide proposed schedule, including names and telephone numbers of attending representatives (3) three weeks in advance of demonstration.

20. Obtain approvals and permits and coordinate inspections and testing with governing local and state agencies.

21. This contractor shall provide factory start up of all equipment and the reports to document the start up's. CM to receive reports following start up.

22. (2) preliminary inspection or walk through of the project with the Health Department is to be include within this contracts scope.

23. This contractor to provide and install all low voltage capacitors, contactors etc. and requited connections to allow the kitchen hood system to communicate and interface with the fire alarm system and exhaust systems. Electrical contractor to provide power connection to units.

24. This Contractor shall verify all measurements at the site and assume full responsibility for their correctness before proceeding with his work. No extra compensation will be allowed because of differences between site conditions and those indicated on the drawings.

25. Provide protection of all equipment during and after installation has been completed.

26. Provide coordinated shop drawings that indicate all MEP requirements and accurately reflect the actual conditions and spacing of the area.

27. All foodservice components consist of those items identified in Section 114000 and the "K" Series drawings that identify the Food Service items. All items are to be included in the base bid of this contract to completely provide all systems in their entirety. This contractor shall pay particular attention to the "Standard Details" section of typical drawings within Specification section 114000.

28. Any items furnished as part of this Scope of Work that require mechanical or electrical rough ins or services that are different from those shown on the Contract Drawings shall be so noted at the time of bid. Failure to do so shall make this Contractor liable for costs of any changes required by same.

29. Provide licensed electrician to make all interconnections within equipment furnished by this contractor. This includes, but is not limited to, power and control wiring interconnecting the kitchen hoods and make-up air units provided by the mechanical contractors.

30. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

31. This contract includes all Division 0 and Division 1 General Requirements. All commissioning requirements are identified in Division 1 and are a requirement of this contract.

32. CONTRACT PROVISIONS FOR THE DISTRICT CONTRACTS UNDER CNP AWARDS

1.0 Clean Air Act (42 U.S.C. 7401-7671q.) and the Federal Water Pollution Control Act (33 U.S.C. 1251-1387)

Clean Air Act

(1) The contractor agrees to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act, as amended, 42 U.S.C. § 7401 et seq.

(2) The contractor agrees to report each violation to the (name of the applicant entering into the contract) and understands and agrees that the (name of the applicant entering into the contract) will, in turn, report each violation as required to assure notification to the appropriate Environmental Protection Agency Regional Office, the Federal awarding agency, or the USDA.

(3) The contractor agrees to include these requirements in each subcontract exceeding $150,000.

Federal Water Pollution Control Act

(1) The contractor agrees to comply with all applicable standards, orders, or regulations issued pursuant to the Federal Water Pollution Control Act, as amended, 33 U.S.C. 1251 et seq.

(2) The contractor agrees to report each violation to the (name of the applicant entering into the contract) and understands and agrees that the (name of the applicant entering into the contract) will, in turn, report each violation as required to assure notification to the appropriate Environmental Protection Agency Regional Office, the Federal awarding agency, or the USDA.

(3) The contractor agrees to include these requirements in each subcontract exceeding $150,000.

2.0 Contract Work Hours and Safety Standards Act (40 U.S.C. 3701-3708)

(1) *Overtime requirements.* No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) *Violation; liability for unpaid wages; liquidated damages.* In the event of any violation of the clause set forth in paragraph (b)(1) of this section the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (b)(1) of this section, in the sum of $27 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (b)(1) of this section.

(3) *Withholding for unpaid wages and liquidated damages.* The (write in the name of the Federal agency or the loan/grant recipient) shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.

(4) *Subcontracts.* The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (b)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (b)(1) through (4) of this section.

3.0 Rights to Inventions Made Under a Contract or Agreement, applicable if the DISTRICT will be using the funding agreement for development, research, or experimental work. 37 CFR 401.14 – Standard patent rights clauses

4.0 Equal Employment Opportunity:

During the performance of this contract, the contractor agrees as follows:

(1) The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, gender identity, or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, sexual orientation, gender identity, or national origin. Such action shall include, but not be limited to the following: Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

(2) The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, or national origin.

(3) The contractor will not discharge or in any other manner discriminate against any employee or applicant for employment because such employee or applicant has inquired about, discussed, or disclosed the compensation of the employee or applicant or another employee or applicant. This provision shall not apply to instances in which an employee who has access to the compensation information of other employees or applicants as a part of such employee's essential job functions discloses the compensation of such other employees or applicants to individuals who do not otherwise have access to such information, unless such disclosure is in response to a formal complaint or charge, in furtherance of an investigation, proceeding, hearing, or action, including an investigation conducted by the employer, or is consistent with the contractor's legal duty to furnish information.

(4) The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representatives of the contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(5) The contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.

(6) The contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(7) In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be canceled, terminated, or suspended in

whole or in part and the contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(8) The contractor will include the portion of the sentence immediately preceding paragraph (1) and the provisions of paragraphs (1) through (8) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: Provided, however, that in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the administering agency, the contractor may request the United States to enter into such litigation to protect the interests of the United States. The applicant further agrees that it will be bound by the above equal opportunity clause with respect to its own employment practices when it participates in federally assisted construction work: Provided, That if the applicant so participating is a State or local government, the above equal opportunity clause is not applicable to any agency, instrumentality or subdivision of such government which does not participate in work on or under the contract. The applicant agrees that it will assist and cooperate actively with the administering agency and the Secretary of Labor in obtaining the compliance of contractors and subcontractors with the equal opportunity clause and the rules, regulations, and relevant orders of the Secretary of Labor, that it will furnish the administering agency and the Secretary of Labor such information as they may require for the supervision of such compliance, and that it will otherwise assist the administering agency in the discharge of the agency's primary responsibility for securing compliance. The applicant further agrees that it will refrain from entering into any contract or contract modification subject to Executive Order 11246 of September 24, 1965, with a contractor debarred from, or who has not demonstrated eligibility for, Government contracts and federally assisted construction contracts pursuant to the Executive Order and will carry out such sanctions and penalties for violation of the equal opportunity clause as may be imposed upon contractors and subcontractors by the administering agency or the Secretary of Labor pursuant to Part II, Subpart D of the Executive Order. In addition, the applicant agrees that if it fails or refuses to comply with these undertakings, the administering agency may take any or all of the following actions: Cancel, terminate, or suspend in whole or in part this grant (contract, loan, insurance, guarantee); refrain from extending any further assistance to the applicant under the program with respect to which the failure or refund occurred until satisfactory assurance of future compliance has been received from such applicant; and refer the case to the Department of Justice for appropriate legal proceedings.

5.0 Debarment and Suspension

(1) This contract is a covered transaction for purposes of 2 CFR pt. 180 and 2 CFR pt. 3000. As such, the contractor is required to verify that none of the contractor's principals (defined at 2 CFR § 180.995) or its affiliates (defined at 2 CFR § 180.905) are excluded (defined at 2 CFR § 180.940) or disqualified (defined at 2 CFR § 180.935).

(2) The contractor must comply with 2 CFR pt. 180, subpart C and 2 CFR pt. 3000, subpart C, and must include a requirement to comply with these regulations in any lower tier covered transaction it enters into.

(3) This certification is a material representation of fact relied upon by (insert name of recipient/subrecipient/applicant). If it is later determined that the contractor did not comply with 2 CFR pt. 180, subpart C and 2 CFR pt. 3000, subpart C, in addition to remedies available to (insert name of recipient/subrecipient/applicant), the federal Government may pursue available remedies, including but not limited to suspension and/or debarment.

(4) The bidder or proposer agrees to comply with the requirements of 2 CFR pt. 180, subpart C and 2 CFR pt. 3000, subpart C while this offer is valid and throughout the period of any contract that may arise from this offer. The bidder or proposer further agrees to include a provision requiring such compliance in its lower tier covered transactions.

Certification Regarding Debarment, Suspension, Ineligibility, and Voluntary Exclusion, Exhibit F, which is attached herein and incorporated by reference and made a part of this Contract. (2 CFR 180) or the DISTRICT includes documentation that Vendor is not listed on governmentwide exclusions in System for Award Management (SAM), which contains the names of parties debarred, suspended, or otherwise excluded by agencies, or declared ineligible under statutory or regulatory authority other than Executive Order 12549.

6.0 Byrd Anti-Lobbying Amendment (31 U.S.C. 1352)

Contractors who apply or bid for an award of $100,000 or more shall file the required certification. Each tier certifies to the tier above that it will not and has not used federally-appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, officer or employee of Congress, or an employee of a Member of Congress in connection with obtaining any federal contract, grant, or any other award covered by 31 U.S.C. § 1352. Each tier shall also disclose any lobbying with non-federal funds that takes place in connection with obtaining any federal award. Such disclosures are forwarded from tier to tier up to the recipient who in turn will forward the certification(s) to the awarding agency. If applicable, the contractor must sign and submit to the non-federal entity, a certification regarding lobbying activities. The certification is attached herein and is incorporated and made a part of this Contract. If applicable, Vendor completed and submitted Standard Form-LLL, Disclosure Form to Report Lobbying, Exhibit G.

7.0 2 CFR 200.322 Domestic preference for procurements

The DISTRICT(s) participate(s) in the National School Lunch Program and School Breakfast Program and is required to use the nonprofit food service funds, to the maximum extent practical, to provide a preference for the purchase, acquisition, or use of goods, products, or materials produced in the United States (including but not limited to iron, aluminum, steel, cement, and other manufactured products) for the production of Program meals. For purposes of this contract, "Produced in the United States" means, for iron and steel products, that all manufacturing processes, from the initial melting stage through the application of coatings, occurred in the United States. "Manufactured products" means items and construction materials composed in whole or in part of non-ferrous metals such as aluminum; plastics and polymer-based products such as polyvinyl chloride pipe; aggregates such as concrete; glass, including optical fiber; and lumber.

8.0 2 CFR 200.323 Procurement of recovered materials

In the performance of this contract, the Contractor shall make maximum use of products containing recovered materials that are EPA-designated items unless the product cannot be acquired:

1. Competitively within a timeframe providing for compliance with the contract performance schedule;

2. Meeting contract performance requirements; or

3. At a reasonable price.

Information about this requirement, along with the list of EPA-designated items, is available at EPA's Comprehensive Procurement Guidelines web site, https://www.epa.gov/smm/comprehensiveprocurement-guideline-cpg-program. The Contractor also agrees to comply with all other applicable requirements of Section 6002 of the Solid Waste Disposal Act.

Vendor has signed the Anti-Collusion Affidavit, Exhibit H, which is attached herein and is incorporated by reference and made a part of this Contract.

9.0 Buy American Provision

As required by the Buy American provision, all products must be of domestic origin as required by 7 CFR Part 210.21(d).

The District(s) participates in the National School Lunch Program and School Breakfast Program and is required to use the nonprofit food service funds, to the maximum extent practical, to buy domestic commodities or products for Program meals. A "domestic commodity or product" is defined as one that is either produced in the U.S. or is processed in the U.S. substantially using agricultural commodities that are produced in the U.S. as provided in 7 CFR Part 210.21(d). Substantially means that at least 51 percent of the final processed product consists of agricultural commodities that were grown domestically.

Exceptions to the Buy American provision should be used as a last resort; however, an alternative or exception may be approved upon request. To be considered for the alternative or exception, the request must be submitted in writing to a designated official, a minimum of __120_day (s) in advance of delivery. The request must include the:

(a) Alternative substitute(s) that are domestic and meet the required specifications:
(i) Price of the domestic food alternative substitute(s); and
(ii) Availability of the domestic alternative substitute(s) in relation to the quantity ordered
(b) Reason for exception: limited/lack of availability or price (include price):
(i) Price of the domestic food product documenting a significant price difference; and
(ii) Price of the non-domestic product that meets the required specification of the domestic product.

10.0 Civil Rights:

The Vendor and DISTRICT agree to adhere to the provisions set forth in the following regulations, as amended:

i) FNS Instruction 113-1, Civil Rights Compliance and Enforcement – Nutrition Programs and Activities
ii) Title VI of the Education Amendments of 1972;
iii) Section 504 of the Rehabilitation Act of 1973;
iv) The Age Discrimination Act of 1975;
v) The Americans with Disabilities Act; and
vi) Title 7 CFR Parts 15, 15a, and 15b

33. Include within this contracts base bid an allocation of $15,000 for work to be determined by owner and

construction manager. Unused allocation funds to be returned to the owner by means of credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-24 - WINDOW SHADES AND ROLLER SHADES

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials, and equipment for:

Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 061000	Rough Carpentry
Section 062000	Finish Carpentry
Section 122400	Window Shades
Section 122413	Window Treatment – Roller Shades

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide window shades and rollers shades complete.

2. Do not fabricate shades until field dimensions for each opening have been taken.

3. Do not install shades until final surface finishes and painting are complete.

4. Provide manual window shades as indicated on the contract documents.

5. Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

6. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

7. Do not install shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

8. This contractor shall include any blocking not identified or specified in the Carpentry contractors scope.

9. Provide all material handling and access equipment required for your work. Including scaffolds and lifts as necessary. CM will not receive or unload an of this contracts materials.

"FOR REFERENCE ONLY"

CONTRACT NO. D-25 - LAMINATE CLAD CASEWORK, COUNTERTOPS, AND SILLS

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 062000	Finish Carpentry
Section 079200	Joint Sealants
Section 123400	Manufactured Plastic Laminate Casework
Section 123600	Countertops, Backsplashes and Window Stools

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide labor and materials to perform the work related to all casework, millwork, counter tops, back splashes and window sills. Coordinate rubber base after installation with flooring contractor.

2. This contractor shall provide all plastic laminate and millwork required in the Auditorium. This shall include panels, sills, casework etc. as detailed in the contract documents.

3. Provide all SS Tops, trims and accessories as required by the contract documents.

4. Provide all field trimming required to adjust to conditions on site.

5. Coordinate power and data requirements and locations with the electrical contractor for locations and sizes of holes needed. Grommets provided by this contractor.

6. Include all venting of cabinets and casework as indicated in the contract documents.

7. Provide solid surface window stools, wood trim, aprons, wood veneer paneling, and plastic laminate veneer paneling.

8. Provide solid surface base.

9. Provide countertops and backsplashes

10. Coordinate cutting holes in casework with other trades, and provide grommets at all openings.

11. Coordinate blocking requirements with Carpentry contract.

12. Provide joint sealants integral to casework/millwork and to dissimilar materials.

13. Provide at least a 48 hour notice prior to any delivery. All deliveries are to be between 7:00 AM and 3:30 PM.

14. This is not a secure site. All contractors are responsible for concealing, locking and/or removing any materials on a daily basis. NCCVT and EDiS will not be responsible for any lost tools, materials or equipment.

15. This contractor shall include within their bid the incorporation of **1000 hours of COOP participation** by a NCCVT student. Contractor to comply with project documents and requirements set forth in 19 del. C.ch.5

16. This contractor must provide a silica exposure plan that meets or exceeds the new 2017 silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

17. Contractor must provide additional crews as needed to maintain the project schedule.

18. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

19. Provide pricing for all alternates as described in Section 012300-Alternates.

20. Include within this contracts base bid an allocation of $15,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner by means of a credit change order.

21. This contractor shall coordinate the installation of the Fume hood assembly with the HVAC contractor who is providing this work.

"FOR REFERENCE ONLY"

CONTRACT NO. D-26 - STAGE RIGGING, LIGHTING, AND ACCESSORIES

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials, and equipment for:

Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 116133	Rigging Systems and Draperies
Section 111663	Loose Performance Lighting Fixtures

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide a complete theatrical rigging system as specified in Section 116133. Provide layout drawings and coordinate with electrical contractor for requirements of stage lighting and electric. This contract is responsible for any supplemental and miscellaneous steel/support required beyond the structural steel shown in the structural drawings to provide a complete and operational rigging system.

2. Provide theatrical draperies, operating systems, control wiring, motors etc. required to provide a complete system.

3. Provide Loose Lighting Fixtures and all low voltage wiring, motors, and controls to make system operational.

4. Provide (4) sets of any keys required to operate systems installed.

5. Provide specified warranties, attic stock, and as-builts. All attic stock to be delivered, inventoried, and delivered to a storage area on site directed by the owner.

6. Provide stage lighting systems including fixtures, controls, wiring, light grids, supports and attachments. Provide any Unistrut, support rods or other required anchoring devices for lighting support in theater. Coordinate work with electrical contractor for power connections.

7. Provide at least a 48 hour notice prior to any delivery. All deliveries are to be between 7:00 AM and 3:30 PM.

8. This is not a secure site. All contractors are responsible for concealing, locking and/or removing any materials on a daily basis. NCCVT and EDiS will not be responsible for any lost tools, materials or equipment.

9. This contractor must provide a silica exposure plan that meets or exceeds the new 2017 silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

10. Provide BIM services as detailed in spec section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

11. Contractor must provide additional crews as needed to maintain the project schedule.

12. Provide pricing for all alternates as described in Section 012300-Alternates.

13. Include within this contracts base bid an allocation of $10,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner by means of a credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-27 - FIXED AUDITORIUM SEATING

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials, and equipment for:

Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 126113	Fixed Audience Seating

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide seating layout, numbering, shop drawings, product data, samples, etc.

2. Provide Fixed, Removable, and loose audience seating as detailed in the drawings and section 126113. Coordinate finishes, coverings, colors, mounting, etc. between the fixed and loose audience seating.

3. This contractor responsible for their own layout and drilling of anchors for fixed seating. After installation, each day the area shall be cleaned of concrete dust, debris, boxes, packing materials etc. All materials must go to dumpster each day. Provide dimensioned layout drawings for lighting box layout for chairs.

4. Provide specified warranty, attic stock, and as-builts. Attic stock shall be delivered, inventoried and move to a storge location on site as directed by the owner.

5. Provide at least a 48 hour notice prior to any delivery. All deliveries are to be between 7:00 AM and 3:30 PM.

6. This is not a secure site. All contractors are responsible for concealing, locking and/or removing any materials on a daily basis. NCCVT and EDiS will not be responsible for any lost tools, materials or equipment.

7. This contractor must provide a silica exposure plan that meets or exceeds the new 2017 silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

8. Provide BIM services as detailed in spec section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

9. Contractor must provide additional crews as needed to maintain the project schedule.

10. Provide pricing for all alternates as described in Section 012300-Alternates.

11. Provide a final clean, vacuuming and wipe down of all seating and support brackets by this contractor. Coordinate scheduling of this work with CM.

12. Include within this contracts base bid an allocation of $10,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner by means of a credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-28 - TELESCOPING BLEACHERS AND PLATFORMS

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 061000	Rough Carpentry
Section 079200	Joint Sealers
Section 126613	Telescoping Bleachers
Section 126623	Telescoping Chair Platforms

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide all Telescoping Bleachers and Telescoping Chair Platforms as required by the contract documents.

2. Provide bleacher seating systems. Coordinate electrical requirements with electrical contractor. Low voltage wiring, motors and controls are to be provided and installed by this contractor. Power supply will be supplied by electrical contractor.

3. This contractor shall coordinate all work of this contract with the carpentry contractor and wood flooring installer.

4. Protection of the work of others including but not limited to protection of all finished flooring installed before your scope of work can be installed. Protection of the flooring shall be reviewed with the CM before installation.

5. Verification of field dimensions is the responsibility of this Contractor.

6. Anchoring devices, fasteners, inserts and other related items associated with the installation of the above items. Provide all material handling and access equipment required for the scope of your contract.

7. All material handling. Loading, moving, lifting of the materials of this contract shall be the responsibility of this contractor. The CM will not receive or unload your materials.

8. Provide at least a 48 hour notice prior to any delivery. All deliveries are to be between 7:00 AM and 3:30 PM.

9. This is not a secure site. All contractors are responsible for concealing, locking and/or removing any materials on a daily basis. NCCVT and EDiS will not be responsible for any lost tools, materials or equipment.

10. This contractor must provide a silica exposure plan that meets or exceeds the new 2017 silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

11. Provide BIM services as detailed in spec section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

12. Provide pricing for all alternates as described in Section 012300-Alternates

13. Include within this contracts base bid an allocation of $10,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner by means of a credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-29 - HYDRAULIC HOLELESS PASSENGER ELEVATOR

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 142013	Hydraulic Holeless Passenger Elevator
Division 26	Electrical (power and communications)
Section 284621	Addressable Fire Alarm Systems (coordination)
Section 281100	Access Control Systems (coordinate elevator access controls)

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide hydraulic elevator system complete. Including all shaft anchoring, framing and Misc. steel required to install the elevator.

2. Grouting of all elevator sill angles will be the responsibility of the Misc. Concrete contractor Contract D-43.

3. Spyders for elevator shaft installation shall be delivered to the site when required by the BP-C Masonry contractor.

4. Coordinate and work directly with the fire alarm contractor to meet all local, state, fire marshal and elevator inspector requirements.

5. Before the owner accepts the elevator for substantial completion, the elevator contractor shall train the owners maintenance personnel on operation of the elevator and review the contact operation and protocol for elevator service, warranty claims, etc. The training shall be professionally videotaped as part of the warranty package.

6. Provide control wiring and telephone signal wiring to top of elevator shaft as required.

7. Provide (2) sets of elevator protection padding, in addition to all other attic stock specified by contract documents. Provide CM one of these sets for use during construction.

8. This Contractor to furnish and install all rough wiring, low voltage wiring and devices (phones) necessary for the installation of emergency telephones.

9. Electric service and disconnect switch for the elevator are the responsibility of the Electrical Contractor. (This contractor shall work with electrical to coordinate type of disconnect with Fire Marshal and Elevator Inspector before installation) All other control wiring as required will be the responsibility of this Contractor.

10. This Contractor to submit for approval the layout and detailed dimensions of the elevator pit area, sump pump area, etc.

11. Provide BIM services as detailed in spec section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

12. Provide and include warranty extensions to include 9 months of temporary construction use. This contractor to include within the base bid 600 hours of temporary elevator operator to be utilized at the discretion of the owner and CM.

13. Include the costs associated with the inspections required for "construction" use in your base bid.

14. This contractor will work with other trades to insure access is given as needed to complete all work for a complete installation. This includes lifting contractors to the top of the shaft to complete work required. This includes but is not limited to fire sealing, sprinkler heads, lighting, smoke detectors, disconnects etc. Include within the base bid 4 separate mobilizations and 8 hours of operator time to allow contractors to access the shaft for work that requires installation.

15. This contractor shall own fire sealing of all penetrations for work of this contract.

16. This contractor to owns coordinating the final keying to the owners keyed system.

17. Provide all temporary signage required for machine room or elevator I order to facilitate inspections, until completion and final signage is installed.

18. Provide (2) complete sets of tools and keys to the owner. Provide and install key cabinet in the machine room, keyed to the building system for use by the owner to store the elevator keys.

19. Provide full and complete coordination with other trades for installations within the elevator shaft and machine room.

20. This contract includes all Division 0 and Division 1 General Requirements. All commissioning requirements are identified in Division 1 and are a requirement of this contract.

21. Include within this contractor's base bid an allocation of $10,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner by means of a credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-30 - FIRE PROTECTION

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Division 22	Plumbing
Division 26	Electrical
Division 32	Site Improvements
Section 312300	Excavation and Backfill for pipelines and Structures
Section 03310	Cast in Place Concrete
Section 210500	Common Work Results for Fire protection
Section 210505	Fire Suppression System Piping, Fittings and Valves
Section 211000	Water Based Fire Suppression System- Fire Pump

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide piping, fittings, couplings, valves and sprinkler heads to provide a complete Fire Protection system.

2. The fire pump, and all related work shall be part if this contract.

3. Excavation and backfill related to fire protection work as detailed below is the responsibility of this Contractor. (Geo-Tech reports included for this contractors review)

4. Backfilling is the responsibility of this Contractor. Soil types shall be in accordance with project documents. Backfill materials shall be covered after excavation and protected. If materials become wet and unusable this contractor shall remove the material from site and provide stone dust (#10 stone dust) to backfill all piping trenches and remove unsuitable material off site.

5. Provide As-built drawings in both hard copy and BIM format.

6. Provide concrete equipment pads, curbs and thrust blocks related to the Fire Protection work (sprinkler system) and Fire Pump system.

7. Permits, testing, inspections required for the Fire Protection work are to be provided by this contractor.

8. Providing of sleeve assemblies for work of this contract that penetrates the foundation wall, interior footings or any concrete footings shall be provided to the masonry and concrete contractor for installation. This contractor shall coordinate and assist with the sleeving install. Sleeves are to be sealed per contract documents.

9. Firesafing of all penetration is a requirement of this contract.

10. Design of the system, submissions to the Fire Marshall, review with Fire Marshall and expediting the permit for the Fire Suppression system is a priority of this contract scope.

11. Flow and tamper switches to be supplied by this Contractor and wired by the Electrical Contractor. It is this Contractors responsibility to provide flow and tamper switches to meet applicable state and local codes as well coordinate with the MEP contract documents.

12. Fire pump, controller and related work. Wiring of pump and controller to be by the Electrical Contractor.

13. If a water meter is required when the review process and permitting is completed, this contractor shall purchase, pay for, install and coordinate all work with the required authorities.

14. This Contractor to coordinate the need for and compatibility of his system to the emergency generator, supplied by other.

15. Pipe identification and labelling is a requirement of this contract. Valve labels, etc. are required as per the contract documents.

16. Provide fire main from +/- 5 feet outside building including connection in the building. Final connection of your fire line and the line provided by the site contractor shall be the Fire Protection contractors responsibility. Provide a registered plumbing contractor licensed to perform the tie in as part of you base bid.

17. This contractor will flush the UG system with the assistance of the site contractor and provide written documentation to the CM.

18. All cored walls require sleeves and are required to be sealed per contract documents. Any mess from the coring operation shall be immediately cleaned up by this contractor and shall not affect any installed finishes. If this work is not performed efficiently, the work will be performed by the owner and back charged to this contractor.

19. This contractor shall be onsite while walls are being constructed for layout and installation of valve cabinets, concealed, piping, etc.

20. The work of this contract will require out of sequence installations. This should be considered and included in your base bid.

21. This contractor shall provide all access panels required for the work of this contract. They should be lockable, fire rated where required. Panels shall meet the requirements of the contract documents.

22. This contractor shall include within their bid the incorporation of **750 hours of COOP participation** by a NCCVT student. Contractor to comply with project documents and requirements set forth in 19 del. C.ch.5.

23. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

24. This contractor must provide a silica exposure plan that meets or exceeds the new 2017silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

25. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

26. Provide the necessary coordination with trades to avoid interferences with other work and make corrections at no extra charge.

27. Include within this contracts base bid an allocation of $20,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner by means of a credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-31 – PLUMBING

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Division 21	Fire Protection (coordination)
Division 22	Plumbing
Division 23	HVAC (coordination)
Division 26	Electrical (coordination)
Division 32	Site Improvements
Section 312300	Excavation and Backfill for pipelines and Structures
Section 03310	Cast in Place Concrete

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide a complete plumbing and piping system as indicated by the contract documents. All plumbing work/systems are to be fully coordinated with all other MEP trades as well as the other trades involved with the project.

2. This contractor shall provide all pipe insulation, insulation coverings, valve insulation, labelling, and identification of plumbing lines.

3. This contractor shall provide the pre-fabricated trench drain as indicated on P302 and subsequent plumbing drawings (typical. The plumbing contractor will be responsible to coordinate the drain installation with the concrete contractor for the SOG pours.

4. This contract includes all Division 0 and Division 1 General Requirements. All commissioning requirements are identified in Division 1 and are a requirement of this contract.

5. Division 26 of the specifications should be reviewed as it relates to the power wiring to trap primers and controls within this contracts scope of work. Coordinate this work with the electrical contractor.

6. Permits, testing, inspections required for the Plumbing system work are to be provided by this contractor. This contractor shall pay all permit and inspection fees for the work of their contract.

7. This Contractor shall be responsible to designate an individual within his organization, intimately familiar with this project and assigned on site, to act as the System Start-up Coordinator. This individual must be pre-approved by the Construction Manager. This individual's responsibilities shall include, but not be limited to, coordinating the start-up of all mechanical equipment, including the coordination between the Electrical Contractor, the Controls Contractor, and all testing, adjusting and balancing work. This individual shall report on a weekly basis, in written form, to the Construction Manager. These reports shall include a summary of current conditions including manufacturers' start-ups, systems' deficiencies noted to date and the remediation of same, coordination issues between trades,

system interfacing and forecasting, as necessary to project the completion of each individual system within the building.

8. Excavation and backfill for underground plumbing work as detailed below is the responsibility of this Contractor. Soil types shall be in accordance with the contract documents Refer Section 312300 for requirements on soils. (Geo-Tech reports included for reference and use)

9. Backfilling is the responsibility of this Contractor. Soil types shall be in accordance with project documents. It is the intent to use on site material and not imported fill. The use of this on site material shall conform with the compaction requirements identified in Section 312300. Excavated materials shall be covered immediately and protected from moisture mitigation. If Materials become unusable, this contractor shall own purchasing #10 stone dust to utilize as backfill in all trench or structure locations. Excess unsuitable materials from plumbing excavations shall be removed from the site by this contractor. (includes water meter pit installation) it is not acceptable for anu UG piping to e in the stone layer installed by the concrete contractor, all UG piping must be installed in the subbase with adequate soil coverage.

10. The Concrete Contractor shall furnish, install and maintain stone fill under slab. The Sitework Contractor shall leave the building pad site at subgrade to the required tolerance in the contract documents to receive stone fill. The Plumbing, Mechanical and Electrical contractors shall complete their work under the slab on grade and shall be responsible to return the pad to the subgrade elevation left by the Sitework Contractor. The Concrete Contractor shall then adjust the select material to final subgrade, fine grade the slab and place the vapor barrier and stone fill. Note: while working on the building pad area this contractor shall utilize track drive equipment only. No rubber tire equipment will be allowed. Preservation of the building pad shall be the responsibility of this contractor. The onsite testing and inspection agency provided the owner will monitor the excavation, travel and backfilling operation.

11. The plumbing and concrete contractor and CM will me to review the building pad for turnover to the next trade. If not accepted correction will need to be made to correct concerns and sign off.

12. Equipment bases and housekeeping pads identified on the structural drawings are to be provided by the BP-C concrete contractor. Any required bads or bases for the scope of this contract not identified on the documents will be provided by this contractor.

13. Permits, testing, inspections required for the Plumbing system work is to be provided by this contractor.

14. Providing of sleeve assemblies for work of this contract that penetrates the foundation wall, interior footings or any concrete footings shall be provided to the masonry and concrete contractor for installation. This contractor shall coordinate and assist with the sleeving install. All sleeves must be provided with the appropriate seals, this contract owns sealing the sleeves related to this contracts work.

15. Pipe insulation, insulation coverings, valve insulation, labelling and identification of plumbing lines shall be provided by this contractor.

16. Valve tags, charts, and labelling shall be part of this contractor's responsibility.

17. Provide Mop sinks and Receptors as indicated on the contract documents.

18. Penetrations through wall, floors, etc. including cutting, patching and fire safing.

19. Testing and balancing shall be provide by a separate contract however the Plumbing contractor shall coordinate and communicate with the testing and balancing contractor for all testing required on the plumbing system.

20. Clean up shall be provided daily, all trash, debris, crates, boxes etc. shall be moved out of the building to the dumpsters each day. No storage of trash will be allowed inside the building or courtyards.

21. All guarantees and warranties to begin at the substantial completion of the entire project. Maintain equipment prior to substantial completion.

22. This contractor shall provide all necessary material handling equipment, cranes, scaffolds, hoisting and rigging equipment and supplies for work associated with this contracts.

23. Coordination with the ATC contractor is required by this contractor.

24. Roof drains, pans, sumps and all related anchoring, support and adjustment elements that are required per the contract documents.

25. This contractor is responsible for providing, setting, bracing, anchoring, and aligning all floor drains, floor basins etc. required by the contract documents. The plumbing contractor shall have a plumber on site 100% of the time when the concrete contractor is pouring S.O.G. floors or elevated slabs. Drains that are misaligned will be demolished, removed, and replaced by this contractor. Including but not limited to replacing and re-engineering floor reinforcement and paying the concrete contractor to re-pour the slab areas.

26. Piping work associated with the emergency generator (including fuel piping, exhaust piping, regulators etc.). Include initial fill up of fuel tanks if Diesel and provide and coordinate the gas piping system is natural gas fueled. The DNREC permit submission will be provided by the Electrical contractor however this contractor must supply any required documentation for the permitting as well as coordinate all work with electrical contractor and other trades.

27. Fuel detection/monitoring system in accordance with local codes.

28. Gas piping, meter and pressure regulator valve. (proper sizing of the regulators is the responsibility of this contractor.) Include anchoring this equipment to the concrete pad provided by the concrete contractor ad anchoring the piping and stand to the exterior wall.

29. Trap priming system, including detailed submittals of the system and then provide as-builts of the location of the rack installations. Photos marked with locations to be provided by this contractor.

30. All utilities will be brought to within +/- 5 feet of the building line by others. The Plumbing Contractor is responsible for connecting the utilities from +/- 5 feet outside the building line and completing the system within the building. This contractor shall own the underground line with the assistance of the site contractor, including any chemical treatment required by NCCo, Artesian or any other regulatory agency. Reports shall be submitted to CM.

31. This contractor will flush the underground with the assistance of site contractor and

provide documentation to CM.

32. Provide complete water sterilization, testing and reporting. Include within your proposal (4) additional testing mobilization for potential Phase utilization.

33. Install Owner pre-purchased equipment, if identified within the contract documents.

34. Provide access panels to the drywall contractor for framing information and final installation.

35. This contractor shall be on site to coordinate when walls are being installed for penetrations and sleeve installations. If penetrations and sleeves are missed, this will be the responsibility of this contractor to cover associated costs of fixing.

36. Final connection of kitchen equipment and appliances is the responsibility of this contractor.

37. As-built drawings is both hard copy and BIM submission as part of the project closeout.

38. This contractor shall include within their bid the incorporation of **2500 hours of COOP participation** by a NCCVT student. Contractor to comply with project documents and requirements set forth in 19 del. C.ch.5

39. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

40. This contractor must provide a silica exposure plan that meets or exceeds the new 2017silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

41. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

42. Provide the necessary coordination with trades to avoid interferences with other work and make corrections at no extra charge.

43. Include within this contracts base bid an allocation of $75,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner by means of a credit change order.

"FOR REFERENCE ONLY"

CONTRACT NO. D-32 – MECHANICAL PIPING - HVAC

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 089100	Louvers
Division 21	Fire Protection (coordination)
Division 22	Plumbing
Division 23	HVAC
Section 230900	Instrumentation and Controls of HVAC system
Division 26	Electrical (coordination)
Division 28	Electronic Safety and Security (coordination of work)

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide a complete mechanical system as indicated on the Drawings and in the Specifications. Coordinate all work with associated trades, Plumbing, Fire Protection, Electrical and Electronic Safety and Security

2. This contract includes all Division 0 and Division 1 General Requirements. All commissioning requirements are identified in Division 1 and are a requirement of this contract.

3. This contractor shall include all piping, fittings, and connections required for the installation of the complete HVAC system.

4. This contract shall provide all Mechanical yard pipe rack steel supports as reference on drawing M315 (typical) the Concrete contract will install the foundation and grout the leveling plates.

5. Provide all insulation, wraps, covers etc. for work of this contract. Include all labelling and identification markers as directed by the contract documents.

6. Provide all condensate piping and condensate pumps and installations. Backcheck valves shall be included as part of this contract.

7. Division 16 of the specifications should be reviewed as it relates to the power wiring and other requirements for HVAC equipment including the coordination of furnishing and installing motor starters as provided in the specifications.

8. This Contractor shall be responsible to designate an individual within his organization, intimately familiar with this project and assigned on site, to act as the System Start-up Coordinator. This individual must be pre-approved by the Construction Manager. This individual's responsibilities shall include, but not be limited to, coordinating the start-up of all mechanical equipment, including the coordination

between the Electrical Contractor, the Controls Contractor, and all testing, adjusting and balancing work. This individual shall report on a weekly basis, in written form, to the Construction Manager. These reports shall include a summary of current conditions including manufacturers' start-ups, systems' deficiencies noted to date and the remediation of same, coordination issues between trades, system interfacing and forecasting, as necessary to project the completion of each individual system within the building.

9. The Concrete Contractor shall furnish, install and maintain stone fill under slab. The Sitework Contractor shall leave the building pad site at subgrade as identified per the contract documents in preparation to receive stone fill. The Plumbing, Mechanical and Electrical contractors shall complete their work under the slab on grade and shall be responsible to return the pad to the subgrade elevation left by the Sitework Contractor. The Concrete Contractor shall then adjust the select material to final subgrade, fine grade the slab and place the vapor barrier and stone fill. Note: while working on the building pad area this contractor shall utilize track drive equipment only. No rubber tire equipment will be allowed. Preservation of the building pad shall be the responsibility of this contractor. The onsite testing and inspection agency provided the owner will monitor the excavation, travel and backfilling operation.

10. The HVAC, and concrete contractor and CM will me to review the building pad for turnover to the next trade. If not accepted correction will need to be made to correct concerns and sign off.

11. Equipment bases and housekeeping pads that are not included in BP-C and identified on the structural documents will be provided by the Misc. Concrete contract. This contract shall provide detailed shop drawings and field layout of the pads/bases for installation by the concrete contractor. Failure to properly coordinate this work will result in the Mechanical contractor installing the pads at no cost to the owner or any other contractor. Any bases or pads related to the scope of this contract, not identified on the drawings will be provided by this contractor (complete installation)

12. Permits, testing, inspections required for the mechanical piping and HVAC work are to be provided by this contractor.

13. Providing of sleeve assemblies for work of this contract that penetrates the foundation wall, interior footings or any concrete footings shall be provided to the masonry and concrete contractor for installation. Provide sealing of all sleeves as required. This contractor shall coordinate and assist with the sleeving install.

14. Pipe insulation, insulation coverings, valve insulation, labelling and identification of mechanical piping, ductwork, shafts, connections to systems etc. shall be provided by this contractor. (all insulation and sealing as it relates to the work of this contract)

15. Valve tags, charts, and labelling shall be part of this contractors responsibility.

16. Penetrations through wall, floors, etc. including cutting, patching and fire safing.

17. Testing and balancing shall be provided by this contract, Coordination of work with other trades is required.

18. Clean up shall be provided daily; all trash, debris, crates, boxes etc. shall be moved out of the building to the dumpsters each day. No storage of trash will be allowed inside the building or courtyards.

19. All guarantees and warranties begin at the substantial completion of the entire project. Maintain equipment prior to substantial completion.

20. This contractor shall provide all necessary material handling equipment, cranes, scaffolds, hoisting and rigging equipment and supplies for work associated with this contracts.

21. Provide pipe and duct insulation, coverings, wraps, supports and bridging for penetrations through wall, floors, etc. including cutting, patching and fire safing and fire caulking as required.

22. This contractor is responsible to coordinate the work of this contract with the Testing and balancing contractor. Coordination and assistance when the balancing is TAB is being performed is a requirement of this contract.

23. This contract should include man hours for season testing from heating to cooling or vice versa to work with the testing and balancing contractor.

24. Ductwork, flex duct, grilles, diffusers, including detailed layout for the drywall and ceiling contractor shall be provided by this contractor.

25. This contractor shall fully coordinate and verify all louver sizes, mounting details, flashing details, colors with the Carpentry and General Trades contract which will supply and install all louvers.

26. Coordinate damper size, location and type of damper with contract documents, pay special attention to architectural drawings and finish surfaces. Fire dampers are to be included as part of this contractors scope.

27. This contractor shall be on site to coordinate when walls are being installed for penetrations and sleeve installations. If penetrations and sleeves are missed, this will be the responsibility of this contractor to cover associated costs of fixing.

28. Temporary heat and ventilation installation, maintenance and removal. Refer to Division 1, Specification Section 015123 - TEMPORARY HEAT AND VENTILATION, for specific scope. This contractor shall include within the base bid an allocation of $200,000 for the fuel to power the temporary heating equipment if no other owner supplied source is available.

29. Electric baseboard heat shall furnished and installed by this contractor. Electrical connection by EC.

30. Roof curbs, rails, etc. to be provided and loaded to the roof by this contractor. Layout and installation by this contractor, coordinate with the carpentry contractor for blocking and the roofing contractor for flashing and roofing details. Include any doghouses or raceways for service lines, including coordination of flashing.

31. Provide access panels to the drywall contractor for framing information and final installation.

32. Final connection of kitchen equipment and appliances related to the mechanical piping and HVAC system provided by this contractor. Coordination with other trades (Special Systems, Electrical, Fire Alarm etc.) for final interconnections of these systems shall be provided by this contractor.

33. This contractor shall provide all required fire dampers, connections and remote controllers for the HVAC system.

34. Provide all VFD's complete for electrical contractor to install.

35. Provide (2) sets of filters for construction use. Include changing out the filters during the construction phase. Additionally include a complete change out of all filters prior to turn over to the owner (these filters shall be separate from the attic stock filters required) Providing a complete filter listing as part of the closeout documents is required.

36. As-built drawings. As-built drawings is both hard copy and BIM submission as part of the project closeout.

37. This contractor shall include within their bid the incorporation of **2000 hours of COOP participation** by a NCCVT student. Contractor to comply with project documents and requirements set forth in 19 del. C.ch.5

38. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

39. This contractor must provide a silica exposure plan that meets or exceeds the new 2017silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

40. This is not a secure site. All contractors are responsible for concealing, locking and /or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

41. Provide the necessary coordination with trades to avoid interferences with other work and make corrections at no extra charge.

42. Include within this contracts base bid an allocation of $75,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner by means of a credit change order.

43. This contractor shall provide the work of Section 230900 Instrumentation and Controls of HVAC system in its entirety. Coordinate with all other trades as required. Provide all instrumentation, controls, coordination of work, testing as required to provide a complete ATC system for this project. This work shall include but not be limited to instrumentation and controls for: Provide all instrumentation, controls, coordination of work, testing as required to provide a complete ATC system for this project.

44. This contract includes all Division 0 and Division 1 General Requirements. All commissioning requirements are identified in Division 1 and are a requirement of this contract.

45. Environmental controls.

46. Ventilation controls.

47. Kitchen Ventilation Controls

48. Carbon Monoxide System Controls

49. Air Flow Monitoring Controls

50. Cooling controls.

51. Humidification controls.

52. Refrigeration controls.

53. Motorized dampers when not specified as part of the factory packaged equipment supplied to job site for distribution and installation by others.

54. Controls air compressor complete with accessories and insulation.

55. Remote reading gauges, transmitters and recorders for automatic temperature controls.

56. Building centralization controls including centralized temperature, humidity, pressure and flow indication and recorders, centralization of air conditioning, heating, ventilation, humidification and refrigeration equipment operation.

57. Smoke hatches and relief vents that are not accessible shall have remote controllers to test and reset units.

58. This contract shall supply control valves per contract documents and drawings.

59. This contractor shall coordinate closely with the Kitchen Equipment contractor for controls to equipment.

60. Coordinate and provide controls required for the emergency generator.

61. Building life safety control and equipment safety control including: operators and controls for motorized smoke dampers, operators and controls for motorized fire dampers, firestats, freeze protection thermostats, shut down safety devices forming part of automatic temperature control.

62. Provide all permits required for the work of this contract, pay all fee's.

63. Inspections as required under this contract scope.

64. Electrical thermostats intended for automatic temperature controls complete with subbases or adapter plates to mount on standard electrical box.

65. Supply only of access doors when specifically required for access to automatic temperature control.

66. Control wiring and/or air piping required for all automatic temperature controls supplied under this contract scope.

67. Wiring for remote thermostats and remote prewired auxiliary control panels for packaged equipment.

68. Boiler feed water control wiring.

69. The magnetic starter coil and relay coils supplied under the electrical contract and intended for automatic temperature controls, including interlocking between starters and/or relays when controlled automatically.

70. Access panels directly associated with this work if not included by other division.

71. Exclude direct reading temperature and pressure gauges connected directly to non-potable water systems.

72. Exclude motorized dampers when specified as integral part of packaged equipment.

73. Exclude automatic temperature controls when specified as integral part of packaged equipment.

74. Exclude flow measuring and control devices.

75. Exclude direct reading temperature and pressure gauges connected directly to refrigeration systems.

76. Exclude filter gauges directly connected to duct systems.

77. Electrical wiring for thermostats and controls which directly switch the power line to the equipment (directly shall mean not through magnetic coil) is by Division 26.

78. Power wiring is by Division 26**.**

79. Control power supply outlets are by Division 26.

80. This contractor shall provide all raceways, conduits, pull strings and boxes required for the complete ATC system.

81. Review Alternate section and provide Alternate #10 to utilize Modern Controls for the work of the scope.

82. Coordinate and work alongside the commissioning team until project is fully accepted. Include multiple trips to the site with testing equipment, ten (10.)

"FOR REFERENCE ONLY"

CONTRACT NO. D-33 - TESTING, ADJUSTING, AND BALANCING

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials, and equipment for:

Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Division 21	Fire Protection
Division 22	Plumbing
Division 23	HVAC
Section 220500	Common Work Results for Plumbing
Section 230900	Instrumentation and Controls
Section 230950	Testing & Balancing of Mechanical Systems

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide water and air testing and balancing.

2. Contractor shall prepare, at a minimum, a preliminary balance report for the New Castle County Final Inspection.

3. This contract includes all Division 0 and Division 1 General Requirements. All commissioning requirements are identified in Division 1 and are a requirement of this contract.

4. Provide pricing for all alternates as described in Section 012300-Alternates.

5. Submissions will be reviewed once, and any resubmittals will be reviewed once. Any other submittals will be billed to the contractor at the Engineers standard rates. Please thoroughly review all submissions prior to forwarding to avoid these costs.

6. Provide complete signed and sealed testing report prior to substantial completion and final inspection as required by New Castle County.

7. This contractor has been allotted 30 days to complete all work and provide final, sealed balancing report by the Construction Manager. This contractor will need to work closely with the Construction Manager and all MEP trades to sequence work so that the completion of the balancing is completed in a manner that does not delay acceptance from New Castle County or owner.

8. Provide a pencil copy for submission to NCCo and have final official report within 30 days of the pencil copy.

9. Provide confirmation of duct testing completed by Mechanical Contractor.

10. This contractor must provide all lifts or scaffold means to access all elements.

11. Provide at least a 48 hour notice prior to any delivery. All deliveries are to be between 7:00 AM and 3:30 PM.

12. This is not a secure site. All contractors are responsible for concealing, locking and/or removing any materials on a daily basis. NCCVT and EDiS will not be responsible for any lost tools, materials or equipment.

13. Provide circulating water system test.

14. Include balancing and testing of all plumbing and heating lines installed to the future field house.

15. This contract should include seasonal testing from heating to cooling, until system has been fully commissioned and accepted.

"FOR REFERENCE ONLY"

CONTRACT NO. D-34 - ELECTRICAL, LIGHTING, AND FIRE ALARM SYSTEMS

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Division 22	Plumbing (coordination of work)
Division 21	Fire Protection (coordination of work)
Division 23	HVAC (coordination of work)
Division 26	Electrical
Section 111663	Loose Performance Lighting Fixtures (coordinate)
Division 27	Communications
Division 28	Electronic Safety and Security raceways and coordination)
Section 284621	Addressable Fire Alarm Systems (complete)

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide a complete electrical system, lighting, addressable fire alarm system and infrastructure for all Division 21, Division 27 and Division 28 as indicated on the contract documents.

2. Provide Transformer and Generator system complete. Include all infrastructure, raceways, duct banks (including all excavation, backfill, identification systems, trace wiring, etc.) This contractor shall be fully responsible for preparing, submitting, paying all fees and coordinating the DNREC required permitting for the Generator. Coordinate with NCCVT as required.

3. Lightning protection shall be provided by this contract and coordinated with the Carpentry contractor and Roofing Installer.

4. This contractor to supply power to all areas of work of other trades requiring electrical power.

5. Provide complete infrastructure system for all Division 27 and Division 28 systems. Including all interior and exterior duct banks, raceways and sleeves for special systems.

6. This contractor shall include in the base bid temporary exterior lighting installed and to provide lighting adequate for safety and security purposes for the exterior of the building for the purpose of site security. The lights must be installed to meet the requirements for exterior use and illuminated during low light hours. These lights will be utilized until permanent exterior lighting has been installed and powered. Supplying the temp power for this lighting is part of this contract. Include providing temporary power and lighting as needed for the entire duration of the project. This include the necessary power outlets required for all contractor use. Power must be available within a reasonable distance at all times.

7. Division 23 of the specifications should be reviewed as it relates to the power wiring and other requirements for HVAC equipment including the coordination of furnishing and installing motor

starters and controllers as detailed in the Specifications and on the Drawings.

8. This contractor shall provide all conduits, raceways and boxes required for thermostat and sensor installation.

9. The HVAC contractor will supply all VFD's to the electrical contractor for installation and powering.

10. Provide all smoke damper, power and remote controllers as required by the contract documents.

11. Excavation and backfill for underground electrical work as required below is the responsibility of this Contractor. Soil types shall be in accordance with project specifications and the Geo-Tech report. Geo-Tech reports included for review and acceptance.

12. Backfilling is the responsibility of this Contractor. Soil types shall be in accordance with project documents. It is the intent to use on site material and not imported fill. The use of this on site material shall conform to the compaction requirements identified in Section 312300. Excavated materials shall be covered immediately and protected from moisture mitigation. If Materials become unusable, this contractor shall own purchasing acceptable off site materials.

13. Provide all excavation, layout, concrete, reinforcing for duct banks, light standards, above ground conduit encasement, equipment bases and any other concrete work specifically related to the electrical work. This shall include services from the roadways and all communication duct banks as required. Include requirements of New Castle County, State and local codes for concrete encasement.

14. All runs in exposed ceilings are to be in conduit.

15. All exterior underground raceways and infrastructure are to be installed by this contractor as required by the contract documents. (Cameras, security, electric etc.)

16. Temporary electric installation, maintenance and removal. Refer to Division 1, Specification Section 015113 - TEMPORARY ELECTRIC, for additional information.

17. This contractor shall provide temporary transformers as required to provide electrical power generation until permanent service is installed by Delmarva power. Include all permits, cabling, switch gear, breakers etc.to provide a complete temporary power system capable of supplying the electrical loads required for the project. This contractor to coordinate and arrange for temporary power from the source, Delmarva Power.

18. Provide temporary power including ten (10) individual electric meters with disconnects for contractors trailers. Coordinate all work with Delmara Power.

19. Power Centers for miscellaneous tools and equipment used in the construction work shall be provided with a minimum of four 20-amp, 120 volt grounding type outlets. Each outlet shall be provided with ground fault detecting circuit breaker protection. The distance between each receptacle location shall <u>not exceed 50 feet.</u>

20. Construction areas, ramps, runways, corridors, offices, shops, and storage areas shall be lighted to not less than the minimum illumination intensities at five (5) foot candles and any additional OSHA Temporary lighting and receptacles exposed to wet or damp locations must be weatherproof. Adequate

lighting for safe working conditions and the exterior of the structure shall be provided and maintained on a 24 hour per day basis throughout the building. Voltage of each lighting component must be able to accommodate lighting requirements.

21. Rough in and final connection and related work for equipment provided under other contracts (i.e. kitchen, elevators, HVAC, sprinkler, motorized doors, vertical walls, etc.)

22. Provide all permits and inspections. Pay all fees associated with the permits and inspection.

23. Penetrations through walls, floors, etc. including cutting, patching and fire safing.

24. Testing of all systems, as related to the scope of work for this contract shall be provided. Reporting and verification documentation shall be supplied to NCCVT and EDiS.

25. This contractor shall provide all supplemental hangers and fasteners for lighting installation to the building structure.

26. All runs in exposed ceilings shall be installed in conduit.

27. Clean up on a daily basis shall be provided by this contractor. All work areas shall be organized and cleaned up to the dumpsters each day.

28. The Concrete Contractor shall furnish, install and maintain stone fill under slab. The Sitework Contractor shall leave the building pad site at subgrade required by the contract documents in preparation to receive stone fill. The Mechanical and Electrical Contractors shall complete their work under the slab on grade and shall be responsible to return the pad to the subgrade elevation left by the Sitework Contractor. The Concrete Contractor shall then adjust the select material to final subgrade, fine grade the slab and place the vapor barrier and stone fill. Note: while working on the building pad area this contractor shall utilize track drive equipment only. No rubber tire equipment will be allowed. Preservation of the building pad shall be the responsibility of this contractor. The onsite testing and inspection agency provided the owner will monitor the excavation, travel and backfilling operation.

29. The electrical, and concrete contractor and CM will me to review the building pad for turnover to the next trade. If not accepted correction will need to be made to correct concerns and sign off.

30. Note: all raceways are to be installed into the subgrade soils and shall have adequate cover for protection from traffic above. No raceways will be installed in the stone base provided by the concrete contractor.

31. All guarantees and warranties to begin at the substantial completion of the entire project. Maintain equipment prior to substantial completion.

32. Hoisting, rigging and scaffolding required to perform you scope of work shall be provided by this contractor.

33. This contract shall provide coordination with Delmarva power for the Primary electrical service which the owner will apply for and pay the associated Delmarva fees. Delmarva will run the power from the pole to the transformer and this contractor shall be responsible for the work from the transformer to the building and throughout.

34. Provide a complete fire alarm system. Water flow devices are supplied and installed by the Sprinkler Contractor and wired by this Contractor. Include tie-in to fire sprinkler flow and tamper switch. (fire dampers, smoke detectors, remote testing switches are all part of this contract)

35. Provide all heat tracing and insulation systems as required.

36. Coordinate closely with the work of the Special Systems contractor. This contract (electrical) provides all infrastructure, conduit and raceways required for the Special Systems work. Provide pull strings and boxes for all systems. (voice, data, communication, fire alarm, AV systems, Audio systems, and public address system, clock system etc.) Include all required sleeving, sealing and fire sealing for raceways and conduits through walls, floors, ceilings etc. for this work.

37. This contract shall provide and install wire mesh cable tray for low voltage distribution as shown on documents and specified. Cable tray shall be installed 3" above drop ceilings and have 3" clear above the top rim for access.

38. This contractor shall provide and install 4' conduits as shown for low voltage distribution.

39. This contractor shall provide and install 2' conduits into each space above the ceiling for low voltage distribution.

40. Coordinate, review and fully understand and integrate all cable tray, raceways and infrastructure interior or exterior that may be indicated on all contract documents including the T series drawings.

41. Lightning protection with master UL certification. Coordinate with the Carpentry and Roofing contractors.

42. Coordinate and provide a complete grounding system for the entire project. This includes but is not limited to the building columns, interior spaces, exterior wall assemblies, Electrical rooms, IDF and IDF rooms) and provide any testing and reports required.

43. As-built drawings in both hard copy, electronic and final BIM modelling per contract documents.

44. Provide rough-in and final connection and related work for equipment provided under other contracts (i.e. kitchen, elevators, HVAC, sprinkler, motorized doors, etc.). Provide power to automatic hardware. Low voltage wiring from the controller to hardware shall be provided by the Doors, Frames and Hardware Contractor. Include power panels and power supplies supplied by other trades.

45. Provide complete infrastructure for audio and audiovisual systems.

46. Provide rough-in and final connection of kitchen equipment and appliances. Refer to Specification Section 11400 Food Service Equipment for specifics. Coordinate power/plug requirements with rough in for equipment with the Kitchen Equipment Contractor.

47. Section 116163 Loose Performance Lighting shall be provided by the Stage Rigging contractor as follows; stage lighting systems including fixtures, controls, light grids, supports and attachments shall be provided. This contract (electrical) shall provide all power and power connections to the Loose Performance lighting. All other lighting in the Auditorium shall be supplied and installed by the

electrical contractor. Coordination of work between trades is tis contractors responsibility.

48. This contractor shall include within their bid the incorporation of **2500 hours of COOP participation** by a NCCVT student. Contractor to comply with project documents and requirements set forth in 19 del. C.ch.5

49. Perform certification testing for all wiring and systems supplied by this contract scope.

50. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

51. Provide access doors and frames for all access to Structured Cable components or equipment that require routine or periodic maintenance. Installation of access doors and frames provided by the Metal Stud & Drywall Contractor. (provide (75) 2′x2′ access panels within your base proposal)

52. Include within this contracts base bid an allocation of $75,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner.

"FOR REFERENCE ONLY"

CONTRACT NO. D-35 - SPECIAL SYSTEMS

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Division 26	Electrical (coordination of work)
Section 078400	Firestopping
Section 079200	Joint Sealants
Section 270500	Telecommunications Pathways and Spaces
Section 271000	Structured Cabling
Section 272000	Network Equipment
Section 274000	Classroom and Conference Room AV Equipment
Section 274100	Specialized AV Systems
Section 274117	Audio Video Systems
Section 275000	Public Address and Clock
Section 280501	Security Pathways and Spaces
Section 281000	Intrusion Detection System
Section 281100	Access Control System
Section 282000	Video Surveillance System

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide a complete Special System package as to include but not limited to, structured cabling, network equipment, AV systems, public address and clock system, intrusion detection, access controls, video surveillance and this section 283112 is removed from Contract D-35.

2. Provide wireless clock system including all equipment, cable, and accessories.

3. Telephone and voicemail system including telephone handsets and patch cables from device to jack will be provided by owner.

4. Provide intercom/public address system. Structured Cable Contractor will provide all network cabling including wiring, devices, and terminations at the source (MDF/IDF patch panel) and at the communication port (jack).

5. Provide complete cafeteria and Auditorium sound reinforcement audio/visual system. Projectors and mounts provided by the owner and installed by the Electrical Contractor.

6. The electrical contractor shall provide and install the fire alarm system, this contractor (Special Systems) will wire fire alarm terminations, and programming of electrified hold open hardware. Low voltage power to electrified hold open hardware provided by this contract. Hold open hardware provided by Carpentry and General Work Contractor.

7. Provide complete intrusion system.

8. Provide access control and security management system complete. Provide coordination with door and frame installation for a complete system. The contractor responsible for supplying the doors, frames, and hardware shall provide all wiring and accessories from the power supply (or junction box) to the door hardware. The contractor responsible for installation of doors and hardware shall provide terminations from door hardware to door whip, from door whip to power transfer, and from frame whip to power transfer. Frame whip shall be secured and protected by the door, frame, and hardware contractor(s) for the direct access of the Special Systems Contractor. Termination of the frame whip to the power supply (or junction box) shall be provided by the Special Systems Contractor. Power supply shall be furnished by the door, frame, and hardware contractor(s) and installed by the Special Systems Contractor. The Special Systems Contractor shall provide low-voltage wire from the card reader to the access controller, from the status switch (door contact) to the access controller, from access controller to the power supply(or junction box), and from power supply (or junction box) to power supply (or junction box) as necessary. The Electrical Contractor is responsible for providing 120v circuits to all power supplies and/or transformers as indicated in the documents. The Electrical Contractor shall provide conduits, device boxes, raceways, and pull strings for low-voltage wiring at doors receiving electronic, security, or access control hardware. Electrical contractor shall provide a junction box above each door scheduled to receive a card reader and a pathway & pull string. A mock-up shall be field installed and coordinated by all related Contractors for review prior to commencing work.

9. Provide a complete CCTV - Network Digital Video Management System. Owner shall provide server.

10. Provide all patch cords from communication port (jack) to each device included in this Contractor's scope. Patch cords at source (MDF/IDF) from patch panel to network switch provided by owner.

11. Provide all patch cords for switches.

12. Supply and install any fiber lines need for a complete installation including terminations.

13. Provide all testing of all installations.

14. Provide and install the racks, switches, uninterrupted power supplies etc. for a complete installation.

15. Coordinate all WAP's as per the specifications if supplied by the owner, install if not supplied provide and install under this contract.

16. This contractor shall own all notes as per the T series drawings unless note otherwise in the scope of this contract or the electrical contract. This includes but is not limited to the following series of notes. Note 6- Audio and Videa Systems, Note 7- Classroom/Conference Room AV Systems, Note 8-Demo Camera System and Note 9- Data Drop Allowance. These systems shall be provide as complete without any qualifications.

17. Provide coordination of the work of this contract with the Electrical including final equipment locations. This contractor must coordinate with Electrical Contractor as indicated on the drawings and as specified. The Electrical Contractor shall provide all device boxes, conduit and pull strings to circuits for special systems as indicated and also to provide 120 Volt circuits for all Special Systems. This

Contractor will be responsible for providing independent support systems, as indicated in the specifications, for all cable and wiring installed by this Contractor in locations where pathways and raceways are not required by the documents. All runs of cable/low voltage in open areas shall be installed in conduit. If raceways are required for the scope of this contract and they are not identified, this contractor shall provide.

18. This contract includes all Division 0 and Division 1 General Requirements. All commissioning requirements are identified in Division 1 and are a requirement of this contract.

19. This contractor shall be on site to coordinate when walls are being installed for penetrations and sleeve installations. If penetrations and sleeves are missed, this will be the responsibility of this contractor to cover associated costs of fixing.

20. Interactive screens/displays and mounting brackets will be supplied by Owner and mounted by the Carpentry & General Works Contractor. The Carpentry and General Works Contractor will coordinate blocking with mounting hardware and install all necessary clips and blocking to the wall for hanging. Audio/visual interface and/or controls by Special Systems Contractor.

21. Hardware for permanent exterior gates will be provided by the other trades. Access control hardware/software and fire alarm integrations of gate hardware, including terminations, cabling, etc. will be provided by this contractor. The Electrical Contractors shall provide all pathways & electrical requirements to support installation.

22. Provide access doors and frames for all access to Special Systems components or equipment that require routine or periodic maintenance. Installation of access doors and frames provided by the Metal Stud & Drywall Contractor.

23. Provide all network cabling including wiring, devices, and terminations to communication devices identified in plans and referenced on "Communications Outlet Configuration" chart on Drawing E-501. Two (2) terminations should be provided (1) at the source (MDF/IDF patch panel) and (1) at the communication port (jack) in all instances.

24. This contract shall provide communication wiring from the (3) access control panels to the source (MDF/IDF patch panel) including terminations on both ends. Location of access control panels to be coordinated with the documents and the Construction Manager prior to installation.

25. This contractor shall provide communication wiring from the intrusion control headend to the source (MDF/IDF patch panel) including terminations on both ends. This communication wiring shall include (1) dedicated POTS line from the MDF room to the intrusion control dialer. Location of intrusion control headend to be coordinated with the documents and Construction Manager prior to installation.

26. This contractor shall provide communication wiring from the Fire Alarm Control Panel (FACP) to the source (MDF/IDF patch panel) including terminations on both ends. This communication wiring shall include (2) dedicated POTS line from the MDF room to the FACP dialer(s). Location of FACP to be coordinated with the documents and the Construction Manager prior to installation.

27. This contractor shall supply communication wiring from the intercom/public address amplifiers to the source (MDF/IDF patch panel) including terminations on both ends. Location of amplifiers to be coordinated with the documents and the Construction Manager prior to installation. Contractor should

assume (3) amplifiers, one located in each MDF/IDF.

28. This contractor shall provide communication wiring from the Building Management System headend to the source (MDF/IDF patch panel). Location of Building Management System headend to be coordinated with the documents, the Mechanical Contractor, and the Construction Manager prior to installation.

29. This contractor will install all network cable within the kitchen and kitchen hood identified on the Kitchen Equipment Drawings. Final location of network drops to be coordinated with the documents, the Kitchen Equipment Contractor, and the Construction Manager prior to installation.

30. This contractor will install communication wiring from the food management systems to the POS devices, menu display boards, and temperature monitoring systems, including terminations on both ends. Final location of the food management systems to be coordinated with the documents and the Construction Manager prior to installation.

31. Provide installation for all wireless access points furnished by owner. Patch cords from device to communication port (jack) provided by this Contractor.
32. Provide penetrations through walls, floors, etc., including cutting, patching and fire safing.

33. Provide all design and coordination necessary to provide complete systems.

34. Provide and coordinate for inspections and testing.

35. Provide fire resistive sealants for the work of this contract.

36. Provide pricing for all alternates as described in Section 012300-Alternates.

37. Provide video documentation of training on systems.

38. Provide at least a 48 hour notice prior to any delivery. All deliveries are to be between 7:00 AM and 3:30 PM.

39. This is not a secure site. All contractors are responsible for concealing, locking and/or removing any materials on a daily basis. NCCVT and EDiS will not be responsible for any lost tools, materials or equipment.

40. This contractor must provide a silica exposure plan that meets or exceeds the new 2017 silica OSHA requirements before any work can commence. At a minimum, it must be incorporated into the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

41. Contractor must provide additional crews as needed to maintain the project schedule.

42. This contractor shall include within their bid the incorporation of **1200 hours of COOP participation** by a NCCVT student. Contractor to comply with project documents and requirements set forth in 19 del. C.ch.5

43. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination

process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

44. This contractor must provide a silica exposure plan that meets or exceeds the new 2017silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

45. Include within this contracts base bid an allocation of $20,000 for work to be determined by owner and construction manager. Unused allocation funds to be returned to the owner.

"FOR REFERENCE ONLY"

CONTRACT NO. D-36 - VERTICAL RETRACTABLE WALLS

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 055000	Metal Fabrications
Section 079200	Joint Sealants
Section 102239	Vertically Retractable Walls
Division 26	Electrical

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide labor and materials to perform all work associated with the Vertically Retractable Walls System to provide a complete operating wall system.

2. Provide Vertically Retractable Walls coordinate any structural requirements with the structural steel and carpentry contractors. Provide all supplementary steel as needed to hang partitions from structural support steel, provided by the Structural Steel Contractor. It is assumed, no additional steel will be required below structural support steel. If so, it will be provided by this contractor.

3. Provide coordinated shop drawings that reflect all structural requirements with the structural steel, metal studs, ceilings, electrical power, lighting and communication systems, etc.

4. This contract includes all Division 0 and Division 1 General Requirements. All commissioning requirements are identified in Division 1 and are a requirement of this contract.

5. Provide all trim components, hardware, hinges, and operators for electrical units, appropriate finishes, sensors, key switches and pocket doors for concealing doors when not in use.

6. Coordinate any structural requirements with the structural steel and carpentry contractors. Provide all supplementary steel as needed to hang partitions from structural support steel, provided by the Structural Steel Contractor. It is assumed, no additional steel will be required below structural support steel. If so, it will be provided by this contractor.

7. Electrical connections will be provided by Electrical Contractor. This contractor shall provide assistance to Electrical Contractor for coordination and installation of necessary connections. Low voltage wiring for devices, controls, raceways, boxes etc. to be provide by this contractor (not electrical contract)

8. Provide any required signage for safe operations.

9. Provide attic stock, warranty and demonstrations for all materials and types of panels.

10. Provide specified testing, adjusting, warranty and training demonstrations on the operation.

11. Provide (3) additional sets of keys for switch operating controls over and above the number of sets required by specifications.

12. Provide data and submittal information related to the Scope of this Contract signed and sealed by a Professional Engineer as required by the Contract Documents, including but not limited to delegated design requirements.

13. Provide all low voltage wiring, motors motor transformers and final connections to allow for a complete operating system. Electrical contractor shall supply the line voltage power connection. Include all raceways and boxes for your work.

14. Provide all BIM services as specified in Section 013700 BIM Execution Plan. As part of the coordination process all contractors are responsible for obtaining a Revizto license. The cost of this license is $1,200 and shall be included in your base bid proposal.

15. This is not a secure site. All contractors are responsible for concealing, locking and/or removing any materials on a daily basis. EDiS will not be responsible for any lost tools, materials or equipment.

"FOR REFERENCE ONLY"

CONTRACT NO. D-37 - MISCELLANEOUS CONCRETE AND GROUTING

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

- Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Division 03	Concrete
Section 033000	Concrete
Division 07	Thermal and Moisture Protection
Section 072100	Thermal Insulation
Section 072600	Under-Slab Vapor Barrier
Section 312300	Excavation and Backfill for pipeline and structures
Section 321313	Concrete Paving

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide Misc. concrete items and grouting as described in the Scope of Work and defined on the contract documents. Include all preparations and excavation, backfill, stone subbase, forms, and reinforcing required.
   - Provide footings and concrete piers as show on drawings A560-A565, include footings for dumpster pad.
   - Provide concrete locker bases as indicated in the contract documents.
   - Provide the electrical, mechanical and plumbing concrete pads as indicated on the contract documents. (Structural foundations and pads shown on Struct. Drawings excluded)
   - Provide all concrete slab on grade at the interior courtyard areas
   - Provide all poured foundations for block walls, poured concrete walls at all areas outside of the main building foot print.
   - Provide all concrete excavation, footings and backfill as required for the masonry walls at the child care and playground areas.
   - MEP Housekeeping Pads throughout, drawings M301, M308, P301, P315, P316 for typical pads
   - MEP Exterior equipment pads reference drawing M310 detail 4 (typical)
   - Mechanical yard pipe rack supports foundations referenced on drawing M315 (typical)
   - Anchor bolts and leveling plates will be supplied by the Misc. Metals contractor.
   - Fire Protection pump and equipment housekeeping pads as shown on Drawing F301
   - Water treatment/expansion tank pad in mechanical room E110 – D-32
   - CA-02 Pad in Mechanical equipment room D212 – D31
   - Dental air and vac pad Mechanical equipment room C 201B – D31
   - Two fuel storage tanks w/Dikes exterior pad – D31

2. This Contractor will be responsible for laying out all concrete work for this contract course of work.

3. This Contractor to furnish and install reinforcing steel, admixtures, curing compound, sealers, accessories, bolsters, ties and braces as required in the Contract Documents and for the performance of

the work of this contract.

4. All work of this contract shall be considered "out of sequence" as such the contractor shall price each element of work as a mobilization and if required "short load" concrete delivery.

5. This contractor is responsible to provide material handling equipment, concrete pumps, etc. for work of this contract. NCCVT and EDiS will not be responsible for any additional material handling costs above the base bid proposal.

6. Provide sealants/caulking as required at grouted freezer and cooler box floors. Caulk all edges where grout seals to box floor panels.

7. This contractor shall provide installation of sleeves required for MEP lines, under footings, below frost walls, under thickened slabs as related to this contractors course of work. This includes all excavation and backfill required for these installations. (sleeves will be supplied by the contractor installing the services, future BP-D) Coordinate with Arch and MEP documents for extent of this work.

8. Provide grouting of floor expansion joints once they are set and adjusted by installing contractors.

9. Grouting of all elevator sill angles will be the responsibility of this contractor.

10. Grouting of all base plates for Mechanical pipe support racks will be the responsibility of this contractor.

11. Provide all door stoops, pads, entrance/exit concrete complete as provided for on the Architectural and MEP drawings. (if the concrete is shown on the structural drawings it shall be part of Contract C-01 Concrete and Reinforcing unless identified elsewhere in the SOW, pre-Bid RFI log or Clarifications by Addendum.) This will be out of sequence work, contractor to include (5) re-mobilization to perform work out of sequence, this shall include premium costs for short load concrete pours as well.

12. Underslab vapor barrier, insulation, reglets, waterstops, control and construction joints. (Caulking by Joint and Sealants Contractor)

13. Provide foundation wall insulation and insulation under slabs. Include backfill of all foundation walls as detailed. Stone under slab to be provided by this contractor. Include re-dressing the stone after the MEP contractors have installed their UG work. As related to the work detailed for this contract.

14. Placement of related items furnished under other Specification Sections.

15. Anchor bolt assemblies to be placed with templates only.

16. All blockouts and embedment's required by plans and specifications.

17. This Contractor is responsible for grouting all structural steel base or leveling plates and elevator sill angles. As defined by the scope of this contract.

18. Include all weather, frost protection, and water pumping as required. This Contractor is also responsible for the premiums required for hot water, heated aggregate and admixtures for cold weather concrete.

19. Provide dewatering as it relates to the work of this contract.

20. All concrete testing will be completed by the Construction Manager, however, it will be the responsibility of this Contractor to furnish all samples.

21. This contractor shall include an allowance amount of $15,000 within the base bid for work to be identified by NCCVT and the CM. All unused portions of this allocation to be returned to the owner by means of a credit change order.

22. Provide all grout infill inside the walk-in freezers and refrigerators after freezers and refrigerators have been set in place. Also grout the space between the freezers and refrigerator and the surrounding concrete. Coordinate requirements with the architectural drawings for BP-D and technical specifications.

23. This contractor owns coordinating all slab depressions identified on the documents with the products, flooring, insulation etc. shop drawings and layout drawings for each material that will be installed in the recess. A pre-install meeting will be held to review this information before each depressed pour.

24. Provide all means of transporting concrete including, but not limited to: pump trucks, cranes, ramps, chutes, buggies.

25. Provide at least 48 hours' notice prior to any delivery. All deliveries are to be between 7:00 AM and 3:30 PM.

26. Provide and maintain a DNREC approved concrete dumpster for washout required by the scope of this contracts work.

27. This is not a secure site. All contractors are responsible for concealing, locking and/or removing any materials on a daily basis. NCCVT and EDiS will not be responsible for any lost tools, materials or equipment.

28. This contractor must provide a silica exposure plan that meets or exceeds the silica OSHA requirements before any work can commence. At a minimum, it must be implemented in to the company safety plan, include all monitoring, testing, limits exposure, provide respiratory plan and/or equipment modifications such as adding water to equipment during exposed work and keep records of exposure.

29. Provide daily fine cleanup of the work is the responsibility of each individual Contractor which includes broom cleaning of their debris as required. Daily Fine clean up, on a daily basis, shall be defined as those means/methods utilized to perform the daily cleaning tasks without producing dust, noise and stacking of stored materials. Furnish fine clean up on a daily basis. All debris must be removed from the work area at the end of each work day to the appropriate dumpster. Cleaning of roadways shall be included and performed daily while this contractor is on site performing work of this contract.

30. All materials excavated for installation of footings and foundations shall immediately be protected with appropriate moisture protection.

31. BIM coordination is "not" part of this contract scope.

END OF SECTION

NEW CASTLE COUNTY
VO-TECH SCHOOL DISTRICT

PAUL M. HODGSON
VOCATIONAL TECHNICAL HIGH SCHOOL

2575 Glasgow Avenue, Newark, DE 19702

PROJECT MANUAL

BSA+A PROJECT #22.011

Contract No. NCC2401D

Volume 5
Division 26

BID PACKAGE D – BUILDING ENVELOPE AND FIT OUT
CONFORMANCE SET

February 16, 2024

ABHA | BSA+A

PROJECT MANUAL

NEW CASTLE COUNTY VO-TECH SCHOOL DISTRICT

PAUL M. HODGSON VOCATIONAL-TECHNICAL HIGH SCHOOL

Contract No. NCC2401D

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CONFORMANCE SET
February 16, 2024

SECTION 00 01 10 - TABLE OF CONTENTS

VOLUME 1

DIVISION 00 PROCUREMENT AND CONTRACT REQUIREMENTS

00 01 10 Table of Contents

00 01 15 List of Drawings

DIVISION 01 GENERAL REQUIREMENTS

01 30 00 Administrative Requirements

01 40 00 Quality Requirements

01 70 00 Execution and Closeout Requirements

01 79 00 Demonstration and Training

01 91 13 General Commissioning Requirements

01 91 14 Plumbing Commissioning Requirements

01 91 15 HVAC Commissioning Requirements

01 91 16 Electrical Systems Commissioning Requirements

DIVISION 02 EXISTING CONDITIONS

Not Used

VOLUME 2

DIVISION 03 CONCRETE

03 30 00 Cast-in-Place Concrete

DIVISION 04 MASONRY

04 20 00 Unit Masonry

04 72 00 Cast Stone Masonry

04 43 16 Stone Fabrications

04 72 00 Cast Stone Masonry

DIVISION 05 METALS

05 12 00 Structural Steel

05 21 00 Steel Joist Framing

05 31 00 Steel Deck

05 40 00 Cold-formed Metal Framing

05 50 00 Metal Fabrications

05 51 00 Metal Stairs

05 51 33 Metal Ladders

05 52 13 Pipe and Tube Railings

05 58 00 Architectural Metal Column Covers

05 73 00 Decorative Metal Railing

DIVISION 06 WOOD AND PLASTIC

06 10 00 Rough Carpentry

06 20 00 Finish Carpentry

DIVISION 07 THERMAL AND MOISTURE PROTECTION

07 05 53 Fire and Smoke Assembly Identification
07 13 00 Sheet Waterproofing
07 21 00 Thermal Insulation
07 21 29 Sprayed Acoustical Insulation
07 25 00 Weather Barriers
07 26 00 Under-Slab Vapor Barrier
07 26 40 Spray Polyurethane Foam Insulating Air Barrier
07 42 13.13 Metal Wall and Roof Panels
07 42 13.23 Metal Composite Material Wall Panels
07 53 00 Elastomeric Membrane Roofing
07 62 00 Sheet Metal Flashing and Trim
07 71 00 Roof Specialties
07 71 23 Manufactured Gutters and Downspouts
07 72 00 Roof Accessories
07 81 00 Applied Fireproofing
07 84 00 Firestopping
07 84 13 Fire Protection, HVAC & Plumbing Penetration Firestopping
07 91 00 Preformed Joint Sealants
07 92 00 Joint Sealants

DIVISION 08 OPENINGS

08 11 13 Hollow Metal Doors and Frames
08 14 16 Flush Wood Floors
08 17 00 Integrated Door Opening Assemblies
08 31 00 Access Doors and Panels
08 33 13 Coiling Counter Door
08 33 23 Overhead Coiling Doors
08 43 13 Aluminum Framed Storefronts

08 43 33 Folding Glass Storefront
08 44 13 Glazed Aluminum Curtain Walls
08 45 23 Translucent Wall Assemblies
08 71 00 Door Hardware
08 71 06 Door Hardware Schedule
08 80 00 Glazing
08 87 23 Safety and Security Films
08 91 00 Louvers

DIVISION 09 FINISHES

09 05 61 Common Work Results for Flooring Preparation
09 21 16 Gypsum Board Assemblies
09 30 00 Tiling
09 51 00 Acoustical Ceilings
09 54 20 Specialty Ceiling Systems
09 64 29 Wood Strip Flooring
09 65 00 Resilient Flooring
09 65 66 Resilient Athletic Flooring
09 66 16 Precast Cement Terrazzo Treads and Landings
09 66 23 Resinous Matrix Terrazzo Flooring
09 67 00 Fluid Applied Flooring
09 68 13 Tile Carpeting
09 68 16 Sheet Carpeting
09 69 33 Low-Profile Fixed Height Access Flooring
09 84 00 Acoustic Room Components
09 91 13 Exterior Painting
09 91 23 Interior Painting

DIVISION 10 SPECIALTIES

10 11 01 Visual Display Boards and Display Cases

10 21 13.19 Plastic Toilet Compartments

10 21 23 Cubicle Curtains and Track

10 22 39 Vertically Retractable Walls

10 26 00 Wall Protection

10 28 00 Toilet Accessories

10 44 00 Fire Protection Specialties

10 51 00 Metal Lockers

10 73 16.13 Metal Canopies

DIVISION 11 EQUIPMENT

11 40 00 Foodservice Equipment

11 61 33 Rigging Systems and Draperies

11 61 63 Loose Performance Lighting Fixtures

11 66 25 Gymnasium Equipment

11 66 53 Gymnasium Dividers

DIVISION 12 FURNISHINGS

12 24 13 Window Treatment – Roller Shades

12 34 00 Manufactured Plastic Laminate Casework

12 36 00 Countertops, Backsplashes and Window Stools

12 61 13 Fixed Audience Seating

12 66 13 Telescoping Bleachers

12 66 23 Telescoping Chair Platforms

12 93 00 Site Furnishings

DIVISION 13 SPECIAL CONSTRUCTION

Not used

DIVISION 14 CONVEYING EQUIPMENT

14 20 13 Hydraulic Holeless Passenger Elevator

VOLUME 3

DIVISION 21 FIRE PROTECTION

21 05 00 Common Work Results for Fire Protection

21 05 05 Fire Suppression System Piping, Fittings and Valves

21 10 00 Water Based Fire Suppression System – Fire Pump

DIVISION 22 PLUMBING

22 05 00 Common Work Results for Plumbing

22 05 05 Plumbing Piping, Fitting and Valves

22 07 01 Plumbing Insulation

22 40 00 Plumbing Fixtures

22 40 05 Plumbing Equipment

22 61 13 Compressed-Air Piping for Dental Systems

22 61 19 Compressed Air Equipment for Dental Systems

22 62 13 Vacuum Piping for Dental Systems

22 62 19 Vacuum Equipment for Dental Systems

VOLUME 4

DIVISION 23 HVAC

23 05 00 Common Work Results for HVAC

23 05 05 HVAC Piping, Fittings and Valves

23 05 48 Vibration Controls for HVAC, Plumbing & Fire Protection Equipment

23 05 93 Testing, Adjusting & Balancing for HVAC and Plumbing

23 06 00 Heating, Ventilating, and Air Conditioning Equipment

23 07 01 HVAC Insulation
23 07 10 Dust Collection System
23 09 00 Instrumentation and Controls of HVAC & Plumbing Systems
23 09 23 Airflow Monitoring Stations
23 30 00 HVAC Air Distribution
23 82 20 Carbon Monoxide Exhaust System
23 8221 Welding Fume Exhaust System
23 82 22 Packaged Kitchen Hood Ventilation Control System

VOLUME 5

DIVISION 26 ELECTRICAL

26 05 00 Common Work Results for Electrical
26 05 13 Medium-Voltage Cables
26 05 19 Low-Voltage Electrical Power Conductors and Cables
26 05 20 Electrical Heating Cables
26 05 26 Grounding and Bonding for Electrical Systems
26 05 29 Hangers and Supports for Electrical Systems
26 05 33 Raceways and Boxes for Electrical Systems
26 05 43 Underground Duct banks
26 05 53 Identification for Electrical Systems
26 05 73 Short Circuit Analysis, Coordination Study, & Arc Flash Hazard Analysis
26 09 23 Lighting Control Devices
26 09 43 Network Lighting Controls
26 09 61 Performance Lighting Systems
26 09 63 Performing Lighting Systems Installation
26 09 73 Audio Video Systems Installation
26 11 20 Utility-Incoming Service Provisions
26 22 00 Low-Voltage Transformers

26 24 13 Switchboards
26 24 16 Panelboards
26 25 50 Manual Transfer Switch/Generator Docking Station
26 27 16 Commercial Pedestals
26 27 26 Wiring Devices
26 28 13 Fuses
26 28 16 Enclosed Switches and Circuit Breakers
26 29 13 Enclosed Controllers
26 32 13 Engine Generators
26 36 00 Transfer Switches
26 41 13 Lightning Protection System
26 4313 Surge Protection Devices
26 51 00 Interior Lighting
26 56 00 Exterior Lighting
26 60 10 Rigging Systems Electrical Work

VOLUME 6

DIVISION 27 COMMUNICATIONS

27 05 00 Telecommunications Pathways and Spaces
27 10 00 Structured Cabling
27 20 00 Network Equipment
27 40 00 Classroom and Conference Room AV Equipment
27 41 00 Specialized AV Systems
27 41 17 Audio Video Systems
27 50 00 Public Address and Clock

DIVISION 28 ELECTRONIC SAFETY AND SECURITY

28 05 01 Security Pathways and Spaces

2810 00 Intrusion Detection System

28 11 00 Access Control System

28 20 00 Video Surveillance System

28 31 12 Public Safety – First Responder Radio Amplification System

28 46 21 Addressable Fire-Alarm Systems

DIVISION 31 EARTHWORK

31 23 00 Excavation & Backfill for Pipelines and Structure

DIVISION 32 SITE IMPROVEMENT

32 13 13 Concrete Paving

32 18 00 Synthetic Turf Shock Pad

32 18 13 Synthetic Turf Carpet

32 31 19 Decorative Metal Fences and Gates

END OF SECTION

DIVISION 26 SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL
TABLE OF CONTENTS

PART 1. GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 ALTERNATES 3
1.3 SUMMARY 3
1.4 PERMITS AND FEES 4
1.5 EXAMINATION OF SITE 4
1.6 INTERPRETATION OF DOCUMENTS 5
1.7 MATERIALS AND EQUIPMENT 6
1.8 ELECTRICAL WORK UNDER OTHER DIVISIONS 6
1.9 FIRE SAFE MATERIALS 7
1.10 REFERENCED STANDARDS, CODES AND SPECIFICATIONS 7
1.11 SUBMITTALS 8
1.12 SUBMITTALS, REVIEW AND ACCEPTANCE 8
1.13 SHOP DRAWINGS 9
1.14 DEFINITIONS 11
1.15 RECORD DRAWINGS 12
1.16 WARRANTY 12
1.17 OPERATIONS AND MAINTENANCE MANUALS 13
1.18 INSTALLATION AND COORDINATION DRAWINGS 14

PART 2. PRODUCTS 16

2.1 SLEEVES FOR RACEWAYS AND CABLES 16
2.2 SLEEVE SEALS 16
2.3 GROUT 17
2.4 FOAM DUCT SEALANT 17
2.5 FASTENERS 18

PART 3. EXECUTION 18

3.1 TEMPORARY FACILITIES 18
3.2 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION 18
3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS 19
3.4 SLEEVE-SEAL INSTALLATION 20
3.5 FIRESTOPPING 20
3.6 SUPPORTS, HANGERS AND FOUNDATIONS 20
3.7 PROVISIONS FOR ACCESS 21
3.8 PAINTING AND FINISHES 22
3.9 COLOR SELECTION 23
3.10 PROTECTION OF WORK 23
3.11 OPERATION OF EQUIPMENT 23
3.12 TESTING AND ADJUSTMENT 23
3.13 WALL AND FLOOR PENETRATIONS 24

3.14 EQUIPMENT BY OTHERS 24
3.15 PHASING 25
3.16 OUTAGES 25
3.17 CUTTING AND PATCHING 25
3.18 PENETRATION OF WATERPROOF CONSTRUCTION 26
3.19 CONCRETE AND MASONRY WORK 26
3.20 CONNECTIONS AND ALTERATIONS TO EXISTING WORK 27
3.21 COORDINATION 27
3.22 DEMOLITION 28
3.23 EXCAVATION AND BACKFILLING 29
END OF SECTION 30

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 ALTERNATES

A. Refer to Division 01 Section 012300, *Alternates* for description of work under this Section affected by Alternates.

1.3 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.

2. Sleeves for raceways and cables.

3. Sleeve seals.

4. Foam Duct Sealant.

5. Grout.

6. Common electrical installation requirements.

B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all electrical work.

C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.

D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Article "Submittals" specified below. The right is reserved to make reasonable changes in location of equipment, boxes, conduit/wiring, and devices, up to the time of rough-in or fabrication.

E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

F. Coordinate the work under Division 26 with the work of all other construction trades.

G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the Contract Documents.

H. Arrange conduit, wiring, equipment, and other work generally as shown, providing proper clearances and access. Carefully examine all Contract Drawings and fit the work in each location without substantial alteration. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Article "Submittals" as hereinafter specified. The right is reserved to make reasonable changes in location of equipment, conduit and wiring up to the time of rough-in or fabrication.

1.4 PERMITS AND FEES

A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.

B. Permits and fees shall comply with Division 01 Section 010000, *General Requirements*.

C. Notify Inspection Authorities to schedule inspections of work.

D. Notify Architect and Engineer in advance of scheduled inspections.

E. An electrical foreman, superintendent or other supervisor shall be in attendance for all scheduled inspections.

1.5 EXAMINATION OF SITE

A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for Contractor's failure to do so.

B. Examine and verify specific conditions described in individual Specifications sections.

C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.6 INTERPRETATION OF DOCUMENTS

A. Any discrepancies between Drawings, Specifications, Drawings and Specifications, or within Drawings and Specifications shall be promptly brought to the attention of the Owner during the bidding period. No allowance shall subsequently be made by reason of failure to have brought said discrepancies to the attention of the Owner during the bidding period or of any error on the Bidder's part.

B. The locations of products shown on Drawings are approximate. Place the devices to eliminate all interference with above-ceiling ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the Owner.

C. All general trades and existing conditions shall be checked before installing any outlets, power wiring, etc.

D. Equipment sizes shown on the Drawings are estimated. Before installing any wire or conduit, obtain the exact equipment requirements and install wire, conduit, or other item of the correct size for the equipment actually installed. However, wire and conduit sizes shown on the Drawings shall be taken as a minimum and shall not be reduced without written approval from the Owner.

E. Where variances occur between the Drawings and Specifications or within either document itself, the item or arrangement of better quality, greater quality, or higher cost shall be included in the Contract Price. The Engineer will decide on the item and manner in which the work shall be installed.

F. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions, and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed Shop Drawings for approval in accordance with Article "Submittals" as herein after specified. The right is reserved to make reasonable changes in location of equipment, conduit/wiring, and devices, up to the time of rough-in or fabrication.

G. Work not specifically outlined, but reasonably incidental to the completion of the work, shall be included without additional compensation from the Architect, Engineer, or Owner.

H. Perform the work in a first-class, substantial and workmanlike manner. Any materials installed which do not present an orderly and neat workmanlike appearance shall be removed and replaced when so directed by the Engineer, at the Contractor's expense.

I. Contact and coordinate service entrance equipment and layout with local power company prior to ordering or installing any service entrance equipment. Contractor shall furnish and install all incoming raceway and service entrance cables. If the power company plans to install cable and/or conduit, Contractor is responsible for proper coordination of cable, conduit, lug sizes, etc., for proper interface between utility owned/installed

equipment and Contractor-installed equipment.

J. The Owner shall make the application for electrical service and pay for all service charges, as coordinated with the Contractor.

K. The complete set of Architectural, Civil, Structural, Mechanical, and Electrical Drawings and Specifications apply to this work. The successful Bidder shall familiarize himself with all other related documents.

1.7 MATERIALS AND EQUIPMENT

A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality. Existing items of equipment are being reconnected under another Division of these Specifications. The Contractor shall be responsible for connecting all utilities as shown on the Drawings, to equipment identified as existing.

B. The Contractor shall only submit those manufacturers indicated in the Specification. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Alternate manufacturers will not be considered unless the specific item indicates “or as approved equal”. Submit all data necessary to determine suitability of substituted items, for approval.

C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.

D. Substitution will not be permitted for specified items of material or equipment where noted.

E. All items of equipment furnished shall have a service record of at least five (5) years.

1.8 ELECTRICAL WORK UNDER OTHER DIVISIONS

A. Mechanical Equipment and Systems

1. In general, power wiring and motor starting equipment for mechanical equipment and systems are furnished and installed under Electrical Division 26.

2. Certain mechanical units are furnished from the factory with starters, contactors, transformers, fuses, wiring, etc., required for fans, pumps, etc. When this equipment is supplied from the factory, the Electrical Contractor must supply power

circuit(s) to the unit and a disconnecting means. Coordinate with Mechanical Contractor so that one and only one, set of starters, fuses, switches, etc., is provided and installed.

3. In general, control and interlock equipment for HVAC systems (including associated wiring, conduit, transformers, relays, contacts, etc.) is furnished under Division 23. Division 26 shall install and connect all such equipment as necessary.

4. Controls, wiring, conduit, transformers, etc., for smoke, fire, and motor-operated dampers are provided under Division 23. Division 26 shall install and connect all such equipment.

B. Architectural Equipment: In general, any electrically operated or controlled equipment furnished under architectural divisions shall be supplied with control wiring, transformers, contacts, etc. Provide power circuits and disconnects to such equipment and install all electrical control equipment related thereto.

C. Owner Furnished Equipment: In general, Owner furnished equipment is either provided or wired by the equipment supplier. Provide power circuits to such equipment and make final connections to equipment being provided by the Owner.

D. Carefully review the Contract Documents and coordinate the electrical work under the various Divisions.

1.9 FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.10 REFERENCED STANDARDS, CODES AND SPECIFICATIONS

A. Specifications, Codes and Standards listed below are included as part of this Specification, latest edition:

1. ADA - Americans with Disabilities Act

2. ANSI - American National Standards Institute

3. ASTM - American Society for Testing and Materials

4. CSA - Canadian Standards Association

5. DNREC - Delaware Department of Natural Resources and Environmental Control

6. EPA - Environmental Protection Agency

7. FM - Factory Mutual

8. IBC - International Building Code

9. IEEE - Institute of Electrical and Electronics Engineers

10. NEC - National Electrical Code

11. NECA - National Electrical Contractors Association

12. NEMA - National Electrical Manufacturers Association

13. NFPA - National Fire Protection Association

14. OSHA - Occupational Safety and Health Act

15. UL - Underwriters' Laboratories

B. The application standards of the local electric utility company.

C. Electrical construction materials shall, where a listing is normal for the particular class of material, be listed in *Electrical Construction Materials List* of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Electrical equipment shall, where a listing is normal for the particular class of equipment, be listed in the *Electrical Appliance and Utilization Equipment List* of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Materials and equipment listed and labeled as "approved for the purpose" by other nationally recognized testing laboratory, inspection agency or approved organization (such as E.T.L. or Factory Mutual) shall be acceptable.

1.11 SUBMITTALS

A. Product Data: For items specified in Part 2 of this Section.

1.12 SUBMITTALS, REVIEW AND ACCEPTANCE

A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Architect/Engineer, to be in best interest of Owner.

B. After acceptance of Material and Equipment List, submit six (6) copies, or more as required under the General Conditions, of complete descriptive data for all items. Data shall consist of Specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to this project.

C. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals.

D. Submittals will be reviewed for general compliance with design concept in accordance with Contract Documents, but dimensions, quantities, or other details will not be verified.

E. Identify submittals, indicating intended application, location and service of submitted items. Refer to Specification sections or paragraphs and Drawings where applicable. Clearly indicate exact type, model number, style, size and special features of proposed item. Submittals of a general nature will not be acceptable. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The Contractor shall be responsible for corrective action and maintaining the Specification requirements if differences have not been clearly indicated in the submittal.

F. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Call attention, in writing, to deviation from contract requirements.

G. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.

H. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold Contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

1.13 SHOP DRAWINGS

A. Prepare and submit Shop Drawings for all electrical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the Contract Drawings, or where the proposed installation differs from that shown on Contract Drawings.

B. Submit Product Data and Shop Drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable Specification paragraph number and Drawing number.

C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.

Items and Systems

1. Analysis and Coordination Study
2. Automatic Transfer Switches
3. Ballasts
4. Basic Electrical Materials
5. Cable – 600 Volt

6. Circuit Breakers
7. Conduit and Surface Raceway
8. Contractor and Subcontractor Qualifications
9. Controllers and Control Devices
10. Engine/Generator
11. Equipment Connections
12. Equipment Pads
13. Firestopping
14. Ground Conductors, Rods
15. Identification System
16. Lamps
17. Lighting Control Equipment
18. Light Fixtures
19. Low Voltage Fuses
20. Material and Equipment List
21. Motor Controllers
22. Occupancy and Vacancy Sensors
23. Outlet Boxes
24. Panelboards
25. Receptacles
26. Record and Information Booklet
27. Safety Switches
28. Schedule of Values
29. Sleeves, Hangers, Supports
30. Submittal Schedule
31. Surge Suppression Devices
32. Switchboards
33. Tests and Reports
34. Transformers
35. Wiring Devices
36. Wiring Diagrams

D. Submittals shall include, but not be limited to, the following information: size, type, functional characteristics, compliance with standards in Division 26, required service access which shall be suitable for intended location and use, electrical service connections and requirements, and deviations from Contract Document requirements.

E. Submit for approval any other shop drawings as required by the Architect/Engineer. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Engineer.

F. Submit for approval schematic diagrams of each electrical system installed in the building. Diagrams shall indicate device location, service, type, make, model number and the identification number of each device in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under glass and hung in each Main Equipment Room. Deliver the tracing or sepia from which the diagrams were reproduced to the Owner.

G. Submittals shall include Riser Diagrams and Schematic Wiring Diagrams, complete conduit and wire requirements, outlet and junction box sizes and power requirements, for the following systems:

1. Fire Alarm System

2. Generator and Automatic Transfer Switch(es)

3. Grounding and Bonding System

H. For any shop drawing requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold Contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return for any reason.

I. Prepare and submit a detailed schedule of values indicating the Contract costs for the major work items. Provide additional detail and information as requested by the Engineer.

J. Submit the following Shop Drawings to the Utility Company for approval:

1. Automatic Transfer Switch

2. C/T Cabinets

3. Metering (Utility)

4. Switchboard

1.14 DEFINITIONS

A. *Approve*: To permit use of material, equipment or methods conditional upon compliance with contract documents requirements.

B. *Building Line*: Exterior wall of building.

C. *Concealed:* Hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction.

D. *Conduits* include conduit, all fittings, identification, and other accessories relative to such conduit.

E. *Contractor:* The Electrical Contractor and any of his subcontractors, vendors, suppliers, or fabricators.

F. *EPDM*: Ethylene-propylene-diene terpolymer rubber

G. *Exposed:* Not installed underground or *concealed* as defined above.

H. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.

I. *Furnish and install* or *provide*: To supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.

J. *Location, Damp*: Locations protected from water and not subject to saturation with water or other liquids, but subject to moderate degrees of moisture. Examples of such locations include interior locations such as basements, crawlspaces, attics, cold-storage rooms, etc.

K. *Location, Dry*: A location not normally subject to dampness or wetness. A dry location may temporarily be subject to dampness or wetness during building construction.

L. *Location, Wet*: Locations subject to saturation with water or other liquids, locations exposed to weather, and installations underground or in concrete slabs or masonry in direct contact with the Earth. Examples of such locations include all exterior locations (including those under canopies, roofed open porches, etc…) commercial kitchens, and vehicle washing areas.

M. *NBR*: Acrylonitrile-butadiene rubber.

N. *Review*: Limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

1.15 RECORD DRAWINGS

A. Upon completion of the electrical installations, the Contractor shall deliver to the Architect one complete set of prints of the electrical Contract Drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.

B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering the same to the Architect.

1.16 WARRANTY

A. Contractor's attention is directed to warranty obligations contained in the General Conditions.

B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer’s warranties shall be included in the operations and maintenance manuals.

C. The Contractor guarantees for a two year period from the time of final acceptance by the Owner:

1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.

2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.

3. That the Contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The Contractor shall also make good all damages caused to their work or materials in the process of complying with this section.

4. That the entire work shall be water-tight and leak-proof.

1.17 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall have prepared six (6) copies of the Operations and Maintenance Manual and deliver these copies of the manual to the Owner. The manual shall be as specified herein. The manual must be approved and will not be accepted as final until so stamped.

B. The manual shall be bound in a three-ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: *Operations and Maintenance Manual – Bayard Middle School Phase 1 - Electrical.* No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.

C. Provide the following data in the manual:

1. As first entry, an approved letter indicating the starting/ending time of Contractor’s warranty period.

2. Maintenance operation and lubrication instructions on each piece of equipment furnished.

3. Complete catalog data on each piece of electrical equipment furnished including approved Shop Drawing/Submittal with Engineer’s Comments (if any).

4. Manufacturer's extended limited warranties on equipment.

5. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.

6. Provide supplier and subcontractor’s names, address, and phone number.

7. Catalog data of all equipment, starters, etc. shall include wiring diagrams, parts list and assembly drawing.

8. Access panel charts with index illustrating the location and purpose of access panels.

9. Approved Electrical Certificates.

10. Start-up reports for equipment.

D. Submit Operations and Maintenance Manual prior to anticipated date of Substantial Completion for Engineer review and approval. Substantial Completion requires that Operations and Maintenance Manuals be reviewed and approved.

E. Post one (1) copy of all instructions, lists, charts and diagrams at the equipment mounted under glass or approved plastic cover.

F. Deliver all instruction materials to the Owner prior to the formal instruction period.

G. Upon completion of all work, thoroughly instruct the Owner's representatives in the proper operation and maintenance of all electrical equipment and systems.

H. Instructions shall be done only after completed systems have been put into operation and tested for proper operation and performance.

I. Instructions shall be given only by experts in the equipment or system and shall include descriptions and demonstrations of procedures of operation, data record keeping, etc.

J. Furnish the necessary technicians, skilled workers, and helpers to operate the electrical systems and equipment of the entire project for one 8-hour day.

K. Where specified in technical sections, provide longer periods required for specialized equipment.

L. Instruct the Owner or designated personnel in operation, maintenance, lubrication, and adjustment of systems and equipment.

M. The Operations and Maintenance Manual shall be available at the time of the instructions, for use by Instructors and Owner personnel.

N. Schedule the general and specialized instruction periods for a time agreed upon by the Owner and Engineer.

1.18 INSTALLATION AND COORDINATION DRAWINGS

A. Prepare, submit and use composite installation and coordination drawings to assure proper coordination and installation of the work. Drawings shall include, but not be limited to the following:

1. Mechanical Rooms indicating transformers, panelboards, enclosures, boxes, conduits, mechanical equipment, ductwork, and piping, etc…

2. Electrical Rooms indicating switchboards, panelboards, enclosures, boxes, transformers, conduits, wireways, etc…

B. Draw plans to a scale not less than ¼ inch equals one foot. Include plans, sections and elevations of the proposed work, showing all equipment (mechanical, plumbing and electrical), conduit and wiring in the areas involved. Fully dimension all work, horizontally and vertically. Show coordination with other work including piping, ductwork and other mechanical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.

C. Identify all equipment and devices on wiring diagrams. Where field connections are shown to factory-wired terminals, furnish manufacturer's literature showing internal wiring of equipment.

D. Prepare, submit, and use scaled layout drawings indicating dimensions, clearances, and actual equipment dimensions. Layout Drawings shall include, but not be limited to the following:

1. Pad-mounted equipment and equipment connections.
2. Underground conduits, ductbanks, and building penetrations.

E. Prepare scaled coordination drawings in accordance with the Specifications. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of power, lighting, and all special system raceways, equipment, and materials. Include the following:

   a. Working space and dedicated space clearances per the NEC.

   b. Clearances for equipment disassembly required for periodic maintenance.

   c. Exterior wall and foundation penetrations.

   d. Fire-rated wall and floor penetrations.

   e. Equipment connections and support details.

   f. Sizes and locations of required concrete bases.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction, including, but not limited to, the following: Major conduits and feeders.

3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

4. The successful Bidder shall be responsible for indicating all raceways described in notes or indicated by home run symbols.

5. The successful Bidder shall check all trades' Drawings, including Civil, Architectural, Structural, Plumbing, and Mechanical, to avoid possible demolition and installation conflicts.

PART 2. PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).

b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.

b. Bridgeport Fittings, Inc.

c. Calpico, Inc.

d. GS Metals Corporation

e. Metraflex Co.

f. O-Z/Gedney

g. Pipeline Seal and Insulator, Inc.

h. Raco, Inc.

2. Sealing Elements: EPDM, NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Stainless Steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 FOAM DUCT SEALANT

A. Description: Two-part, high-expansion foam duct sealant to keep water, acids, dust, gases, insects and rodents out of ducts (conduits).

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. American Polywater Corporation

C. Basis of Design: FST Foam Sealant by American Polywater Corporation.

D. The foam duct sealant shall be a two-part "blown" urethane foam with 98% closed cell content.

E. The foam duct sealant shall have a compressive strength of 300 pounds (ASTM D1691), a ten sile strength of 250 pounds (ASTM D1623), and a flexural strength of 450 pounds (ASTM D790).

F. The foam duct sealant shall be compatible with common cable jacket materials. The cured foam shall be an inert solid that does not affect jacket materials.

G. The foam duct sealant shall withstand temperatures from -20 degrees Fahrenheit to 200 degrees Fahrenheit and shall not lose function in direct sunlight

H. The foam duct sealant shall be chemically resistant to gasoline, oils, dilute acids and bases, and most unsaturated hydrocarbons.

I. The foam duct sealant shall foam and react in five to ten minutes at 70 degrees Fahrenheit.

J. When installed, the sealant shall be capable of holding 7.25 psi air pressure continuously (equivalent of 16.4 feet water-head pressure).

2.5 FASTENERS

A. All fasteners located in public spaces including classrooms, corridors, lobbies, toilet rooms, etc., shall be provided with tamper proof fasteners. Provide Pin Phillips hardware as manufactured by Challenge Industries or approved equal.

PART 3. EXECUTION

3.1 TEMPORARY FACILITIES

A. General: Refer to the Division 01 Sections for general requirements of temporary facilities.

B. Description: Furnish and install the necessary metering and distribution equipment for an adequate, 3-phase, 4-wire temporary electrical service and all temporary wiring and lighting, including step-down or step-up dry-type transformers as required. Exact requirements for temporary service will be determined by the General Contractor.

C. Attention is directed to the Occupational Safety and Health Act (OSHA), Americans with Disabilities Act (ADA) and National Electrical Code (NEC) requirements for electrical work on construction sites.

D. The Contractor shall pay for all energy charges for temporary service.

3.2 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Install equipment with working space and dedicated space in strict accordance with 2008 NEC Article 110.26.

E. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

F. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

G. Verify exact electrical service requirements for each piece of equipment receiving electrical connections. Provide proper service for each.

H. Include any and all items required by the National Electrical Code and/or field conditions for the proper connection and installation of each piece of equipment.

I. Right of Way: Give to piping systems installed at a required slope.

J. Coordinate electrical work with architectural items and equipment by others. Typical equipment refers to, but is not limited to, the following:

1. Countertops, Casework and Cabinets.

a. Do not install outlets, switches, etc., behind casework, cabinets, etc.

b. Data, phone, and other low voltage system outlets shall be mounted above the counter tops to match power outlets in the same areas.

c. Coordinate counter top outlets with drilling of casework/counters.

d. Coordinate surface raceways and outlets above and below counters with approved casework shop drawings to avoid conflicts with sinks and other appurtenances.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements of Division 07 Section 079200 *Joint Sealants*.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements of Division 26 Section 260528 *Electrical Firestopping*.

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Cut sleeves to length for mounting flush with both surfaces of walls.

3.4 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 26 Section, *Electrical Firestopping*.

3.6 SUPPORTS, HANGERS AND FOUNDATIONS

A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.

C. Installing Equipment Foundations (Housekeeping Pads):

1. Provide four (4) inch high concrete foundations (housekeeping pads) for all floor-mounted equipment extending a minimum of 6 inches beyond equipment bases for interior equipment and a minimum of 12 inches beyond equipment bases for exterior equipment, unless otherwise noted. Furnish foundations, bolts, sleeves, and appurtenances and set under the section furnishing the equipment. Anchor the concrete foundations by dowels inserted into the floor slab. Provide welded wire fabric reinforcement, chamfer exposed edges and corners, and finish exposed surfaces smooth.

2. Unless otherwise specified, provide all concrete work required in accordance with the requirements of Division 03.

3. Equipment shall be properly aligned. Level and grout equipment where necessary. Support conduit independently of equipment and so as not to cause a strain or thrust.

4. Determine exact location of all equipment, foundations, and supports after Shop Drawings of equipment have been approved.

D. Where new concrete housekeeping pads are placed on existing concrete, saw cut the existing concrete to the perimeter dimension of the new pad to a depth of ½ inch. Break out the top ½ inch area of the existing concrete. Add stubs of #4 rebar angled into the existing concrete at a depth of approximately 50 percent of the existing slab thickness. The top portion of the rebar stub shall extend into the new pad by approximately 50 percent of its thickness. Furnish one rebar stub per every two square feet of new pad. Chemically bond the new concrete to the existing concrete.

3.7 PROVISIONS FOR ACCESS

A. The Contractor shall provide access panels and doors for all concealed equipment, and other devices requiring maintenance, service, adjustment or manual operation.

B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.

1. Acoustical or Cement Plaster: Style B

2. Hard Finish Plaster: Style K or L

3. Masonry or Dry Wall: Style M

C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.

D. Access panels, doors, etc. described herein shall be furnished under the section of Specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing Contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.

E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.

F. Provide sufficient access and working space for repair and maintenance about all lighting and electrical equipment to permit ready and safe operation and maintenance of such equipment OSHA 29 CFR 1910 Subpart D and 1910.303(g).

3.8 PAINTING AND FINISHES

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.

B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.

D. Protect all finishes and restore any finishes damaged as a result of work under Division 26 to their original condition.

E. The preceding requirements apply to all work, whether exposed or concealed, as defined herein.

F. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces. Do not paint manufacturer's labels or tags.

G. All exterior equipment and conduits shall be painted to match adjacent surface in color as selected by Architect, unless otherwise indicated by the Architect.

H. All exposed conduit, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

3.9 COLOR SELECTION

A. Color of finishes shall be as selected by the Architect.

3.10 PROTECTION OF WORK

A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in conduits and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver conduits with factory applied end caps.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

E. Protect stored conduits from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.11 OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.

B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.

C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing.

D. Do not use electrical systems for temporary services or during construction, unless approved by Owner in writing. Refer to Division 01 Section 015000 *Temporary Facilities and Controls*.

E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items.

3.12 TESTING AND ADJUSTMENT

A. Perform all tests which are specified or required to demonstrate that the work is installed and operating properly. Where formal tests are required, give proper notices and perform all necessary preliminary tests to assure that the work is complete and ready for final test.

B. Adjust all systems, equipment and controls to operate in a safe, efficient and stable manner.

C. On all circuits, 600 volts or less, provide circuits that are free from ground faults, short circuits and open circuits.

D. Other tests of a specific nature for special equipment shall be as specified under the respective equipment.

E. Submit all test results to the Architect/Engineer for approval.

3.13 WALL AND FLOOR PENETRATIONS

A. All penetrations of partitions, ceilings, roofs and floors by or conduit under Division 26 shall be sleeved, sealed, and caulked airtight for sound and air transfer control. Penetrations of mechanical room partitions, ceilings, and floors shall be as specified in Division 26.

B. All penetrations of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 26 Section, *Electrical Firestoppin*g.

C. Where penetrating through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these Specifications.

D. Provide conduit escutcheons for all exposed conduit penetrations in finished interior spaces and all exposed exterior penetrations. Escutcheons shall match those provided under Division 23.

E. Conduit sleeves:

1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.

2. Twenty-two (22) gauge galvanized steel elsewhere.

3.14 EQUIPMENT BY OTHERS

A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.

B. It shall be the responsibility of the supplier of the equipment to furnish complete instructions for connections. Failure to do so will not relieve the Contractor of any responsibility for improper equipment operation.

3.15 PHASING

A. Refer to Architectural Specifications and Contract Drawings for any required phasing.

B. Maintain building egress and traffic ways at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and Authorities Having Jurisdiction (AHJ).

C. Provide dust barriers/partitions, penetration closures, etc, to ensure safety of building occupants and protection of existing surroundings.

D. The Building shall remain watertight at all times.

E. Refer to phasing plans for additional requirements.

F. Within thirty days of Award of Contract, the Contractor shall submit a minimum of six (6) copies of the proposed Phasing Plan (Drawings and detailed written description) to the Architect for review and approval based on the general and specific requirements indicated on the Drawings and Specifications. The phasing plan shall reflect the work of all trades. The phasing plan shall be updated as often as needed (i.e. major deviations and/or modified sequence of events) and reviewed during each progress meeting so the Owner and Architect can be aware of the areas of construction and progress as it relates to the approved schedule.

G. While work is in progress, except for designated short intervals during which connections are made, continuity of service shall be maintained to all existing systems. Interruptions shall be coordinated with the Owner as to time and duration. The Contractor shall be responsible for any interruptions to service and shall repair any damages to existing systems caused by his operations.

3.16 OUTAGES

A. Provide a minimum of fourteen (14) days notice to schedule outages. The Contractor shall include in their bid outages and/or work in occupied areas to occur on weekends, holidays, or at night. Coordinate and get approval of all outages with the Owner.

B. Submit *Outage Request Form*, attached at the end of this Section, to Owner for approval.

3.17 CUTTING AND PATCHING

A. Accomplish all cutting and patching necessary for the installation of work under Division 26. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.

B. Do not cut structural members without approval from the Architect or Engineer.

3.18 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

B. Where conduits penetrate roofs, flash pipe with Stoneman *Stormtite*, Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing sleeve.

C. Furnish and install pitch pockets or weather tight curb assemblies where required.

D. Furnish and install curbs, vent assemblies, and sleeves specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer’s instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these Specifications.

3.19 CONCRETE AND MASONRY WORK

A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 26. Perform work in accordance with requirements of Division 03 and other applicable Divisions of these Specifications.

B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.

C. Grout shall be non-shrink, high strength mortar, free of iron of chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.

D. Installing Outdoor Equipment Foundations:

1. Provide equipment foundations as indicated in Article “Supports, Hangers, and Foundations” in this Section.

2. Place reinforcement accurately in position shown, securely fasten and support to prevent displacement before or during pouring. Clean, bend, place, and splice reinforcement in accordance with approved shop drawings. Lap ends and sides of mesh reinforcement in slabs not less than one inch. Coverage of main reinforcing shall be as follows:

    a. Slabs - 3/4 inch

    b. Concrete poured against earth - 3 inches

    c. Other locations - 2 inches

3. Properly align, level, and grout all equipment where necessary.

3.20 CONNECTIONS AND ALTERATIONS TO EXISTING WORK

A. Unless otherwise noted on the Drawings, where existing electrical work is removed, including hangers, to a point below finished floors or behind finished walls and capped, such point shall be far enough behind finished surfaces to allow for installation of normal thickness of required finish material.

B. Where work specified in Division 26 connects to existing equipment, conduits, etc., Contractor shall perform all necessary alterations, cuttings, fittings, etc., of existing work as may be necessary to make satisfactory connections between new and existing work, and to leave completed work in a finished and workmanlike condition.

C. Where the work specified under Division 26, or under other Divisions, requires relocation of existing equipment, conduit etc., Contractor shall perform all work and make necessary changes to existing work as may be required to leave completed work in a finished and workmanlike condition.

D. Where the relocation of existing equipment is required for access or the installation of new equipment, the Contractor shall temporarily remove and/or relocate and re-install as required to leave the existing and new work in a finished and workman like condition.

3.21 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

3. To allow right of way for piping and conduit installed at required slope.

4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

5. To provide working space and dedicated space clearances per 2008 NEC Article 110.26.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in this Section, Article “Provisions for Access”.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 26 Section 260528 *Electrical Firestopping*.

3.22 DEMOLITION

A. Unless otherwise noted all existing equipment, conduit, wire, etc., shall remain.

B. Where existing equipment is indicated to be removed, all associated conduit, power, controls, insulation, hangers, supports and housekeeping pads, etc…, shall also be removed. Patch, paint and repair walls/roof/floor to match existing and/or new finishes.

C. The Contractor shall be responsible for visiting the site and determining the existing conditions in which the work is to be performed.

D. Refer to phasing plans for additional requirements.

E. Where any abandoned conduits in existing floors, walls, pipe tunnels, ceilings, etc., conflict with new work, remove abandoned conduits as necessary to accommodate new work.

F. The location of all existing equipment, conduits etc., indicated is approximate only and shall be checked and verified. Provide all new electrical work required to connect to or clear existing work as applicable.

G. Maintain egress at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and the Authorities Having Jurisdiction (AHJ).

H. Make provisions and include in bid all costs associated with confined entry/space requirements in crawl spaces and all other applicable OSHA regulations.

I. Where required to maintain the existing systems in operation, temporarily backfeed existing systems from new equipment. Contractor shall temporarily extend existing conduit systems to new conduit systems.

J. At completion of project all temporary conduit, wires, etc., shall be removed in their entirety.

K. Existing conduit, equipment, wiring, etc., not required for re-use or re-installation in this project, shall be removed from the project site.

L. Deliver to the Owner, on the premises where directed, existing equipment and materials which are removed and which are desired by the Owner or are indicated to remain the property of the Owner.

M. All other materials and equipment which are removed shall become property of the Contractor and shall be promptly removed, from the premises, and disposed of by the Contractor, in an approved manner. Contractor shall be responsible for proper disposal of all removed equipment containing PCB’s.

N. Where conduit and wiring are removed, remove all conduit hangers which were supporting the removed conduit. Patch the remaining penetration voids with like materials and paint to match existing construction.

O. Where required, provide and coordinate removal and re-installation of existing equipment. Take care to protect materials and equipment indicated for reuse. Contractor shall repair or replace items which are damaged. Contractor shall have Owner's representative present to confirm condition of equipment prior to demolition.

P. Before demolition begins, and in the presence of the Owners representative, test and note all deficiencies in all existing systems affected by demolition but not completely removed by demolition. Provide a copy of the list of system deficiencies to the Owner and the Engineer. Videotape existing conditions in each space prior to beginning demolition work.

Q. The Owner shall have the first right of refusal for all fixtures, devices and equipment removed by the Contractor.

R. All devices and equipment designated by the Owner to remain the property of the Owner shall be moved and stored by the Contractor at a location on site as designated by the Owner. It shall be the Contractor's responsibility to store all devices and equipment in a safe manner to prevent damage while stored.

S. All existing equipment refused by the Owner shall become the property of the Contractor and shall be removed from the site by the Contractor in a timely manner and disposed of in a legal manner.

T. Work Abandoned in Place: Cut and remove conduit a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.

U. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

V. Terminate services and utilities in accordance with local laws, ordinances, rules and regulations.

3.23 EXCAVATION AND BACKFILLING

A. General:

1. Perform all necessary excavation, or installation of work under Division 26, in whatever materials or conditions encountered, using suitable methods and equipment.

2. Accurately establish required lines and grades and properly locate the work.

3. Determine the locations of all existing utilities before commencing the work.

B. Excavation: (Refer also to other portions of the Specifications)

1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.

2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, OSHA, and MOSHA Guidelines.

3. Keep excavations dry. Protect excavations from freezing.

C. Backfilling: (Refer also to other portions of the Specifications)

1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.

2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.

3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.

4. Do not backfill against frozen material. Do not use frozen material for backfill.

END OF SECTION

OUTAGE REQUEST

DATE APPLIED: _____ BY: _____

DATE FOR OUTAGE: _____ FIRM: _____

START OUTAGE-TIME: _____ DATE: _____

END OUTAGE - TIME: _____ DATE: _____

AREAS AND ROOMS: _____

FLOOR(S): _____

AREA(S): _____

ROOM(S): _____

WORK TO BE PERFORMED: _____

SYSTEM(S): _____

REQUEST APPROVED BY: _____
(FOREMAN OR OTHER PERSON IN CHARGE)

(FOR OWNER'S USE ONLY):

APPROVED: _____

YES ____ NO ___ BY: _____ DATE: _____

DATE/TIME-AS REQUESTED: _____ OTHER: _____

OWNER'S PRESENCE REQUIRED: _____

YES: ____ NO: ____ NAME: _____

POINT OF CONTACT: _____ PHONE: _____

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DIVISION 26 SECTION 26 05 13
MEDIUM-VOLTAGE CABLES
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 SUMMARY 3
1.2 ACTION SUBMITTALS 3
1.3 INFORMATIONAL SUBMITTALS 3

PART 2 - PRODUCTS 3

2.1 SYSTEM DESCRIPTION 3
2.2 CABLES 4
2.3 CONNECTORS 4
2.4 SOLID TERMINATIONS 5
2.5 SEPARABLE INSULATED CONNECTORS 5
2.6 MEDIUM-VOLTAGE TAPES 6
2.7 ARC-PROOFING MATERIALS 6
2.8 FAULT INDICATORS 7
2.9 SOURCE QUALITY CONTROL 7

PART 3 - EXECUTION 7

3.1 INSTALLATION 7
3.2 FIELD QUALITY CONTROL 9
END OF SECTION 9

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SECTION 26 05 13
MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cables.
2. Connectors.
3. Solid terminations.
4. Separable insulated connectors.
5. Medium-voltage tapes.
6. Arc-proofing materials.
7. Fault indicators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Indicate location of each cable, splice, and termination.

B. Material Certificates: For each type of cable and accessory.

C. Source quality-control reports.

D. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2 and NFPA 70.

C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.2 CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Okonite Company.
2. Southwire Company.
3. Superior Essex, Inc.
4. Rome Cable Company.
5. Aetna Insulated Wire, Inc.
6. Kerite Company.
7. General Cable; General Cable Corporation.

B. Cable Type: Type MV 105.

C. Conductor Insulation: Ethylene-propylene rubber.

1. Voltage Rating: 25 kV.
2. Insulation Thickness: 100 percent insulation level.

D. Conductor: Aluminum.

E. Comply with UL 1072, AEIC CS8, and ICEA S-94-649.

F. Conductor Stranding: Solid.

G. Shielding: Solid copper wires, helically applied over semiconducting insulation shield.

H. Cable Jacket: Chlorosulfonated polyethylene.

2.3 CONNECTORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. 3-M Manufacturing Company
2. nVent (Raychem)
3. TE Connectivity
4. G&W

B. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.

C. Copper-Conductor Connectors: Aluminum barrel crimped connectors.

2.4 SOLID TERMINATIONS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. 3-M Manufacturing Company
2. nVent (Raychem)
3. TE Connectivity
4. G&W

B. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.

C. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations:

a. Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.
b. Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. 3-M Manufacturing Company
2. nVent (Raychem)
3. TE Connectivity
4. G&W

C. Load-Break Cable Terminators: Elbow-type units with 200 A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

E. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.6 MEDIUM-VOLTAGE TAPES

A. Description: Electrical grade, insulating tape rated for medium voltage application.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. 3-M Manufacturing Company
2. nVent (Raychem)
3. TE Connectivity
4. G&W

C. Ethylene/propylene rubber-based, 30 mil (0.76 mm) splicing tape, rated for 130 deg C operation. Minimum 3/4 inch (20 mm) wide.

D. Silicone rubber-based, 12 mil (0.30 mm) self-fusing tape, rated for 130 deg C operation. Minimum 1-1/2 inch (38 mm) wide.

E. Insulating-putty, 125 mil (3.175 mm) elastic filler tape. Minimum 1-1/2 inch (38 mm) wide.

2.7 ARC-PROOFING MATERIALS

A. Description: Fire retardant, providing arc flash protection.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. 3-M Manufacturing Company
2. nVent (Raychem)
3. TE Connectivity
4. G&W

C. Tape for First Course on Metal Objects: 10 mil (250 micrometer) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

D. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, and compatible with cable jacket.

E. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch (25 mm) wide.

2.8 FAULT INDICATORS

A. Indicators: Automatically reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

2.9 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 and ICEA S-94-649 before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inch (1200 to 1800 mm) on the pull rope.

1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.

2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.

2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.

4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

E. Install cable splices at pull points and elsewhere as indicated; use standard kits.

F. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

G. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.

2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.

3. Standoff Insulator: At each terminal junction, with one on each terminal.

H. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.

2. Wrap metallic cable components with 10 mil (250 micrometer) pipe-wrapping tape.

3. Smooth surface contours with electrical insulation putty.

4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.

5. Band arc-proofing tape with two layers of 1 inch (25 mm) wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.

I. Seal around cables passing through fire-rated elements according to Section 078413 "Penetration Firestopping."

J. Install fault indicators on each phase where indicated.

K. Ground shields of shielded cable at one point only. Maintain shield continuity and connections to metal connection hardware at all connection points.

L. Identify cables according to Section 260553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

3. Perform direct-current High Potential test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.

4. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.

5. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.

B. Medium-voltage cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

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DIVISION 26 SECTION 26 05 19
LOW-VOLTAGE ELECTRIAL POWER CONDUCTORS AND CABLES
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 SUBMITTALS 3
1.4 QUALITY ASSURANCE 3

PART 2 - PRODUCTS 4

2.1 CONDUCTORS AND CABLES 4
2.2 COPPER BUILDING WIRE 5
2.3 METAL-CLAD CABLE, TYPE MC 5
2.4 MINERAL INSULATED (MI) CABLE 6
2.5 FIRE-ALARM WIRE AND CABLE 9
2.6 CONNECTORS AND SPLICES 9
2.7 DROP CORDS 10

PART 3 - EXECUTION 11

3.1 CONDUCTOR MATERIAL APPLICATIONS 11
3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS 11
3.3 INSTALLATION OF CONDUCTORS AND CABLES 12
3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE 12
3.5 CONNECTIONS 13
3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS 14
3.7 FIRESTOPPING 14
3.8 FIELD QUALITY CONTROL 14
END OF SECTION 15

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SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.

2. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35,000 V.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Testing Agency: Engage a qualified independent testing agency to perform field quality-control testing.

B. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements. Procedures: Perform each visual and mechanical inspection and electrical test state din NETA ATS Section 7.3.1. Certify compliance with test parameters.

C. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

D. Measure tightness of bolted connections and compare torque measurements with manufacturer’s recommended values.

E. Verify continuity of each branch circuit conductor.

F. Tests: Service Entrance Cables, Power & Lighting Distribution Feeders and Feeders to all major mechanical equipment at 60A and over (i.e., chillers, AHU's, etc.).

1. Tests shall be performed with a 1000-volt megger, and conductors shall test free from short-circuits and grounds.

2. Conductors shall be tested phase-to-phase and phase-to-ground.

3. Furnish the instruments, materials, and labor required. Perform the tests in the presence of the Contracting Officer.

4. Test readings shall be recorded and delivered to Owner and Engineer in a report.

5. Copy of Test results shall be included in O&M Manuals.

G. Demonstration: Subsequent to wire and cable hook-ups, energize circuit and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Wires and Cables:

a. American Insulated Wire Corp.; Leviton Manufacturing Co.
b. BICC Brand-Rex Company.
c. Carol Cable Co., Inc.
d. Senator Wire & Cable Company.
e. Southwire Company.
f. Encore Wire.
g. CommScope.
h. nVent PYROTENAX

2. Connectors and Accessories for Wires and Cables:

a. AMP Incorporated.
b. Buchanan.
c. General Signal; O-Z/Gedney Unit.
d. Monogram Company; AFAC.
e. NSI Industries, Inc.
f. Square D Company; Anderson.
g. 3M Company; Electrical Products Division.

B. Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN/THWN-2, XHHW, USE, and SO.

D. Multiconductor Cable: Comply with NEMA WC 70 for metal clad cable, Type MC and Type SO with ground wire.

2.2 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2. RoHS compliant.

3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8. for stranded conductors.

D. Conductor Insulation:

1. Type RHH and Type RHW-2: Comply with UL 44.

2. Type THHN and Type THWN-2: Comply with UL 83.

3. Type XHHW-2: Comply with UL 44.

4. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.

E. Shield:

1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, and sunlight- and oil-resistant outer PVC jacket.

2.3 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2. Comply with UL 1569.

3. RoHS compliant.

4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Circuits:

1. Single circuit and multicircuit with color-coded conductors.

2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Ground Conductor: Insulated.

F. Conductor Insulation:

1. Type THHN/THWN-2: Comply with UL 83.

2. Type XHHW-2: Comply with UL 44.

G. Armor: Steel, interlocked.

H. Jacket: PVC applied over armor.

2.4 MINERAL INSULATED (MI) CABLE

A. Provide mineral insulated (MI) cable as indicated on the drawings. Provide all necessary accessories, supports, connectors, etc. as required for a complete installation. Acceptable manufacturer shall be BICC Pyrotenax System 1850 2-hour fire rated or approved equal.

B. Mineral-Insulated Metal–Sheathed Cable shall be provided with the following characteristics:

1. Description: ANSI/NFPA 70, Type MI.

2. Conductor: Solid high conductivity copper.

3. Insulation Voltage Rating: 600 volts.

4. Cable Temperature Rating: 90 degrees C.

5. Termination Temperature Rating: 150 Degrees C.

6. Insulation Material: Magnesium oxide refractory material.

7. Metal-sheath Material: Seamless soft drawn copper.

8. Fire Rating: Cable assembly including supports shall have a 2-hour fire rating as listed and classified by Underwriters' Laboratories, Inc. (UL 2196)

9. Overjacket: None required; or PVC if required to be directly buried.

C. Provide cable and lug terminations and splices as follows:

1. Cable Termination:

a. BICC Pyrotenax Model Pyro-Pak Installation Sheet 545U.
b. BICC Pyrotenax Model Quick-Term Installation Sheet 599U.

2. Lug Connection:

a. ILSCO Model Lo-250: #1 AWG through 250 kcmil
b. ILSCO Model CRA-300: 350 kcmil
c. ILSCO Model CRA-400: 500 kcmil

3. Cable Splice: BICC Pyrotenax Installation Sheet 550.

D. Examination: Verify that cable end factory temporary seals have remained intact, that the insulation has not been exposed to air, and that no moisture has entered cable insulation. Verify that work of other trades likely to damage cable has been completed.

E. Storage: Cables shall be shipped from the manufacturer with ends sealed against moisture ingress. Protect the exposed cable ends with shrinkable, molded polyolefin end caps or other suitable means such as standard conduit sealing compound and PVC tape. Cable shall be stored in a clean dry location.

F. Handling: Cable shall be uncoiled by rolling or rotating supply reel. Do not pull from coil periphery or center. Take precautions necessary to prevent damage to cable from contact with sharp objects, including pulling over foreign material on sheaves.

G. Installation: Install products in accordance with manufacturer's instructions and the requirements of the UL Fire Resistance Directory Listing.

1. Bending: Not less than five (5) times the cable diameter for cable not more than 3/4-inch (250 kcmil). Not less than ten (10) times the cable diameter for cable more than 3/4 inch (350 and 500 kcmil).
2. Pulling: For all cables up to and including #1 AWG use ten inch (250mm) or larger sheaves. For #1/0 through 250 kcmil inclusive use 18 inch (460mm) or larger sheaves. For 350 kcmil and larger cables use 24 inch (590mm) or larger sheaves.

On pulls of over 360 degrees, contact manufacturer for assistance. 350 and 500 kcmil cables shall not be pulled more than 360 degrees in total.

H. Splicing: All fire rated splices shall be made in the factory. In the event a field splice is necessary, it must be approved by the engineer and be made in the field by a manufacturer's field technician or made in the field by personnel trained by the cable manufacturer using manufacturer's components.

I. Terminations: Field made terminations shall be made with cable manufacturer's termination kits only. Stripping tools, crimping and compression tools available from the manufacturer shall be used for proper cable termination. Terminations must be completed immediately once started to avoid moisture ingress from surrounding air. Prior to completing each termination, test insulation resistance and follow manufacturer's drying procedures until insulation resistance reaches an acceptable level. Connections to ferrous cabinets for single conductor cables shall incorporate brass plates ¼ inch (6mm) thick by 4 inch (100mm) wide by length as required with ¾ inch (19mm). 1 inch (25mm), or 1-1/4 inch (32mm) drilled and tapped holes. Installed per manufacturer's drawing. For applications using 90 degree C rating of cable lugs shall be rated 90 degrees C.

J. Sheath induction reduction: When multi-phase circuits have paralleled single conductors, cables shall be run in groups having one of each phase in each group. Each set of paralleled conductors shall be separated by at least two single cable diameters. On balanced three-phase wye circuits neutral conductors may be located within the two cable diameter space between groups of phase conductors. Each group of cables shall be fastened tightly together at least twice between each cable support using ½ inch (13mm) wide by 0.030 inch (0.75mm) thick stainless steel straps or heavy plastic cable ties.

K. Exposed or Surface Installations: Cable may be secured directly to building structure using one of, or any combination of, the following approved methods:

1. Straps: ½ inch (13mm) wide by 1-1/2 inch (38mm) long by 0.030 inch (0.75mm) thick stainless steel or copper straps. Each strap shall contain two ¼ inch (6mm) holes for securing with 3/16 inch (5mm) by minimum 1-3/4 inch (44mm) long steel anchors.

2. Steel struts and cable tray: Approved steel strut framing system with fittings manufactured by strut manufacturer.

3. Steel cable tray: Approved steel cable tray system.

4. Other approved method

Supports shall not exceed three feed on center horizontally or six feet on center vertically. Cables shall be installed parallel to building lines.

L. Embedded installations: Cables will be run in the same trifoil configuration as exposed installations. Protect against damage during pulling, and during concrete pouring or backfill and tamping. Where cables emerge from grade provide PVC conduit, metal plate

or angle iron. This protection shall minimally extend from 18 inches (460mm) below grade to 8 feet (2.5m) above grade.

M. Wall or floor penetrations: Provide sleeve to protect cable and penetration openings during pulling. Provide approved fire stopping of all penetrations. Neatly train and lace cable inside boxes, equipment, and panelboards.

N. Field Quality Control: Inspect cable for physical damage and proper connection. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values. Verify continuity of each conductor. Prior to energizing cables, measure insulation resistance of each cable. Tabulate and submit for approval. Provide certification from cable manufacturer that installation is in accordance with their requirements.

2.5 FIRE-ALARM WIRE AND CABLE

A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.

2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.

3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.6 CONNECTORS AND SPLICES

A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 "Wire and Insulation Applications" Article.

B. Split Bolt Connectors: Not Acceptable.

C. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment pads or terminals. Not approved for splicing.

D. Spring Wire Connectors: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.

E. All wire connectors used in underground or exterior pull boxes shall be gel-filled twist connectors or a connector designed for damp and wet locations.

F. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.

G. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic high conductivity copper tubing, internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps.

H. Heat shrinkable tubing shall meet the requirements of ANSI C119.1-1986 for buried connections to 90°C and shall be material flame-retarded per IEEE 383 "Vertical Tray Flame Test". Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and a high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer's tolerances.

I. Wire Nut Connectors:

1. Wire nuts install in wet locations, exterior, etc., shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air.

2. Connectors shall be UL listed appropriately sized according to manufacturer's recommendation for the suitable wire sizes and voltage rating (600 volt minimum).

3. Connectors body shall have a color-coded outer shell.

4. Connectors shall be as manufactured by King Technology or approved equal.

2.7 DROP CORDS

A. Description: Continuous length of cable with locking blade type connector body at lower end as indicated on Drawings. Secure cable at both ends with wire type stainless steel cable grips to prevent transmission of tension directly to conductors or terminal screws.

B. Junction Box: Furnished and installed flush with ceiling anchored to building structure for fastening of upper cord grip.

C. Cable: Type SO 600 volt flexible cord with three #12 stranded wires.

D. Connector Body: Single 120 volt, grounding receptacle of twistlock type that grips on cable insulation and is manufactured for use with wire cable grips. Furnish and install drop cords in length required for a receptacle height of 6 feet 8 inches above the finished floor.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Soft Drawn Copper, 98% conductivity minimum, solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Soft Drawn Copper. 98% Conductivity minimum, Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. 600 volt, unless otherwise noted, #12 AWG minimum (except control cable may be #14 AWG).

B. Service Entrance: Type THHN/THWN-2, single conductors in raceway.

C. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

E. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

F. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Metal-clad cable, Type MC, except branch circuits concealed in CMU wall shall be EMT.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

I. Branch Circuits Installed below Raised Flooring: Metal-clad cable, Type MC.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

K. Class 1 Control Circuits: Type THHN/THWN-2, in raceway.

L. Class 2 Control Circuits: Type THHN/THWN-2, in raceway.

M. Conductors shall be rated 75 deg C in wet locations and 90 deg C in dry locations.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Section 260429, "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Section 260553, “Identification for Electrical Systems."

3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

A. Comply with NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 260529 "Hangers and Supports for Electrical Systems."

1. Install plenum cable in environmental airspaces, including plenum ceilings.

2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.

a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.

3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.

4. Signaling Line Circuits: Power-limited fire-alarm cables must not be installed in the same cable or pathway as signaling line circuits.

5. Wiringwithin Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all

connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.

D. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

E. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.

F. Wiring to Remote Alarm Transmitting Device: 1 inch (25 mm) conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 8 inches (200 mm) of slack.

D. Comply with requirements in Section 284621 "Addressable Fire-Alarm Systems" for connecting, terminating, and identifying wires and cables.

E. Wiring for general 15 and 20 amp 120 volt and 277 volt branch circuit work shall be as follows unless otherwise indicated:

HOME RUN LENGTH AND WIRE SIZE				CIRCUIT LENGTH AND WIRE SIZE			
120 Volt		277 Volt		120 Volt		277 Volt	
0 – 60’	#12	0 – 175’	#12	0 – 100’	#12	0 – 200’	#12
60 – 100’	#10	175 – 350’	#10	100’ & Up	#10	200’ & Up	#10
100’ & Up	#8	350’ & Up	#8				

Circuit length as given above shall be the wire length between the first and last outlet on the circuit. Home run length as given above shall be the wire length between the first outlet and the panelboard. In accordance with the above, where the size of branch circuit conductors is increased by the minimum required by the NEC for the branch circuit rating, it is the Contractor’s responsibility to ensure that the termination provisions of all equipment connected to such circuits are listed as suitable for the conductor sizes involved.

F. Joints of #10 AWG and smaller shall be made with properly insulated solderless type pressure connectors. Where stranded conductors or multiple solid conductors are connected to terminals, solderless lugs manufactured by Thomas and Betts Company or equivalent shall be used.

G. Joints of #8 AWG and larger in power and lighting circuits shall be of the type indented into the conductor by means of a hand or hydraulic pressure tool. Connectors shall be Burndy “Hy-dent’, T&B “St-Kon”, or equivalent. Connectors for control wiring shall be Burndy “Hy-Lug”, or equivalent.

H. All circuits for exterior electric work shall be #10 AWG (minimum) and contain an extra #10 AWG (minimum) copper ground conductor. All exterior wiring shall be installed in conduit as specified above, unless otherwise noted as larger on the Drawings.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 26 Section "Firestopping" and “Common Work Results for Electrical”.

B. Install to seal underground exterior-wall penetrations according to Division 26 Section, “Common Work Results for Electrical”.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 7 Section "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing agency to perform field quality-control testing.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.

    a. Tests shall be performed with a 1000-volt megger, and conductors shall test free from short-circuits and grounds.
    b. Conductors shall be tested phase-to-phase and phase-to-ground.
    c. Furnish the instruments, materials, and labor required. Perform the tests in the presence of the Contracting Officer.
    d. Test readings shall be recorded and delivered to Owner and Engineer in a report.
    e. Copy of Test results shall be included in O&M Manuals.

2. Perform each of the following visual and electrical tests:

a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
b. Test bolted connections for high resistance using one of the following:
   1) A low-resistance ohmmeter.
   2) Calibrated torque wrench.
   3) Thermographic survey.

c. Inspect compression-applied connectors for correct cable match and indentation.
d. Inspect for correct identification.
e. Inspect cable jacket and condition.
f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
g. Continuity test on each conductor and cable.
h. Uniform resistance of parallel conductors.

3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

   a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

D. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

E. Verify continuity of each branch circuit conductor.

F. Demonstration: Subsequent to wire and cable hook-ups, energize circuit and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION

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DIVISION 26 SECTION 26 05 20
ELECTRIC HEATING CABLES
TABLE OF CONTENTS

PART 1. GENERAL 3
1.1. RELATED DOCUMENTS 3
1.2. SUMMARY 3
1.3. DEFINITIONS 3
1.4. SUBMITTALS 3
1.5. QUALITY ASSURANCE 3
1.6. COORDINATION 4
1.7. WARRANTY 4
PART 2. PRODUCTS 4
2.1. MANUFACTURERS 4
2.2. ELECTRICAL HEAT TRACING FOR PIPELINES 5
2.3. DOMESTIC WATER PIPING FREEZE PROTECTION CONTROLS 6
2.4. FIRE SPRINKLER PIPING FREEZE PROTECTION CONTROLS 6
2.5. ACCESSORIES 7
PART 3. EXECUTION 7
3.1. EXAMINATION 7
3.2. INSTALLATION 7
3.3. CONNECTIONS 8
3.4. FIELD QUALITY CONTROL 8
3.5. ADJUSTING 8
3.6. PROTECTION 9
END OF SECTION 9

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SECTION 26 05 20
ELECTRIC HEATING CABLES

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2. SUMMARY

A. This Section includes heating cables for the following applications:

1. Heat tracing for freeze protection.

1.3. DEFINITIONS

A. AWG: American Wire Gauge.

B. C: Celsius.

C. F: Fahrenheit.

1.4. SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer installed and field installed wiring.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

D. Maintenance Data: For electric heating cables to include in maintenance manuals specified in Division 01.

E. Warranties: Special warranties specified in this Section.

1.5. QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70,

Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6. COORDINATION

A. Coordinate layout and installation of electric heating cables and system components with other construction.

1. Coordinate with Food Service Equipment installer for piping installed under Division 11.

2. Coordinate with piping installer, for condensate piping provided under Division 23.

1.7. WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of electric heating cables that fail in materials or workmanship within specified warranty period.

C. Warranty Period: Two years from date of Substantial Completion.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Accutron Heat Tracing Systems.

2. Ari Industries.

3. BICC Pyrotenax USA Inc.

4. Caloric, Inc.

5. Chromalox; Wiegard Industrial Division; Emerson Electric Company.

6. Copperheat Inc.

7. Delta Therm Corp.

8. Easy Heat, Inc.

9. INDEECO.

10. Maxxon Corp.; Infloor Heating Systems Div.

11. Nelson Heat Tracing Systems.

12. Omega Engineering Inc.

13. Raychem Corporation.

14. Thermon Manufacturing Co.

2.2. ELECTRICAL HEAT TRACING FOR PIPELINES

A. The self-regulating heater shall consist of two (2) 16 AWG nickel coated-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heater to be crossed over itself without overheating, to be used directly on plastic pipe, and to be cut to length in the field. The heater shall be covered by a radiation cross-linked modified polyolefin dielectric jacket.

B. In order to provide energy conservation and to prevent overheating, the heater shall have a self-regulating factor of at least 90 percent. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heater output going from 40 degrees F pipe temperature operation to 150 degrees F pipe temperature operation.

C. The heater shall operate on line voltages of 120 volts without the use of transformers.

D. The heater shall be sized according to this table. The required heater output rating is in watts per foot at 50 degrees F.

Pipe Size	Watts per foot
3 inch or less	5 watt
4 inch	5 watt
6 inch	8 watt
8 inch	2 strips - 5 watt
12 inch to 14 inch	2 strips - 8 watt

E. Power connection, end seal, splice and tee kit components shall be applied in the field.

F. The system shall be controlled by a thermostat set at 40 degrees F either directly or through an appropriate contactor.

2.3. DOMESTIC WATER PIPING FREEZE PROTECTION CONTROLS

A. Heat trace cables providing freeze protection for water piping shall be controlled by an electronic outdoor thermostat.

B. Outdoor thermostat shall utilize stainless steel sensor with 25 foot lead to sense pipe temperature, and shall have adjustable temperature range from 30 to 110 degrees Fahrenheit (-1 to 43 degrees Celsius).

C. Thermostat switch shall be rated at 120VAC, 30 amperes.

D. Thermostat shall have LED indicators for alarm, power, and heating cable status.

E. Provide Raychem Digitrace EC-TS electronic thermostat, or approved equal by listed manufacturer.

2.4. FIRE SPRINKLER PIPING FREEZE PROTECTION CONTROLS

A. Heat trace cables providing freeze protection for fire sprinkler piping shall be controlled by an electronic controller that is UL Listed for protection of fire sprinkler piping against freezing.

B. Electric heat trace controllers shall control, monitor, and communicate alarms and data for one heating cable circuit.

C. Electronic heat trace controllers shall have the following features:

1. Modbus, BACnet and Ethernet communication module. Coordinate Modbus/BACnet module type with building management/ATC system installer and Division 23.

2. Six character alphanumeric display.

3. -40 degrees Fahrenheit to 140 degrees Fahrenheit (-40 degrees Celsius to 60 degrees Celsius) operation.

4. Single or dual temperature sensor inputs to allow selection of one or eight control modes and programming of all temperature parameters.

5. High and low temperature alarms.

6. High temperature cut-out.

7. Low current alarms.

8. 30A rated electromechanical relay (EMR) output switch with device failure alarm.

9. Ground fault alarm and trip.

10. Proportional ambient sensing control to maximize energy efficiency.

11. Minimum/Maximum temperature tracking

12. Auto-cycling to momentarily energize the circuit during periods of non-use to detect issues with the heat tracing circuit.

D. Provide Raychem Digitrace C910-485 heat trace controller, or approved equal by listed manufacturer.

2.5. ACCESSORIES

A. Cable Installation Accessories: Tapes, cable ties, warning labels, end seals and splices, and installation clips.

PART 3. EXECUTION

3.1. EXAMINATION

A. Examine surfaces and substrates to receive heating cables for compliance with requirements for installation, tolerances, and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

2. Ensure pipe testing is complete.

3. Ensure surfaces and substrates are level and plumb.

B. Test cables for electrical continuity before installing.

C. Test cables for insulation resistance before installing.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. INSTALLATION

A. Cut cable(s) to lengths required.

B. Install heater to cold lead connections in accessible locations. Do not embed in concrete or plaster.

C. Avoid crossing expansion, construction, or control joints with heating cables. Provide sufficient slack conductor in expansion loop.

D. Provide labels for piping insulation/jacketing to identify the same as “electrically heat-traced”.

3.3. CONNECTIONS

A. Electrical installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of wiring, conduit, and specialties.

B. Connect heating cables and other components to wiring systems.

C. Ground equipment:

1. Tighten electrical connectors and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Connect heat trace controllers for fire sprinkler freeze protection to fire alarm systems as required to transmit the following alarm conditions:

1. Low pipe temperature.
2. High pipe temperature.
3. Loss of power.
4. Ground fault trip.

3.4. FIELD QUALITY CONTROL

A. Testing: Perform tests after installation but before application of coverings, such as insulation, plaster, or concrete.

1. Test cables for electrical continuity before energizing.

2. Test cables for insulation resistance before energizing. Remove cables if measured resistance is less than 10 megohms to ground.

3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation.

C. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.5. ADJUSTING

A. Set field adjustable thermostat ranges as indicated.

3.6. PROTECTION

A. Protect installed heating cables, including leads, from damage prior to Substantial Completion.

END OF SECTION

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DIVISION 26 SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 SUBMITTALS 3
1.4 QUALITY ASSURANCE 4

PART 2 - PRODUCTS 4

2.1 CONDUCTORS 4
2.2 CONNECTORS 4
2.3 GROUNDING ELECTRODES 5

PART 3 - EXECUTION 6

3.1 APPLICATIONS 6
3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS 6
3.3 GROUNDING AT THE SERVICE 7
3.4 GROUNDING SEPARATELY DERIVED SYSTEMS 7
3.5 EQUIPMENT GROUNDING 7
3.6 FENCE GROUNDING 7
3.7 INSTALLATION 8
3.8 FIELD QUALITY CONTROL 10
END OF SECTION 11

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SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:

1. Underground distribution grounding.

2. Common ground bonding with lightning protection system.

3. Fence grounding.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Test wells.

2. Ground rods.

3. Grounding arrangements and connections for separately derived systems.

4. Grounding for sensitive electronic equipment.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, grounding connections for separately derived systems based on NETA MTS.

a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.

2. Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.

4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter, unless otherwise noted.

5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor, unless otherwise noted.

6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

G. Conduit Hubs: Mechanical type, terminal with threaded hub.

H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with socket set screw.

I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

J. Lay-in Lug Connector: Mechanical type, aluminum terminal with set screw.

K. Straps: Solid copper, copper lugs. Rated for 600 A.

L. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

M. Water Pipe Clamps:

1. Mechanical type, two pieces with zinc-plated bolts.

a. Material: Die-cast zinc alloy.
b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and copper ground connector.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4-inch by10 feet (19 mm by 3 m) in diameter.

B. Ground Plates: 1/4 inch (6 mm) thick, hot-dip galvanized.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

1. Bury at least 30 inches (900 mm) below grade.

C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.

4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

3.3 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.4 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits of the same type as the circuit conductors. Install in same conduit with circuit conductors.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-24-inch (6-by-50-by-600-mm) grounding bus.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

E. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.6 FENCE GROUNDING

A. Fence Grounding: Install at maximum intervals of 750 feet (225 m).

a. Gates and Other Fence Openings: Ground fence on each side of opening.
1) Bond metal gates to gate posts.

2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.

B. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

C. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 2 AWG conductor. Connect conductor to each fence component at grounding location.

D. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

E. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.7 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Where ground lug and bonding conductors installed indoors exceed 3 feet in length, install in EMT conduit.

B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 30 inches (900 mm) below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

2. Use exothermic welds for all below-grade connections.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ductbanks," and shall be at least 12 inches (300 mm) deep, with cover.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set

top of test well flush with finished grade or floor. Provide all test wells with twist lock cover, Harger#GAW910 or approved equal.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

H. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet (6.0 m) long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

I. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

J. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

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

2. Make connections with clean, bare metal at points of contact.

3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System: 5 ohms.
2. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm.
3. Substations and Pad-Mounted Equipment: 5 ohms.
4. Manhole Grounds: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

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DIVISION 26 SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 DEFINITIONS 3
1.4 PERFORMANCE REQUIREMENTS 3
1.5 SUBMITTALS 4
1.6 QUALITY ASSURANCE 4
1.7 COORDINATION 4

PART 2 - PRODUCTS 5

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS 5
2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES 6

PART 3 - EXECUTION 7
3.1 APPLICATION 7
3.2 SUPPORT INSTALLATION 7
3.3 INSTALLATION OF FABRICATED METAL SUPPORTS 8
3.4 CONCRETE BASES 8
3.5 PAINTING 9
END OF SECTION 9

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SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.

2. Concrete Bases

B. Related Sections include the following:

1. Metal Fabrications – For requirements for miscellaneous metal items involved in supports and fastenings.

2. Joint Sealants – For requirements for firestopping at sleeves through walls and floors that are fire barriers.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.

2. Slotted support systems.

3. Equipment supports.

4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.

2. Include design calculations for seismic restraints.

D. Welding certificates.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide slotted metal angle and U-channel systems by one of the following:

a. Thomas & Betts Corporation.
b. Alstrut.
c. Unistrut; Diversified Products
d. Power-Strut.

2. Manufacturers: Subject to compliance with requirements, provide conduit sealing bushings and accessories by one of the following:
a. Bridgeport Fittings
b. GS Metals, Corporation
c. O-Z / Gedney
d. Raco, Inc.

3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

6. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1) Hilti Inc.
2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
3) MKT Fastening, LLC.
4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.

7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

C. Submit structural calculations for load and strength of each component and detailing of each assembly.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1, NECA 101 and NECA 105 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

E. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Expansion anchor fasteners.

5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.

6. To Light Steel: Sheet metal screws.

7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Comply with requirements in Section 099113 "Exterior Painting," Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

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DIVISON 26 SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 DEFINITIONS 3
1.4 SUBMITTALS 3
1.5 QUALITY ASSURANCE 4

PART 2 - PRODUCTS 4

2.1 METAL CONDUIT AND TUBING 4
2.2 NONMETALLIC CONDUIT AND TUBING 5
2.3 BOXES, ENCLOSURES, AND CABINETS 6
2.4 WIREWAYS AND AUXILIARY GUTTERS 8
2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING 9
2.6 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES 10

PART 3 - EXECUTION 10

3.1 RACEWAY APPLICATION 10
3.2 INSTALLATION 12
3.3 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES 15
3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS 15
3.5 FIRESTOPPING 15
3.6 PROTECTION 16
END OF SECTION 16

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SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Section 262726 “Wiring Devices” for multi-outlet assemblies.

2. Section 260543 Section "Underground Ductbanks" for exterior ductbanks, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. LFNC: Liquidtight flexible nonmetallic conduit.

F. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.

2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

1. AFC Cable Systems, Inc.

2. Alflex Inc.

3. Allied Tube & Conduit; a Tyco International Ltd. Co.

4. Anamet Electrical, Inc.; Anaconda Metal Hose.

5. Electri-Flex Co.

6. Manhattan/CDT/Cole-Flex.

7. Maverick Tube Corporation.

8. O-Z Gedney; a unit of General Signal.

9. Wheatland Tube Company.

10. Steel City.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. EMT: ANSI C80.3.

E. FMC: Zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket.

G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.

2. Fittings for EMT: Steel compression type.

3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

H. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.

2. Anamet Electrical, Inc.; Anaconda Metal Hose.

3. Arnco Corporation.

4. CANTEX Inc.

5. CertainTeed Corp.; Pipe & Plastics Group.

6. Condux International, Inc.

7. ElecSYS, Inc.

8. Electri-Flex Co.

9. Lamson & Sessions; Carlon Electrical Products.

10. Manhattan/CDT/Cole-Flex.

11. RACO; a Hubbell Company.

12. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

C. LFNC: UL 1660.

D. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

E. Fittings for LFNC: UL 514B.

2.3 BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.

2. EGS/Appleton Electric.

3. Erickson Electrical Equipment Company.

4. Hoffman.

5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.

6. O-Z/Gedney; a unit of General Signal.

7. RACO; a Hubbell Company.

8. Robroy Industries, Inc.; Enclosure Division.

9. Scott Fetzer Co.; Adalet Division.

10. Spring City Electrical Manufacturing Company.

11. Thomas & Betts Corporation.

12. Walker Systems, Inc.; Wiremold Company (The).

13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Metal Floor Boxes: Cast metal (slab on grade application) or sheet metal, fully adjustable, rectangular, listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, round.

H. Metallic Recessed Access-Floor Boxes and Recessed Floor Box Covers:

1. Description: Floor box with provisions for mounting wiring devices below floor surface and floor box cover with provisions for passage of cords to recessed wiring devices mounted within floor box.

2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

a. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
b. Walker Systems, Inc.; Wiremold Company (The).
c. FSR, Inc.

3. Applicable Standards:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
b. General Characteristics:
1) Reference Standards: UL 514A and UL Category Control Number QCIT.

I. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

J. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

K. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

L. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

M. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

N. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep), except shallow boxes shall be permitted to accommodate framing.

O. Gangable boxes are allowed.

P. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

Q. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panelboards.

4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

2.4 WIREWAYS AND AUXILIARY GUTTERS

A. Metal Wireways and Auxiliary Gutters:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
b. EGS/Appleton Electric.
c. Erickson Electrical Equipment Company.
d. Hoffman.
e. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
f. O-Z/Gedney; a unit of General Signal.
g. RACO; a Hubbell Company.
h. Robroy Industries, Inc.; Enclosure Division.
i. Scott Fetzer Co.; Adalet Division.
j. Spring City Electrical Manufacturing Company.
k. Thomas & Betts Corporation.

l. Walker Systems, Inc.; Wiremold Company (The).
m. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

2. Applicable Standards:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
b. General Characteristics:
1) Reference Standards: UL 870 and UL Category Control Number ZOYX.
2) Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
3) Finish: Manufacturer's standard enamel finish.

c. Options:
1) Degree of Protection: Type 12 unless otherwise indicated.
2) Wireway Covers: Screw-cover type unless otherwise indicated.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.

2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of fiberglass.

1. Standard: Comply with SCTE 77.

2. Color of Frame and Cover: Gray.

3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.

4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

6. Cover Legend: Molded lettering, "ELECTRIC."

7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

8. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.6 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit.

2. Concealed Conduit, Aboveground: Rigid steel conduit.

3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried, unless otherwise noted.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT, support 6’ on center maximum for sizes over 2-inches.

2. Exposed, Not Subject to Severe Physical Damage: EMT, support 6’ on center maximum for sizes over 2-inches.

3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:

a. Loading dock.

b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT, support 6’ on center maximum for sizes over 2-inches.

5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.

6. Damp or Wet Locations: Rigid steel conduit.

7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway.

8. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.

9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

3. Fasten rigid steel conduit with threaded galvanized steel fittings, double locknuts, and insulated bushings. Insulated bushings shall be OZ Gedny Type B.

4. Exterior rigid steel conduit box connections shall be made with a Meyers Hub fitting only. Meyers Hub fittings shall be Cooper Crouse-Hind type.

5. All LB”s, C, and T condulets shall be constructed of malleable iron. No aluminum/die pot metal type permitted.

6. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.

7. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit within CMU walls, finished walls, ceilings, and floors, unless otherwise indicated. Conduits to surface mounted panelboards in electrical equipment rooms may be installed exposed.

H. Raceways Below Slabs:

1. Refer to section 260543 for additional requirements.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Do not embed threadless fittings in concrete unless specifically approved by Engineer for each specific location.

4. Change from PVC to GRC before rising above floor.

5. Arrange stub-ups so curved portions of bends are not visible above finished slab.

6. Conduits in close proximity to each other shall be located and wrapped with wire mesh to prevent cracking of slab.

7. Permitted below slab where specifically indicated below and specifically indicated on the Drawings.

   a. Feeders to panelboards for slab on grade application.
   b. Branch circuits to surface mounted panels in Shop Areas.
   c. Branch circuit permitted below slab for first floor floor box locations only. Branch circuit conduits shall stub-up at nearest wall or panel, whichever is closer.

I. Stub-Ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.

2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

L. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where an underground service raceway enters a building or structure.

3. Conduit extending from interior to exterior of building.

4. Conduit extending into pressurized duct and equipment.

5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.

6. Where otherwise required by NFPA 70.

N. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

O. Expansion-Deflection Fittings: Provide an expansion/deflection fitting in each concealed or exposed electrical run crossing a building expansion joint. Fittings shall be complete with bronze end couplings, neoprene sleeve, tinned copper braid integral bonding jumper and stainless steel bands. Expansion/deflection fittings shall be suitable for the size and type of conduit run they connect. Bonding jumper shall comply with NEC and UL requirements.

1. Expansion/deflection fitting shall accommodate the following movements without collapsing or fracturing the conduit and damaging the wires it contains:

a. Axial expansion or contraction up to 3/4-inch.
b. Angular misalignment of the axes of the conduits up to 30 degrees in all directions.
c. Parallel misalignment of the axes of the conduits up to 3/4-inch in all directions.

2. Expansion/Deflection fitting shall be OZ/Gedney Type DX or approved equal by Crouse Hinds (Type XD).

P. Bushings:

1. Bushings for 1-inch conduit and smaller shall be self-extinguishing thermoplastic type – 150 deg C temperature rating.

2. Bushings for 1-1/4-inch conduit and larger shall be malleable iron body with 150 deg C insulating ring. Insulating material shall be locked in place and non-removable. Provide O-Z/Gedney Type B.

Q. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.

2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

R. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

S. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

T. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

U. Locate boxes so that cover or plate will not span different building finishes.

V. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

W. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

X. Set metal floor boxes level and flush with finished floor surface.

Y. Raceways Penetrating Rooms or Walls with Acoustical Requirements:

1. Seal raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.

Z. Exposed conduits in finished spaces where there is no ceiling, and where ceiling is perforated, shall be painted, color as selected by architect.

3.3 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

DIVISION 26 SECTION 26 05 43
UNDERGROUND DUCTBANKS
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 DEFINITION 3
1.4 SUBMITTALS 3
1.5 QUALITY ASSURANCE 5
1.6 DELIVERY, STORAGE, AND HANDLING 5
1.7 PROJECT CONDITIONS 5
1.8 COORDINATION 6
1.9 EXTRA MATERIALS 6

PART 2 - PRODUCTS 6

2.1 CONDUIT 6
2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES 6
2.3 PRECAST CONCRETE HANDHOLES AND BOXES 7
2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE 9
2.5 PRECAST MANHOLES 10
2.6 UTILITY STRUCTURE ACCESSORIES 10
2.7 SOURCE QUALITY CONTROL 13

PART 3 - EXECUTION 13

3.1 PREPARATION 13
3.2 UNDERGROUND DUCT APPLICATION 14
3.3 UNDERGROUND ENCLOSURE APPLICATION 14
3.4 EARTHWORK 15
3.5 DUCT AND DUCTANK INSTALLATION 15
3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES 18
3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE 19
3.8 GROUNDING 20
3.9 FIELD QUALITY CONTROL 20
3.10 CLEANING 20

END OF SECTION 20

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SECTION 26 05 43
UNDERGROUND DUCTBANKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.

2. Handholes and boxes.

3. Manholes.

1.3 DEFINITION

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.

2. Multiple duct banks.

D. GRC: Galvanized rigid (steel) conduit.

E. RNC: Rigid nonmetallic conduit.

F. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.

2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.

3. Accessories for manholes, handholes, boxes, and other utility structures.

4. Warning tape.

5. Warning planks.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.

2. Reinforcement details.

3. Frame and cover design and manhole frame support rings.

4. Ladder details.

5. Grounding details.

6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.

7. Joint details.

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.

2. Cover design.

3. Grounding details.

4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

2. Drawings shall be signed and sealed by a qualified professional engineer.

E. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.

F. Qualification Data: For professional engineer and testing agency.

G. Source quality-control test reports.

H. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Owner's written permission.

B. General: Clearing work shall not begin until temporary fences, barricades, warning signs and other pedestrian control devices are installed.

C. Traffic Access:

1. Conduct operations and schedule cleanup in a manner which causes the least possible obstruction and inconvenience to adjacent property owners, pedestrians and vehicular traffic. Furnish, erect, construct and maintain such temporary fences, barriers, lights, reflectors, cones, signs, ramps, etc., that may be necessary to adequately provide separation and warn the public of work in progress and of any existing dangerous conditions. This requirement shall apply continuously and shall not be limited to normal working hours.

2. Maintain continued access to parking areas, roads, abutting properties, and other facilities which the construction will cross.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.

10. Manhattan/CDT; a division of Cable Design Technologies.

11. Spiraduct/AFC Cable Systems, Inc.

B. Underground Plastic Utilities Duct: Type EPC-80-PVC and Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

C. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.

2. Warning Tape: Underground-line warning tape specified in Division 26 Section.

3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.

a. Color. Red dye added to concrete during batching
b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

D. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carder Concrete Products.

2. Christy Concrete Products.

3. Elmhurst-Chicago Stone Co.

4. Oldcastle Precast Group.

5. Riverton Concrete Products; a division of Cretex Companies, Inc.

6. Utility Concrete Products, LLC.

7. Utility Vault Co.

8. Wausau Tile, Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

3. Cover Legend: Molded lettering, "ELECTRIC," "TELEPHONE," and/or as indicated for each service.

4. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.

5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

   a. Extension shall provide increased depth of 12 inches (300 mm).
   b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

   a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

   a. Type and size shall match fittings to duct or conduit to be terminated.
   b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

8. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color: Gray.

2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.

3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

5. Cover Legend: Molded lettering, "ELECTRIC," "TELEPHONE," or as indicated for each service.

6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

8. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Armorcast Products Company.
b. Carson Industries LLC.
c. CDR Systems Corporation.
d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Armorcast Products Company.
b. Carson Industries LLC.
c. Christy Concrete Products.
d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

2.5 PRECAST MANHOLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.

B. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

   a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

   a. Type and size shall match fittings to duct or conduit to be terminated.
   b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

C. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.

D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.6 UTILITY STRUCTURE ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Bilco Company (The).
2. Campbell Foundry Company.
3. Carder Concrete Products.
4. Christy Concrete Products.
5. East Jordan Iron Works, Inc.
6. Elmhurst-Chicago Stone Co.
7. McKinley Iron Works, Inc.
8. Neenah Foundry Company.
9. NewBasis.
10. Oldcastle Precast Group.
11. Osburn Associates, Inc.
12. Pennsylvania Insert Corporation.
13. Riverton Concrete Products; a division of Cretex Companies, Inc..
14. Strongwell Corporation; Lenoir City Division.
15. Underground Devices, Inc.
16. Utility Concrete Products, LLC.
17. Utility Vault Co.
18. Wausau Tile, Inc.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches (737 mm).

    a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
    b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Selected to suit system.

    a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
    b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.

3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

    a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.

C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-(50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.

1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.

E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (32-mm-) diameter eye, rated 2500-lbf (11-kN) minimum tension.

F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.

G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (32 mm) minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.

H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.

I. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.

1. Stanchions: T-section or channel; 2-1/4-inch (57-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.

2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (460 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.

3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

J. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.

1. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of 9 holes for arm attachment.

2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (508 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.

K. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

L. Fixed Manhole Ladders: Arranged for attachment to wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.

M. Portable Manhole Ladders: UL-listed, heavy-duty fiberglass specifically designed for portable use for access to electrical manholes. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches (900 mm). One required.

N. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater. Two required.

2.7 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

C. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-80-PVC where direct-buried, RNC, NEMA Type EPC-40-PVC where concrete-encased, unless otherwise noted.

D. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

E. Underground Ducts Crossing Paved Paths, walks, driveways and roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

F. Ducts for electrical feeders over 600V: RNC, NEMA Type EPC-80-PVC where direct-buried, RNC, NEMA Type EPC-40-PVC where concrete-encased, unless otherwise noted.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.

2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.

4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

5. Cover design load shall not exceed the design load of the handhole or box.

B. Manholes: Precast or cast-in-place concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Division Section "Earthwork" but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division Sections "Lawns and Grasses" and "Exterior Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.5 DUCT AND DUCTANK INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 25 feet (7.5 m), both horizontally and vertically, at other locations, unless otherwise indicated. Provide minimum radius for utility primary feeders as required by the utility company.

D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

E. Duct Entrances to Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.

2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.

3. Grout end bells into structure walls from both sides to provide watertight entrances.

F. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

H. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.

I. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

   a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
   b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.

7. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.

8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.

9. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

J. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.

2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.

3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division Section "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.

4. Install backfill as specified in Division Section "Earth Moving."

5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division Section "Earth Moving."

6. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.

7. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated.

8. Set elevation of bottom of duct bank below the frost line.

9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.

10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

11. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above direct-buried ducts and duct banks, placing them 24 inches (600 mm) o.c. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.

2. Install units level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances.

3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Install handholes with bottom below the frost line, below grade.

2. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

3. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.

2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Dampproofing: Apply dampproofing to exterior surfaces of handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07. After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, as required for installation and support of cables and conductors and as indicated.

G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (97 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

H. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with bottom below the frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.

2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.8 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding of Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding of Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.10 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

DIVISION 26 SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 SUBMITTALS 3
1.4 QUALITY ASSURANCE 3
1.5 COORDINATION 3

PART 2 - PRODUCTS 4

2.1 POWER RACEWAY IDENTIFICATION MATERIALS 4
2.2 METAL-CLAD CABLE IDENTIFICATION MATERIALS 4
2.3 CONDUCTOR IDENTIFICATION MATERIALS 4
2.4 UNDERGROUND-LINE WARNING TAPE 5
2.5 WARNING LABELS AND SIGNS 5
2.6 EQUIPMENT IDENTIFICATION LABELS 6
2.7 CABLE TIES 6
2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS 7

PART 3 - EXECUTION 7

3.1 INSTALLATION 7
3.2 IDENTIFICATION SCHEDULE 8
END OF SECTION 11

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SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual;

and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field for normal feeders, black letters on a yellow field for emergency feeders.

2. Legend: Indicate voltage and system or service type.

C. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field for normal circuits, black letters on a yellow field for emergency circuits.

2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

2.4 UNDERGROUND-LINE WARNING TAPE

A. Tape: Permanent, bright-colored, continuous-printed polyethylene tape.

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

4. Embedded continuous metallic strip or core.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.

2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.

3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.5 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.

2. 1/4-inch (6.4-mm) grommets in corners for mounting.

3. Nominal size, 7 by 10 inches (180 by 250 mm).

C. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.

2. 1/4-inch (6.4-mm) grommets in corners for mounting.

3. Nominal size, 10 by 14 inches (250 by 360 mm).

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background for equipment connected to normal power source, white letters on a red background for equipment connected to an emergency power source. Minimum letter height shall be 3/8 inch (10 mm).

B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

C. Comply with NFPA 70E and Section 260573 “Coordination Study" requirements for arc-flash warning labels.

2.7 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).

3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).

3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).

3. UL 94 Flame Rating: 94V-0.

4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).

5. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. In finished spaces, nameplates for panelboards shall be secured to the interior behind the door.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Attach signs and plastic labels with stainless screws.

E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

F. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.

2. In Spaces Handling Environmental Air: Plenum rated.

G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 8 inches (200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

H. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 20 A: Identify with snap-around label applied in bands. Install labels at 10-foot (3-m) maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power System - Yellow.

2. Power - Orange.

3. Fire Alarm System – Red.

4. Security System – Blue and Yellow.

5. Mechanical and Electrical Supervisory System – Green and Blue.

6. Telecommunication Systems - Green and Yellow.

7. Control Wiring – Green and Red.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.

b. Colors for 208/120-V Circuits:
   1) Phase A: Black.
   2) Phase B: Red.
   3) Phase C: Blue.
   4) Neutral: White.
   5) Ground: Green.

c. Colors for 480/277-V Circuits:
   1) Phase A: Brown.
   2) Phase B: Orange.
   3) Phase C: Yellow.
   4) Neutral: Gray.
   5) Ground: Green.

d. All control wiring shall be color-coded when using wires of different color from the type used to designate phase wires.

e. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs and metal-backed, butyrate warning signs.

1. Comply with 29 CFR 1910.145.

2. Identify system voltage with black letters on an orange background.

3. Apply to exterior of door, cover, or other access.

4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.

b. Controls with external control power connections.

J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. For electrical equipment such as disconnect switches, motor starters, contactors, relays, pushbutton stations, etc., the label shall have the same designation as the equipment it serves. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Engraved, laminated phenolic nameplates. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
d. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated phenolic nameplate, “Panel (designation)”, “Served from “(designation)”.
b. Enclosures and electrical cabinets.
c. Access doors and panels for concealed electrical items.
d. Switchboards.
e. Transformers.
f. Electrical rooms/closets.
g. Emergency system boxes and enclosures.
h. Motor-control centers.
i. Enclosed switches.
j. Enclosed circuit breakers.
k. Enclosed controllers.

l. Variable-speed controllers.
m. Push-button stations.
n. Power transfer equipment.
o. Contactors.
p. Remote-controlled switches, dimmer modules, and control devices.
q. Power-generating units.
r. Monitoring and control equipment.
s. UPS equipment.

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DIVISION 26 SECTION 26 05 73
SHORT CIRCUIT ANALYSIS, COORDINATION STUDY,
& ARC FLASH HAZARD ANALYSIS
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SCOPE 3
1.3 REFERENCES 3
1.4 SUBMITTALS 4
1.5 QUALITY ASSURANCE 5

PART 2 - PRODUCTS 5

2.1 COMPUTER SOFTWARE DEVELOPERS 5
2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS 5

PART 3 - EXECUTION 6

3.1 EXAMINATION 6
3.2 POWER SYSTEM DATA 6
3.3 FAULT-CURRENT STUDY 7
3.4 COORDINATION STUDY 8
3.5 ARC-FLASH HAZARD 9
3.6 ARC FLASH LABELS 10
3.7 AVAILABLE FAULT CURRENT LABELING 11
END OF SECTION 11

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SECTION 26 05 73
SHORT CIRCUIT ANALYSIS, COORDINATION STUDY, & ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study. Electrical equipment shop drawings will not be reviewed/approved until the overcurrent protective device coordination study has been submitted.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the current version of NFPA 70E – *Standard for Electrical Safety in the Workplace*. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584-2002, the IEEE *Guide for Performing Arc-Flash Calculations*. Arc-Flash Hazard Labels shall be provided for all electrical distribution equipment with level as determined by Study.

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.

2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.

4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.

5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.

6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations.

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.

3. ANSI C37.010 – Standard Application Guide for AC High Voltage Power Circuit Breakers Rated on a Symmetrical Current Basis.

4. ANSI C37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)

1. NFPA 70 – National Electrical Code, latest edition.

2. NFPA 70E – Standard for Electrical Safety in the Workplace.

1.4 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.

2. Study and Equipment Evaluation Reports.

3. Coordination-Study Report.

4. Arc Fault Hazards Evaluation.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Engineering Analysis and Coordination Study performed by Coordinated Power Engineering, Inc., or a comparable product by one of the following:

1. CGI CYME.

2. EDSA Micro Corporation.

3. ESA Inc.

4. Operation Technology, Inc.

5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

   a. Arcing faults.
   b. Simultaneous faults.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Impedance of utility service entrance.

3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

   a. Circuit-breaker and fuse-current ratings and types.
   b. Relays and associated power and current transformer ratings and ratios.
   c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
   d. Generator kilovolt amperes, size, voltage, and source impedance.
   e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
   f. Busway ampacity and impedance.
   g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

   a. Special load considerations, including starting inrush currents and frequent starting and stopping.
   b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
   c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

d. Generator thermal-damage curve.
e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system, determined from both the utility and paralleled generator sources. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchboard bus.

2. Distribution panelboard.

3. Branch circuit panelboard.

4. Automatic Transfer Switch.

5. Uninterruptible Power Supply.

B. Study electrical distribution system from normal power sources throughout electrical distribution system for Project.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, and IEEE 242.

1. Transformers:

a. IEEE C57.12.00.
b. IEEE C57.96.

2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.

3. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.

3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.

2. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 141 and IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag.
b. Voltage and current ratio for curves.
c. Three-phase and single-phase damage points for each transformer.
d. No damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer inrush points.
g. Maximum fault-current cutoff point.

F. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC-FLASH HAZARD

A. Perform Arc-Flash Hazard Analysis for each piece of distribution equipment and provide results indicating personnel protective equipment required for the potential hazard. Provide arc flash hazard labels as required by the NEC on each piece of equipment indicating the calculated arc-flash hazard.

3.6 ARC FLASH LABELS

A. Contractor shall provide a 4.0 in. x 4.0 in. Brady thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The labels shall be designed according to the following standards:

1. UL969 – Standard for Marking and Labeling Systems
2. ANSI Z535.4 – Product Safety Signs and Labels
3. NFPA 70 (National Electrical Code) – Article 110.16

C. The labels shall include the following information:

1. System Voltage
2. Flash Protection boundary
3. Personal Protective Equipment category
4. Arc Flash Incident energy value (cal/cm^2)
5. Limited, restricted, and prohibited Approach Boundaries
6. Study report number and issue date

D. Labels shall be printed by a thermal transfer type printer, with no field markings.

E. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:

1. Floor Standing Equipment – Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.
2. Wall Mounted Equipment – Labels shall be provided on the front cover of a nearby adjacent surface, depending upon equipment configuration.
3. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.

F. Labels shall be field installed by Contractor.

3.7 AVAILABLE FAULT CURRENT LABELING

A. Contractor shall provide a 4.0 in. x 4.0 in. Brady thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The labels shall include the following information:

1. Line 1 – "Maximum Available Fault Current"

2. Line 2 – "_____ Amperes"; Contractor shall field mark maximum available fault current available at the line terminals of the equipment.

3. Line 3 – Date of Installation

C. Labels shall be printed by a thermal transfer type printer.

D. Labels shall be field-installed by the Contractor.

END OF SECTION

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DIVISION 26 SECTION 26 09 23
LIGHTING CONTROL DEVICES
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 DEFINITIONS 3
1.4 SUBMITTALS 3
1.5 QUALITY ASSURANCE 4
1.6 SUBSTITUTIONS 4
1.7 COORDINATION 5

PART 2 - PRODUCTS 5

2.1 GENERAL 5
2.2 TIME SWITCHES 5
2.3 OUTDOOR PHOTOELECTRIC SWITCHES 5
2.4 CONTACTORS 6
2.5 DAYLIGHT-HARVESTING DIMMING CONTROLS 7
2.6 INDOOR OCCUPANCY/VACANCY SENSORS 8
2.7 SWITCHBOX-MOUNTED OCCUPANCY/VACANCY SENSORS 10
2.8 LOW VOLTAGE SWITCHES 11
2.9 DIGITAL ROOM CONTROLLERS 12
2.10 CONFIGURATION TOOL 14
2.11 EMERGENCY SHUNT RELAY 14
2.12 CONDUCTORS AND CABLES 15

PART 3 - EXECUTION 15

3.1 PRE-INSTALLATION MEETING 15
3.2 SENSOR INSTALLATION 16
3.3 CONTACTOR INSTALLATION 16
3.4 WIRING INSTALLATION 16
3.5 IDENTIFICATION 16
3.6 FIELD QUALITY CONTROL 16
3.7 ADJUSTING 17
3.8 DEMONSTRATION 17
END OF SECTION 17

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SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Provide lighting controls that can operate as standalone local room network(s) and have the capability to expand to a central building wide network. The building wide network shall provide control, monitoring, adjustment and scheduling functionality. The system shall be PC based with software and historical data storage. The system shall support third party integration with the building management system through BACnet/IP.

B. This Section includes the following lighting control devices:

1. Time switches.
2. Photoelectric switches.
3. Daylight-harvesting controls.
4. Indoor occupancy/vacancy sensors.
5. Low voltage switches.
6. Contactors.
7. Emergency shunt relays.

C. Related Sections include the following:

1. Division 26 Section 262726, *Wiring Devices* for snap switches.
2. Section 260943 “Network Lighting Controls”.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Coverage Plans: Provide full scale plans showing locations and coverage patterns for all occupancy/vacancy sensors.

C. Location Plans: Provide full scale plans showing locations and coverage patterns for all devices.

D. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.

2. Include diagrams for power, signal, and control wiring.

3. Include riser diagrams showing all devices and wiring.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 SUBSTITUTIONS

A. The lighting control specification and lighting control details represent the basis of design. Acceptable manufacturers must meet the criteria listed in the system requirements as well as intent demonstrated through control details. Compliant systems are required to achieve the design intent and are not required to have all the parts and pieces listed.

B. Manufacturers not listed in the list of Acceptable Manufacturers must submit for approval within 10 days prior to bid.

C. Acceptable Manufacturers

1. Basis of Design

a. Acuity Brand Controls; nLight.

2. Alternative Manufacturers

a. Wattstopper; Digital Lighting Management
b. Hubbell NX
c. Eaton; Room Controller System

1.7 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide a wired digital networked lighting control system as indicated on the drawings. The system shall include, but not be limited to, occupancy/vacancy sensor(s), photo sensor(s), digital room controller(s), digital switches, and all interconnecting wiring required for a complete operational system. The Basis-of-Design System is the Acuity Brand Controls; nLight.

2.2 TIME SWITCHES

A. Basis-of-Design product: Subject to compliance with requirements, provide Acuity or a comparable product by one of the following:

1. Wattstopper.

2. Leviton Manufacturing Company, Inc.

3. Pass & Seymour.

4. Cooper Industries, Inc.

5. Intermatic, Inc.

B. Digital Time Switches: Wall switch style, electroluminescent back-lit LCD display shows timer countdown, time-out adjustments from 5 minutes to 12 hours, compatible with electronic ballasts; UL listed, five-year warranty.

2.3 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Acuity.

2. Cooper Industries.

3. Intermatic, Inc.

4. NSi Industries, LLC; TORK Products.

5. Tyco Electronics; ALR Brand.

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.

3. Time Delay: 15-second minimum, to prevent false operation.

4. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.

5. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.4 CONTACTORS

A. Basis of Design Product: Subject to compliance with requirements, provide ASCO; 918 series with solid-state control module for 2 wire control with number of poles and ratings as indicated on the drawing, or a comparable product by one of the following:

1. Square D; Schneider Electric.

2. Allen-Bradley/Rockwell Automation.

B. Description: Electrically operated and mechanically held, combination type with nonfused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).

2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.

3. Enclosure: Comply with NEMA 250.

4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

1. Monitoring: On-off status.

2. Control: On-off operation.

2.5 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight nCm ADCX RJB or comparable product by one of the following:

1. Wattstopper DLM

2. Hubbell NX

3. Eaton

B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:

a. When no daylight is present (target level).
b. When significant daylight is present.

2. System programming is done with a hand held digital configuration tool or a PC with appropriate software.

a. Initial setup tool: a hand held digital configuration tool. Sensor adjustments may also be made using configuration pushbuttons on the sensors.
b. USB interface and PC software: capability to program, read, store, modify and document device and system configuration.

C. Ceiling-Mounted Dimming Controls: Solid-state, digital light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye in order to automatically dim a lighting zone.

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operating Ambient Conditions: Dry interior conditions, 32 to 104 deg F (0 to 40 deg C).

3. Sensor Output: Digitally communicates with room controller to dim loads based on lighting conditions. Sensor is powered from the room controller.

E. Light-Level Sensor Set-Point Adjustment Range: 10 to 200 fc (108 to 2152 lux)

F. Provide unit suitable for Low Temp/High Humidity environments in SHOPS and other unconditioned spaces.

G. Provide single or dual zone control capability, as applicable.

2.6 INDOOR OCCUPANCY/VACANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight nCM PDT RJB, nWV PDT, or comparable product by one of the following:

1. Wattstopper DLM

2. Hubbell NX

3. Eaton

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state digital indoor occupancy/vacancy sensors with a separate controller unit.

1. Systems programming is done with a hand held digital configuration tool or a PC with appropriate software.

a. Initial setup tool: a hand held digital configuration tool. Sensor adjustments may also be made using configuration pushbuttons on the sensors.
b. USB interface and PC software: capability to program, read, store, modify and document device and system configuration.

2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Operation:

a. Occupancy Sensor: Automatic-on when coverage area is occupied, and automatic-off when unoccupied.
b. Vacancy Sensor: Manual-on when coverage area is occupied, and automatic-off when unoccupied.
c. Time Delay for turning lights off adjustable over a minimum range of 1 to 30 minutes in 1-minute increments. Default setting: 20 minutes.

4. Sensor Output: Digitally communicates with room controller to turn loads on and off based on occupancy. Sensor is powered from the room controller.
5. Mounting:

a. Sensor: Suitable for mounting, ceiling mounting and corner mounting.
b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind removable cover.

6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.

C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).

2. Detection Coverage (Standard Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

3. Detection Coverage Large Room): Detect occupancy anywhere in a circular area of 2000 sq.ft. (186 sq.m) when mounted on a 96-inch-(2440-mm) high ceiling.

D. Ultrasonic/Microphonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

2. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

3. Detection Coverage (Corridor): Detect occupancy anywhere within 48 feet (18.0 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 12 feet (3.7 m).

4. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

5. Detection Coverage (corner mount): Detect occupancy anywhere within a 30 foot (9145 mm) radius when corner mounted at ceiling or on wall at 120-inches (3058 mm) above the finished floor. Provide stem mount as required to maintain manufacturer's recommended mounting height.

6. Detection Coverage (high bay): Detect occupancy anywhere within a 20 foot (6096 mm) radius when mounted at ceiling at 180-inches (4572 mm) above the finished floor. Provide stem mount as required to maintain manufacturer's recommended mounting height.

2.7 SWITCHBOX-MOUNTED LOW VOLTAGE OCCUPANCY/VACANCY SENSORS

A. Subject to compliance with requirements, provide Sensor Switch nWSX-PDT-LV or nWSX-PDT-LV-DX (On/Off or Dimming to match function indicated on the drawings) or comparable product by one of the following:

1. Wattstopper DLM

2. Hubbell NX

3. Eaton

B. General Description: Wall-mounting, solid-state units suitable for mounting in a single-gang switchbox.

1. Operation:

a. Occupancy Sensor Mode: Automatic-on when coverage area is occupied, and automatic-off when unoccupied.
b. Vacancy Sensor Mode: Manual-on when coverage area is occupied, and automatic-off when unoccupied.
c. Time Delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes in 1-minute increments. Default setting: 15 minutes.

2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
3. Mounting:

a. Sensor: Suitable for mounting in a standard outlet box.
b. Time-Delay and Sensitivity Adjustments: Recessed and concealed.

4. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

5. Bypass Switch: Override the on function in case of sensor failure.

C. Dual-Technology Type: Wall mounting; detect occupancy by using a combination of PIR and ultrasonic or microphonic detection methods in area of coverage. Particular

technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6-inch (150 mm) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12-inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12-inches/s (305 mm/s).

3. Detection Coverage: (Standard Room): Detect occupancy anywhere within a 15 foot radius (4572 mm) when wall mounted at 48-inches (1220 mm) above finished floor.

2.8 LOW VOLTAGE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight PODM, or comparable product by one of the following:

1. Wattstopper DLM

2. Hubbell NX

3. Eaton

B. General Description: Low-voltage, momentary pushbutton switches in 1, 2, 3, 4, 5, and 8 button configuration with the following features.

1. Two-way infrared (IR) transceiver for use with personal, and configuration remote controls.

2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.

3. Configuration LED on each switch that blinks to indicate data transmission.

4. Load/Scene Status LED on each switch button with the following characteristics:

   a. Bi-level LED
   b. Dim locator level indicates power to switch
   c. Bright status level indicates that load or scene is active

5. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.

C. Two RJ-45 ports for connection to local network.

D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required to achieve multi-way switching.

E. The following switch attributes may be changed or selected using a wireless configuration tool:

1. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).

2. Individual button function may be configured to Toggle, On only, or Off only.

3. Individual scenes may be locked to prevent unauthorized change.

4. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.

5. Ramp rate may be adjusted for each dimmer switch.

6. Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads.

2.9 DIGITAL ROOM CONTROLLERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight nPP16 or comparable product by one of the following:

1. Wattstopper DLM

2. Hubbell NX

3. Eaton

B. Description: Self configuring, digitally addressable one, two or three relay controllers with 0-10 volt control for drivers and single relay application-specific plug load controllers (if applicable) Room controllers shall be provided to match room lighting load and control requirements and have the following features:

1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.

2. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.

3. Device Status LEDs to indicate:

a. Data transmission.
b. Device has power.
c. Status for each load.

d. Configuration status.

4. Quick installation features including:

a. Standard junction box mounting.
b. Quick low voltage connections using standard RJ-45 patch

5. Plenum rated.

6. Manual override and LED indication for each load.

7. Dual voltage (120/277 VAC, 60 Hz)

8. Zero cross circuitry for each load.

9. Controllers shall be equipped for fail-safe operation and shall be evaluated for this purpose.

10. Controllers shall be activated by activation of the building fire alarm system.

11. Controllers shall be equipped for activation by the building security system.

C. On/Off/Dimming enhanced room controllers shall include:

1. Real time current monitoring.

2. One, two or three relay configuration.

3. Efficient 250 mA switching power supply.

4. Four RJ-45 local network ports.

5. One 0-10 volt analog output per relay for control of compatible LED drivers.

6. Optional Network Bridge for BACnet MS/TP communications (LMRC-3xx).

7. The following dimming attributes may be changed or selected using a wireless configuration tool:

a. Establish preset level for each load from 0-100%.
b. Set high and low trim for each load.
c. Set lamp burn in time for each load up to 100 hours.

8. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.

a. One relay configuration only.
b. Automatic-ON/OFF configuration.

2.10 CONFIGURATION TOOL

A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight, or comparable products by one of the following:

1. Wattstopper DLM

2. Hubbell NX

3. Eaton

B. A configuration tool facilitates customization of local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface. Features and functionality of the wireless configuration tool shall include:

1. Two-way infrared (IR) communication with IR-enabled devices within a range of approximately 30 feet.

2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.

3. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.

4. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.

5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting.

6. Adjust or fine-tune daylighting settings established during auto-commissioning, and input light level data to complete commissioning of open loop daylighting controls.

2.11 EMERGENCY SHUNT RELAY

A. Basis-of-Design Product: Subject to compliance with requirements, provide Bodine or comparable product by one of the following:

1. Lighting Control and Design, Inc.

2. Nine Twenty Four.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 1008 and/or UL 924.

1. Coil Rating: 120 / 277 V.

2.12 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section, Low-Voltage Electrical Power Conductors and Cables.

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 24 AWG. Comply with requirements in Division 26 Section 260519, *Low-Voltage Electrical Power Conductors and Cables*.

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section 260519, *Low-Voltage Electrical Power Conductors and Cables*."

PART 3 - EXECUTION

3.1 PRE-INSTALLATION MEETING

A. Convene minimum two weeks prior to commencing Work of this section. Meeting to be attended by Contractor, Owner's representative, system installer, factory authorized manufacturer's representative, and representative of all trades related to the system installation.

B. Review installation procedures and coordination required with related Work and the following:

1. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.

2. Review the specifications for low voltage control wiring and termination.

3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.

4. Discuss requirements for integration with other trades.

C. Inspect and make notes to job conditions prior to installation:

1. Record minutes of the conference and provide copies to all parties present.

2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.

3. Installation shall not begin until all outstanding issues are resolved to the satisfaction of the Owner's representative.

3.2 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section 260519, *Low-Voltage Electrical Power Conductors and Cables*. Minimum conduit size shall be 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section 260553, *Electrical Identification*.

1. Identify controlled circuits in lighting contactors.

2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.

2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section 017900, *Demonstration and Training*.

END OF SECTION

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DIVISON 26 SECTION 26 09 43
NETWORK LIGHTING CONTROLS
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 SUMMARY 3
1.2 DESCRIPTION OF WORK 3
1.3 SUBMITTALS 3
1.4 INFORMATIONAL SUBMITTALS 4
1.5 CLOSEOUT SUBMITTALS 4
1.6 SUBSTITUTIONS 4

PART 2 - PRODUCTS 4

2.1 GENERAL SYSTEM REQUIREMENTS 4
2.2 DISTRIBUTED SYSTEM POWER, SWITCHING AND DIMMING CONTROLS 5
2.3 WIRED NETWORK RELAY AND DIMMING PANEL 6
2.4 WIRED NETWORKED WALL SWITCHES, DIMMERS, SCENE CONTROLLERS 6
2.5 WIRED NETWORKED OCCUPANCY AND PHOTOSENSORS 6
2.6 WIRED NETWORKED AUXILIARY INPUT / OUTPUT (I/O) DEVICES 7
2.7 WIRED NETWORKED WALL SWITCH SENSORS 8
2.8 SYSTEM CONTROLLER 8
2.9 SYSTEM SOFTWARE INTERFACES 9

PART 3 - EXECUTION 10

3.1 CONTRACTOR RESPONSIBILITY 10
3.2 SYSTEM START UP AND COMMISSIONING 10
END OF SECTION 11

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SECTION 26 09 43
NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. The work covered in this section is subject to all of the requirements in the General Conditions of the Specifications. Contractor shall coordinate all of the work in this section with all of the trades covered in other sections of the specification to provide a complete and operable system. Provide all Labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section.

1.2 DESCRIPTION OF WORK

A. Furnish and install a complete system for the control of lighting and other equipment as indicated on the plans, detailed in the manufacturer submittal, and as further defined herein. Contractor is solely responsible to verify quantity, installation locations and wiring requirements for this project. Specific manufacturer's catalog numbers, when listed in this section are for reference only. It is the responsibility of the contractor to verify with lighting control manufacturer all catalog information and specific product availability.

B. The system shall include but not be limited to the following list: Pre-wired, microprocessor controlled relay or dimming panels with latching relays controlled via switches, photocells, occupancy sensors, time based control, building automation systems, thermostats, and other control devices.

1.3 SUBMITTALS

A. Shop Drawings: Submit drawings of lighting control system and accessories including, but not necessarily limited to, relay panels, switches, occupancy sensors, photocells and other interfaces. Shop drawings shall indicate location of each device. Plans are diagrammatical. Electrical Contractor shall verify all lighting control material requirements from approved shop drawings. "Cut Sheet" submittal not acceptable.

B. Product Data: Submit for approval manufacturer's data for each type of product. Include construction details, descriptions, dimensions, and conductors and cables. Submit a complete bill of materials with part numbers, description and voltage specifications.

C. One Line Diagram: Submit a one-line diagram of the system configuration indicating the type, size and number of conductors between each component. Submittals that show typical riser diagrams are not acceptable.

1. Show installation details for all devices including interconnection diagrams showing all field installed wiring.

2. Include diagrams for power, signal and control wiring.

D. Coverage Plans: Show locations and coverage patterns for all occupancy sensors.

E. Programming Forms: Submit programming forms with complete information describing the operation of the network lighting control system and all other information necessary to show proper operation of the system.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation and maintenance manuals.

1.6 SUBSTITUTIONS

A. The lighting control specification and lighting control details represent the basis of design. Acceptable manufacturers must meet the criteria listed in the system requirements as well as intent demonstrated through control details. Compliant systems are required to achieve the design intent.

B. Manufacturers not listed in the list of Acceptable Manufacturers must submit for approval within ten (10) days prior to bid.

C. Acceptable Manufacturers

1. Basis of Design

a. Acuity Brand Controls; nLight.

2. Alternative Manufacturers

a. Wattstopper; Digital Lighting Management.
b. Hubbell NX
c. Eaton; Room Controller System.

PART 2 - PRODUCTS

2.1 GENERAL SYSTEM REQUIREMENTS

A. System Architecture

1. System shall have an architecture that is based upon wired networkable intelligent lighting control devices, standalone lighting control zones using distributed intelligence, and system backbone for remote, time based and global operation between control zones.

2. The system shall be capable of providing individually addressable switching and dimming control of the following: control zones to include multiple switch legs or circuits, relays and dimming outputs from centralized panels and networked luminaires. System shall be capable of integrating indoor and outdoor lighting controls.

3. Lighting control zones shall be capable of being networked with a higher level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through software.

4. System shall be capable of 'out of box' sequence of operation for each control zone. Standard Sequence is:

   a. All switches control all power packs in a zone.
   b. All occupancy sensors automatically control all power packs in the control zone with a default time out.

B. Wired Network Control Zone Characteristics

1. Following proper installation and provisions of power, all networked devices connected together with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming. The 'out of box' default sequence of operation is intended to provide typical sequence of operation so as to minimize the system start up and programming requirements and to also have functional lighting control operation prior to system startup and programming.

2. System shall be able to automatically discover all connected devices without requiring any provisioning of system or zone address.

C. System Integration Capabilities

1. The system shall be capable of interface with third party building management systems to support two-way communication using the industry standard BACnet/IP or BACnet/MSTP protocols.

2.2 DISTRIBUTED SYSTEM POWER, SWITCHING AND DIMMING CONTROLS

A. Devices shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage class 2 power to the rest of the system.

B. Device programming parameters shall be available and configurable remotely from the software and locally via the device push-button.

C. Power packs shall accept 120 or 277 volt VAC and shall be plenum rated.

D. Devices shall be UL listed for load and load types as specified on the plans.

2.3 WIRED NETWORK RELAY AND DIMMING PANEL

A. Relays and dimming panels shall be capable of providing the required amount of relay capacity indicated as 4-relay, 8-relay, or 16-relay, as required per panel schedules shown on drawings, with an equal number of individually 0-10v dimming outputs.

B. Standard relays used shall have the following required properties:

1. Configurable in the field to operate with normally closed or normally open behavior.

2. Provide visual status of current state and manual override control of each relay.

3. Be individually programmable.

C. 0-10 VDC dimming outputs shall support a minimum of 100 mA sink current per output.

D. Panel shall be UL924 listed for control of emergency lighting circuits.

E. Panel shall provide a contact closure input that acts as a panel override to activate the normally configured state of all relays in the panels.

2.4 WIRED NETWORKED WALL SWITCHES, DIMMERS, SCENE CONTROLLERS

A. Wall switches & dimmers shall support the following device options:

1. Number of control zones: 1, 2 or 4.

2. Control Types Supported: On / Off or On / Off / Dimming.

B. Scene controllers shall support the following device options:

1. Number of Scenes: 1, 2 or 4.

2. Control Types Supported:

a. On / Off or On / Off / Dimming
b. Preset Level Scene Type
c. Reprogrammed or other devices within daisy-chained zone so as to implement user selected lighting scene.
d. Selecting a lighting profile to be run by the system’s upstream controller so as to implement a selected lighting profile across multiple zones.

2.5 WIRED NETWORKED OCCUPANCY AND PHOTOSENSORS

A. Sensors shall utilize passive infrared (PIR) or dual technology (microphonic/ultrasonic plus passive infrared) to detect both the major (walking) and minor (hand) motion as defined by NEMA WD-7 standards.

B. Sensing technologies that are acoustically passive, meaning they do not transmit sound waves to any frequency, do not require commissioning. Ultrasonic based sensing

technologies may require commissioning or sensitivity adjustment due to the active nature of their technology, if factory required.

C. Sensor coverage shall be coordinated with the floor plans. Sensors shall be available in standard and extended range, as well as being available with option for High Bay mounting.

D. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device.

E. Sensor mounting type shall match project design requirements as shown on the plans.

1. Sensors shall have optional features for photosensor/daylight override, dimming control and low temperature/high humidity operations.

F. The system shall support the following types of photocell-based control:

1. On / Off: The control zone is automatically turned off if the photocell reading exceeds the defined setpoint and automatically turned on if the photocell reading is below the defined setpoint. A time delay or adaptive setpoint adjustable behavior may be used to prevent the system from exhibiting nuisance on/off switching.

2. Continuous Dimming: The control zone automatically adjusts its dimming output in response to photocell readings, such that a minimum light level consisting of both electric light and daylight sources is maintained at the task. The photocell response shall be configurable to adjust the photocell setpoint and dimming rates.

2.6 WIRED NETWORKED AUXILIARY INPUT / OUTPUT (I/O) DEVICES

A. Auxiliary Input / Output Devices shall be specified as an input or output device with the following options:

1. Contact closure input

a. Input shall be programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, ramp light level up or down, or toggle lights on/off.

2. 0-10v analog input

a. Input shall be programmable to function as a daylight sensor.

3. RS-232/RS-485 digital input

a. Input supports activation of up to 4 local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.

4. 0-10v dimming control output, capable of sinking a minimum of 20 mA of current

a. Output shall be programmable to support all standard sequence of operations supported by system.

2.7 WIRED NETWORKED WALL SWITCH SENSORS

A. Wall switches sensors shall support the following device options:

1. User input control types supported: On / Off or On / Off / Dimming.

2. Occupancy Sensing Technology: PIR or Dual Technology.

3. Daylight Sensing Option: Inhibit Photosensor.

2.8 SYSTEM CONTROLLER

A. System Controller shall be a multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.

B. System Controller shall perform the following functions:

1. Facilitation of global network communication between different areas and control zones.

2. Time-Based control of downstream wired and wireless network device.

3. Linking to an Ethernet network.

4. Integration with Building Management System (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.

5. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.

C. System Controller shall not require a dedicated PC or a dedicated cloud connection.

D. Device shall automatically detect all networked devices connected to it, including those connected to wired and wireless communication bridges.

E. Devices shall have a standard and astronomical internal time clock.

F. Shall be capable of connecting to the customers Local Area Network (LAN) via IEEE 802.11.x Wireless and IEEE 802.3 wired connection.

G. System Controllers shall support BACnet/IP and BACnet/MSTP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.

1. BACnet/MSTP shall support a minimum of 50 additional BACnet MS/TP controllers in addition to the expansion I/O modules.

2. BACnet/MSTOP shall support 9600 to 115200 baud.

3. System Controllers shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building (B-BC) with outlined enhanced features.

4. System controllers must support BACnet/IP Broadcast Management Device (BBMS) and Foreign Device Registration (FDR).

H. Controllers shall be equipped for fail safe operation and shall be evaluated for this purpose.

I. Controllers shall be activated by activation of the building fire alarm system.

J. Controllers shall be equipped for activation by the building security system.

2.9 SYSTEM SOFTWARE INTERFACES

A. Management Interface

1. System shall provide a web-based management interface that provides remote system control, live status monitoring, and configuration capabilities of lighting control settings and schedules.

2. Management interface must be compatible with industry-standard web browser clients.

3. All system software updates must be available for automatic download and installation via the internet.

B. Historical Database and Analytics Interface

1. System shall be capable of providing a browser-based trending and monitoring interface that stores historical data for all occupancy/daylight sensors and lighting loads. Additionally, the system shall optionally upload that data to a cloud based server.

C. Visualization Interfaces

1. System shall be capable of providing an optional web-based visualization interface that displays a graphical floorplan. System data, to include status of occupancy sensors, daylight sensors and light output shall be overlaid to the floorplan to provide a graphical status page.

D. Portable Programming Interface for Standalone Control Zones

1. System shall have option for a portable handheld application interface for standalone control zones.

2. Programming capabilities through the application shall include, but not be limited to, the following:

a. Switch/occupancy/photosensor group configuration.
b. Manual/automatic on modes.
c. Turn-on dim level.
d. Occupancy sensor time delays.
e. Dual technology occupancy sensors sensitivity.
f. Photosensor calibration adjustment and auto-setpoint.
g. Trim level settings.

E. Demand Response Client Interface

1. System shall be capable of receiving a signal from the Utility or through a BAS control sequence and initiating load shed in response.

a. One full test of the Demand Response plan shall be performed and reports shall be included in the operations and maintenance manual.

PART 3 - EXECUTION

3.1 CONTRACTOR RESPONSIBILITY

A. Contractor shall provide the proper quantities and types of sensors for complete coverage of the areas to be controlled.

B. Contractor shall properly install, wire, test and adjust sensors according to manufacturer instructions.

C. Contractor shall be responsible for a complete operational system as specified.

D. Contractor shall warrant all equipment and installation for a period of two (2) years from date of substantial completion. Contractor shall make any necessary adjustments to the system at no charge to the Owner during the warranty period.

E. Contractor/Regional Sales Manager shall provide training to the Owner’s representative in the use, operation, adjustment and maintenance of the equipment.

F. Contractor shall set the sensors time delays per owner’s instruction.

3.2 SYSTEM START UP AND COMMISSIONING

A. To facilitate start-up, all devices daisy-chained together shall automatically be grouped together into a functional lighting control zone.

B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.

C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.

D. All system devices shall be capable of being given user defined names.

E. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.

F. All sensor devices shall have the ability to detect improper communication wiring and blink it's LED in a specific cadence as to alert installation/startup personnel.

END OF SECTION

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SECTION 26 09 61
PERFORMANCE LIGHTING SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section includes furnishing the following equipment for installation as described under Section 260963:
   1. Intelligent Breaker Panel
   2. Panic Control System
   3. Emergency Lighting Transfer System
   4. Equipment Racks
   5. House & Work Lighting Controls
   6. Lighting Control Console & Accessories
   7. Performance Lighting System Ethernet Network
   8. Control Device Faceplates
   9. Performance Lighting Outlet Devices
   10. Spare Parts

B. Related sections include the following:
   1. Performance Lighting Systems Installation
   2. Common Work Results for Electrical
   3. Interior Lighting Fixtures
   4. Loose Performance Lighting Fixtures
   5. Acoustical Shells
   6. Rigging Systems and Controls
   7. Commissioning of Electrical Systems

1.03 FULLY WORKING SYSTEMS

A. Review Drawings and Specifications that affect work in this Section.

B. Notify Architect upon indication that work in this Section cannot be completed as specified or scheduled.

C. Provide additional parts or devices required for functional requirements of control systems at no extra cost to Owner.

1.04 DEFINITIONS

A. Data Communication Protocol: Signal that provides control and feedback communications between devices in control system.

B. DMX 512: Data communications protocol compliant to USITT DMX-512/1990 specification (ANSI E1.11-2004).

C. RDM: Data communications protocol compliant to ANSI/PLASA Remote Device Management specification (ANSI/PLASA E1.20 RDM).

D. ACN: Data communications protocol compliant to ANSI/PLASA Architecture for Control Networks specification (ANSI E1.17-2006 ACN & E1.31 Streaming ACN).

E. POE / Power Over Ethernet: 802.3AT compliant scheme of powering devices on an Ethernet system.

1.05 QUALITY ASSURANCE AND STANDARDS

A. References to code, standards, specifications, and recommendations of technical societies, trade organizations, and governmental agencies will refer to the latest edition of such publications adopted and published prior to bid submittal. All codes and standards will be considered a part of this specification as if they were fully included.

B. Work and materials shall comply with rules and recommendations of:
   1. Prevailing national, state and local building codes.
   2. UL, ETL, cUL, CSA and CE Labels – where materials and equipment are available under the continuing inspection and labeling service of applicable independent product testing and certification services, provide such labels, materials, and equipment.
   3. National Fire Protection Associate (NFPA) Publication: National Electrical Code, NFPA70 as applicable to installation and construction of performance lighting and control equipment.
   4. NEMA Compliance pertaining to components of performance lighting equipment.
   5. United States Institute for Theatre Technology, Inc. (USITT) DMX512/1990 (ANSI E1.11-2004).
   6. ANSI/PLASA Remote Device Management (ANSI/PLASA E1.20 RDM) and Architecture for Control Networks (ANSI E1.17-2006 ACN & E1.31 Streaming ACN) standards.
   7. Institute of Electrical and Electronics Engineers, Inc. (IEEE) 802.3 and 802.11n.

1.06 SUBMITTALS

A. Bid Submittals
   1. Bill of materials: Identify parts by common industry standard numbers and descriptions.
   2. Cut Sheets: Manufacturer's catalog datasheets of all products listed in bill of materials.
   3. Statement: Manufacturer agrees to warranty provisions.
   4. Projected Timetable: List time in weeks for following activities:
      a. Shop drawing preparation
      b. Fabrication
      c. Shipping to site
      d. System commissioning
      e. As-built drawing preparation

B. Shop Drawings
   1. Format: Uniform sheet size.
   2. Binding: Bind shop drawings of more than five drawings.
   3. Shop drawings shall include:
      a. Pictorial drawings: All major components, sub-assemblies, parts list, dimensions, material and finish notes, quality assurance listings.
      b. Wiring diagrams: Components and interconnections to other components.
      c. Bill of materials: Accessories and spare parts not drawn.
      d. Not acceptable: Catalog cut sheets.
   4. Review: Fabrication shall not commence until Theatre Consultant and Architect determine that the shop drawings are in compliance with design intent of Contract Documents.
   5. Revisions: Resubmit as required.

C. Manuals
   1. Format: Letter and/or tabloid size paper.
   2. Binding: Standard 3-ring binder.
   3. Electronic Format: PDF files on USB flash drive.
   4. Manuals shall include:
      a. System description.

b. Operation instructions, including safety measures.
c. Maintenance instructions, including recommended procedures and schedules for inspecting system components.
d. Catalog cut sheets for all purchased equipment.
e. Recommended spare parts list.

D. As-Built Drawings
1. Format: Letter and/or tabloid size paper.
2. Binding: Standard 3-ring binder.
3. Electronic Format: PDF files on USB flash drive.
4. Delivery: Within one month of system acceptance.
5. As-built drawings shall include:
a. Drawings of all system components.
b. Control schematics and risers.
c. Bill of materials.

1.07 PROJECT CONDITIONS
A. Submit: Written confirmation that related electrical work, as shown on Drawings, provides necessary physical accommodations or installation and operation of equipment.
B. Delivery: Within three weeks of award of contract.

1.08 WARRANTY
A. Manufacturer shall warrant equipment as follows:
1. According to guarantee provisions in General Conditions.
2. For two years from acceptance of systems, provide services detailed below:
a. Technical and Operational Assistance Hotline: Shall be available during normal working hours, evening, and weekends at no additional cost.
b. In-stock Spare Parts: Available for major assemblies within 24 hours of contact.
1) Additional Cost: No charge during duration of warranty for exchanges not caused by misuse.
c. Warranty period: Commence upon final acceptance by Owner.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER
A. The equipment may be manufactured by the following:
1. Electronic Theatre Controls
3031 Pleasant View Road
Middleton, WI 53562
608.831.4116
2. Vari*Lite
10911 Petal St
Dallas, TX 75238
214.647.7880
B. The equipment may be supplied by one of the following:
1. Barbizon
6437-G General Green Way
Alexandria, VA 22312
703.750.3900
2. Candela Controls
15 Oweno Place
Mahwah, NJ 07430
201.529.2423

3. Century Lighting Services
   18-02 River Rd
   Fair Lawn, NJ 07410
   201.791.7000
4. M. Cramer & Associates
   229 North 12th St
   Philadelphia, PA 19107
   215.627.1225
5. Parlights
   1662 Bowmans Farm Rd
   Frederick, MD 21701
   301.698.9242
6. Starlite Productions
   9 Whittendale Drive
   Moorestown, NJ 08057
   856.780.8000

C. Furnishing: Equipment and services shall be provided by one manufacturer.
D. Experience: Manufacturer shall have been continuously engaged in production of performance lighting and control equipment for at least 20 years.
E. Emergency Support: Manufacturer shall have a toll-free, 24 hour emergency phone line. Response shall be within 30 minutes of phone call.
F. Substitutions: Substituted equal products shall not be allowed without prior approval of Architect, Electrical Engineer, Theatre Consultant, or Owner.
G. New products: Provide latest model of specified products provided latest model retains or exceeds characteristics of products specified herein. Manufacturer shall provide demonstration for Architect, Electrical Engineer, Theatre Consultant, or Owner.
H. Testing: Test and label all equipment at factory prior to shipment.

2.02 PARTS

A. All materials and equipment provided shall be new and of high quality.

2.03 GROUNDING

A. These systems shall be grounded, as shown on Drawings and in accordance with applicable codes and regulations and/or at the advice of the Manufacturer.

2.04 CIRCUIT BREAKERS

A. Conformity: All applicable codes and standards.
B. Interrupting capacity: 10,000 amperes SCCR for all primary and secondary circuit breakers unless otherwise specified.
C. Toggle Guard: Provide for branch circuit breakers in equipment rack component mounting panels, control device faceplates, and outlet device faceplates.

2.05 IDENTIFICATION LABELS

A. Provide labeling and signage for equipment as described herein and/or noted on the Drawings.
   1. Equipment designations and headings: 1/4" height.
   2. Secondary information: 3/16” height.

2.06 INTELLIGENT BREAKER PANELS

A. Basis of Design: Sensor IQ relay panel
B. General

1. Relay panel shall be dead front switch boards complete with all relays, control electronics, circuit breakers, and wiring terminations. No external components shall be required.
2. Mounting: Wall mount, surface or recessed.
3. Maximum Dimensions: 64” high x 20” wide x 5.25” deep.
4. Electrical operation: 120/208V 3 phase, 4 wire + ground.
5. Feed Size: Accept up to 400A per phase.
6. Listing and label: UL/cUL; UL508, UL67, UL924
7. Provide terminals to accept feed and branch wire sizes shown on Drawings.
8. Fault current protection rating: 65,000 SCCR.
9. Voltage Separation: Provide between high voltage and low voltage compartments.
10. Branch load circuit breakers shall be provided as required for branch load terminations.
    a. Listing and label: UL/cUL; UL489
    b. Integral mechanically held air gap relay
    c. Trip current shall not be affected by ambient temperature
    d. Rated for tungsten loads having an inrush of no less than 20 times normal current.
    e. Switching duty application rating: 100%
    f. Load rating: continuous operation at 100% load
    g. Rapid load switching: internal solenoid shall switch load when breaker at “on” position.
11. Branch circuit capacity: 48 poles, 15A to 30A one, two, and three-pole circuits as required.
12. Relay bank signage: Permanently attached to equipment with following information:
    a. Project name
    b. Manufacturer name, toll-free service phone number, and job reference number
    c. "Designed by Stages Consultants" statement with phone number and web address
13. Relay panel section signage: Permanently attached to equipment with following information:
    a. Performance venue name
    b. Equipment designation
    c. Feed size and source identification
    d. Schedule of relay numbers listing use, circuit identification, relay type, and load; load information verified to match final as-built conditions

C. Electronics
1. Control electronics shall be microprocessor based, designed specifically for control of dimming systems.
2. Backlit, graphical LCD display shall access following information:
    a. Breaker state
    b. Relay state
    c. Current draw
    d. Voltage
    e. Energy use over time
3. Rack shall accept DMX-512/1990 control signal input and one Category 5 or greater IEEE 802.3 Ethernet protocol control signals.
4. Opto-isolated contacted input shall be provided for panic system control.
5. Control modules shall directly support ANSI E1.31 sACN network protocol. Control modules that do not support these protocols shall not be accepted.
6. Control signal input of each individual dimmer rack shall be fully opto-isolated from control signal input of any other rack, and fully opto-isolated from any control signal output.

2.07 PANIC CONTROL SYSTEM

A. The panic control system shall instantly bring a programmable selection of dimmers and non-dim relays to full with the push of "Panic" button. Panic state shall be released with the push of "Normal" button.
B. The system shall always be enabled at every control location, regardless of the state of other control systems and independent of emergency power transfer relays.
C. Panic stations shall consist of the following:
    1. Each panic control location shall consist of two EAO series 61 momentary pushbutton switches with requisite switching electronics.
    2. Pushbutton momentary switches shall be illuminated, with colored lens engraved with button label.
    3. One button shall be labeled "Normal" with green lens.
    4. One button shall be labeled "Panic" with red lens and, hinged protective cover.

2.08 EMERGENCY LIGHTING TRANSFER SYSTEM

A. Basis of Design: ELTS2
B. General
    1. Emergency lighting transfer system shall be mounted in NEMA 1 type enclosure with hinged locking door.
    2. Enclosure Material: 14 gauge steel.
    3. Mounting: Wall mount, front.
    4. Maximum Dimensions (enclosure containing no more than 12 poles): 36" high x 24" wide x 9" deep.
    5. Maximum Dimensions (enclosure containing no more than 24 poles): 48" high x 30" wide x 9" deep.
    6. Electrical operation: 120/208V 3 phase, 4 wire + ground.
    7. Feed Size: Accept up to 160A per phase.
    8. Listing and label: UL/cUL
    9. Provide terminals to accept feed and branch wire sizes shown on Drawings.
    10. Fault current protection rating: 65,000 SCCR.
    11. The emergency transfer system shall monitor three phases of the normal feed. Upon loss of power to one or more phases, normal system failure, or activation of the panic condition designated branch circuits shall be transferred from dimming system to second power source.
    12. Transfer poles: Phase and neutral legs of each branch circuit load.
    13. Transfer Switch Unit: Electrically-operated and mechanically-held.
    14. Electrical operator: Single-solenoid mechanism, momentarily energized.
    15. The switch shall be positively locked and unaffected by voltage variations or momentary outages such that constant contact pressure is maintained and temperature rise at contacts is minimized.
    16. The transfer switch shall be rated to withstand the RMS symmetrical short circuit current without welding contacts.
    17. Fire alarm interface: Isolated signal input shall automatically transfer loads to available secondary power source when facility fire alarm is activated.
    18. Test Switch: Key-operated momentary switch for manual control.
C. Safety Standards: Comply with ANSI/UL1008, ANSI/NFPA 70, ANSI/NFPA 110.

2.09 EQUIPMENT RACKS

A. Basis of Design:
    1. Middle Atlantic Products WR series for pull-out frame racks
    2. Middle Atlantic Products DWR series for swing frame racks
B. General

1. Equipment rack shall be EIA compliant 19”, steel cabinet.
2. Color: Powder coat black
3. Rackrail Type: 10-32
4. Maximum Dimensions: 89” high x 24” wide x 33” deep.
5. Usable Depth: as required for specified equipment
6. Blank Filler Plates: Provide in un-used spaces. Internal space behind filler plates shall not be obstructed or used.
7. Panel Legends and Lines: Engraved and filled with engraver's enamel.
8. Provide non-combustible brackets, shelves, and other supports for heavy components and internal wiring assemblies and harnesses. Provide interior mounting angles to support work-writing tops and drawers.
9. Component Wiring: 36” long flexible cable harness to numbered barrier terminal block. Terminal block shall be attached to frames in line with associated panels and shall not interfere with adjacent components or filler panels.
10. Signage: Permanently attached to equipment with following information:
    a. Project name
    b. Performance venue name
    c. Equipment designation
    d. Feed size and source identification
    e. Manufacturer name, toll-free service phone number, and job reference number
    f. "Designed by Stages Consultants" statement with phone number and web address

2.10 HOUSE & WORK LIGHTING CONTROLS

A. Basis of Design: Unison Paradigm

B. General

1. Provide microprocessor based, solid state architectural control processor (ACP) that functions independently and in conjunction with lighting control console.
2. ACP shall be capable of controlling dimmer racks, relay panels, LED systems, automated lighting fixtures, and other device via DMX and ACN.
3. ACP functions:
    a. Station programming
    b. Macro sequencing
    c. Electronic lockout
    d. Room combine
    e. Astronomical time clock events
    f. Preset recall: 512
    g. Fade time between presets
    h. Rate of fade time modification
    i. Concurrent preset recall
        1) Multiple presets controlling the same attribute shall first interact based on priority and second based on latest takes precedence (LTP) or highest takes precedence (HTP) as configured.
        2) A preset may be designated as an HTP override and shall cause HTP values to be discarded. It shall be possible to specify that a preset or attribute will persist when overridden.
        3) When in use, the lighting control console shall override preset levels on a HTP basis. Where there are multiple external sources then priority and HTP shall be used to perform arbitration.
    j. Record presets from lighting control console or other control sources on lighting system
4. Communication protocols:

a. DMX-512/1990
b. ANSI E1.31 (sACN)
c. ANSI E1.17 (ACN)
d. EIA-232 serial
e. Dry contact closure input and output
f. Network Time Protocol

5. Control channel capacity: 1,024 parameters

C. Master Stations

1. Master stations shall consist of backlit LED display
   a. Minimum viewable display size: 7” WVGA
   b. Minimum resolution: 800x480
   c. Bezel: Aluminum
   d. Touch interface: Capacitive with LED backlight
   e. Viewing angle: 178° horizontal and vertical
   f. Finish: Shown on drawings
   g. Provide metal backbox and mounting frames
2. Connect to control system using category 5e or better wire.
3. Master stations shall provide control of lighting processor presets, sequences, fade times, macros, timeclock events, and interfaced external systems.
4. Master stations shall operate using graphic buttons, faders, and other images on programmable control pages. There shall at least 30 custom control pages available.
5. Graphic controls shall represent the active state of all presets, zones, and devices. Status indication shall be tracked across all stations in real-time, including tracking of fades on graphical fader controls.
6. Stations shall allow programming of multiple-level passcodes, page lockout, and visibility.
7. Control pages shall include:
   a. House light presets (House Full, House Half, House Preset, House Out, Cleaning); work light presets (Pre-Show, Show, Post-Show, Rehearsal, Work, Off); system wide presets (Blackout, Night)
   b. Performance lighting presets with snapshot record function
   c. House light zone faders and House light master fader
   d. Work light, run light, and non-dim zone control buttons
   e. Lockout function to disable other stations and remote switches
   f. Setup display for administrative functions
8. Page layout and interface functionality shall be determined by the Theatre Consultant following approval of shop drawings. Programming services shall be provided by the Manufacturer.

D. Entry Stations

1. Entry stations shall consist of programmable momentary pushbutton switches.
   a. Pushbuttons: EAO series 61
   b. Mounting panel: 1/8” (3mm) T-5 aluminum
   c. Finish: Shown on drawings
   d. Provide flush or surface backbox
2. Momentary push button switches shall be illuminated, with colored lens as noted on the Drawings.
3. Entry Stations shall provide control of a single channel or presets as required.
4. Electronics shall consist of an interface board connected to the control system using Manufacturer’s recommended wire type, network topology, and communication protocols.

E. Keyswitch Stations

1. Keyswitch stations shall consist of programmable momentary switches.
    a. Key switch: EAO series 51
    b. Pushbuttons: Manufacturer's standard
    c. Finish: Shown on drawings
    d. Provide flush or surface backbox
2. Keyswitch shall unlock tour and cleaning pushbuttons for a period of one hour.
3. Tour pushbutton shall energize a user programmable preset of house light zones.
4. Cleaning pushbutton shall energize a user programmable preset of house and work light zones.
5. Keyswitch Station shall connect to the control system using Manufacturer's recommended wire type, network topology, and communication protocols.

2.11 LIGHTING CONTROL CONSOLE

A. Basis of Design: Element 2 – 6k

B. General

1. Lighting control console shall be a microprocessor-based system specifically designed to provide complete control of performance lighting systems.
    a. External multi-touch screen capability
    b. Remote video support
    c. Lighting network device control
        1) Direct control of third party sACN/ACN devices
        2) DMX512 / RDM hardware interfaces
        3) Support MIDI, SMPTE and RS-232 interfaces
2. User interface shall be fully graphical with command line. Control commands shall be accepted as either command line or direct entry.
3. The main control shall consist of numeric keypad, dedicated control keys, context sensitive soft keys, level control wheel, and pointing device.
4. A blind display mode shall allow viewing and modification of all recordable attributes without affecting live stage levels.
5. A patch display mode shall be used to display and modify system control channels with their associated data.
6. Control and programming features for automated fixtures shall include a standard library of fixture profiles; ability to copy and edit existing profiles and create new profiles; and patch displays including channel and output addressing, 16-bit fade resolution, color characterization allowing color mixing and storing in hue and saturation or native device values.
7. Control channel data shall be recordable as cues, groups, submasters, palettes, effects, macros, curves, and patch contained in non-volatile electronic memory and stored as show data to internal storage or USB storage device.
8. Simultaneous playback of recorded cue lists shall be possible on up to 200 faders.
9. The console shall be capable of being placed in Tracking or Cue Only record mode by the user.
10. Integrated, integral virtual media server shall allow mappable images and animations to rig array. System shall be capable of 40 maps, 12 layers each.
11. User definable, interactive magic sheet displays shall allow graphical layout of channels, desk functions, and programming tools in live and blind operating modes. Provide standard symbol library and user-import tool for custom graphics.
12. A freely available offline editing application shall be provided for creation and modification of show data on a personal computer.

13. A personal computer running client software application shall be able to connect to a control system via the network and view current show data in a mirrored display environment.
14. The system shall allow remote control from a wireless handheld remote.
15. The system shall support configuration and operation of two consoles or a console and a dedicated processor as a main and fully tracking backup.

C. Provide the following control consoles:
1. Venue 1: ETC Element 2 with 6,144 outputs

D. Provide with the console (2) external 22" or larger multi-touch monitors, keyboard, mouse, and task lights.

E. Furnish the following console accessories:
1. Vinyl dust covers for the consoles and monitors. Dust covers shall cover top, sides, front and rear surfaces of equipment.
2. Cables for control console and remote video interface
   a. 10'-0" power: 1
   b. 25'-0" power: 1
   c. 10'-0" Ethernet: 1
   d. 25'-0" Ethernet: 1
3. Surge protected power strips for console and accessories: 1
4. Portable uninterruptible power supply, APC Smart-UPS 750VA: 1
5. 8 GB capacity USB storage keys: 2

2.12 PERFORMANCE LIGHTING SYSTEM ETHERNET NETWORK

A. Provide a fully functioning Ethernet system. Systems using proprietary formats or protocols other than TCP/IP shall not be accepted.

B. Network Components
1. Provide IEEE 802.3at 10/100/1000 L3 switches in quantities and locations shown in the Drawings and described herein.
   a. Switches shall contain auto-sensing ports supporting 10Base-T, 100Base-T, and 1000Base-T. Switches shall support IEEE 802.3ab Type 1000Base-T standard.
   b. Switches shall be rack mounted in standard 19" racks.
   c. Switches shall have UTP ports on the front face for connection to other network devices via standard 19" patch panels.
   d. Switches shall have high mean time between failure (MTBF) value as comparatively analyzed with industry standard 802.3at products.
   e. Provide ports or media converter modules as required for UTP to Fiber-Optic conversion.
   f. Provide switches in quantities and configurations having sufficient UTP ports for simultaneous connection of all patch bay ports assigned to performance lighting network devices.
   g. Acceptable manufacturer shall be Cisco Systems or approved equal.
2. Provide Category 6a or better patch bays as required for termination of network cabling.
   a. Patch bays shall be rack mounted in standard 19" racks.
   b. Provide Category 6a or better patch cords as required for connection between the patch bays, switches, and other network devices.
   c. Provide rack mounted standard 19" cable management systems for each patch panel.
   d. Acceptable manufacturer shall be Hubbell or approval equal.
3. Provide Network Services Gateway in quantities and types as shown on Drawings.
   a. Gateway shall support the following protocols:
      1) Dynamic Host Control Protocol (DHCP) for automatic assignment of IP address

2) Dynamic Name Service (DNS)
3) Simple Network Time Protocol (sNTP) for automatic time assignment and synchronization
4) File Transfer Protocol (FTP) for configuration storage and backup
5) Windows File Sharing (SMB) for configuration and file storage and backup

b. Gateway shall support real-time logging and notifications of system errors.
1) Logging shall utilize a standard Syslog database.
2) Notifications shall be provided via email messages.

c. Gateway shall support storage of performance lighting system and system device configurations.

4. Provide DMX Gateways in quantities and types as shown on Drawings.
a. Gateways shall be intelligent Ethernet devices providing DMX & RDM data distribution over Ethernet data network. Nodes shall be connected using Category 6a or better wire, and powered via Ethernet connection using Power Over Ethernet (IEEE 802.3af). Ethernet connection receptacle shall be Neutrik Ethercon D-Series CAT5e receptacle.
b. Gateways shall directly support ANSI E1.31 (sACN) and ANSI E1.17 (ACN) network protocols. Gateways that do not support these protocols shall not be accepted.
c. There shall be as standard DMX512 5-pin XLR connectors on the front panel, or as shown on the drawings. It shall be possible to factory configure the connectors to be male or female to meet project requirements.
d. Gateways shall be remotely configured via network system wiring using manufacturer's software, control console interface, or standard Web Browser. Specific DMX channels input or output by Node shall be freely configurable by user. Configuration of Node shall be stored in non-volatile memory.
e. Portable nodes shall be provided with appropriate mounting hardware for 1.9" (48mm) O.D. pipe as shown on Drawings.

2.13 PERFORMANCE LIGHTING CONTROL DEVICE FACEPLATES

A. Faceplate: 1/8" (3mm) aluminum component mounting panel.
B. Surface back boxes: Supplied by performance lighting manufacturer
C. Floor boxes: As shown on drawings
D. Color: Powder coat black, or as shown on drawings
E. Legends: Engraved in component mounting panel and filled with engraver's enamel of contrasting color. Legends in black panels shall be white.
F. Components: As shown on drawings
G. DMX receptacles: Neutrik B-Series XLR receptacles.
H. Ethernet receptacles: Neutrik Ethercon CAT6a receptacles. Provide Neutrik HX-CAT6A parallel press tool for cable terminations.
I. Low voltage barrier: Install between control and power receptacles
J. Mounting hardware: Coordinate device mounting requirements as noted on drawings and per field conditions.

2.14 PERFORMANCE LIGHTING OUTLET DEVICES

A. Faceplate: 1/8" (3mm) aluminum component mounting panel.
B. Surface Back boxes: Supplied by performance lighting manufacturer
C. Floor boxes: As shown on drawings
D. Connector strips: As shown on drawings
E. Color: Powder coat black, or as shown on drawings

F. Legends: Engraved in component mounting panel and filled with engraver's enamel of contrasting color. Legends in black panels shall be white.
G. Components: As shown on drawings
    1. Flush receptacles: Individually mounted, readily replaceable, and installed off-center to allow space for circuit identification labels.
    2. Pigtail receptacles: Suitable strain relief grips for SOOW cables that engages cable's outer jacket.
    3. Pigtail length: 18" (0.5M) or as shown on drawings.
H. Terminals: Provide numbered screw terminals on barrier terminal blocks for field connections within each device. Devices shall be internally wired by Manufacturer.
I. Mounting hardware: Coordinate device mounting requirements as noted on drawings and per field conditions.

2.15 SPARE PARTS
A. Furnish 10% spare parts for all perishable items such as pilot light lamps and fuses.
B. Furnish 2% spare parts for all low voltage and line voltage connectors, minimum of 2 per type.
C. Furnish the following additional spare parts:
    1. (2) Spare dimmer and relay modules of each type listed in the Drawings
    2. (1) Spare dimmer rack control electronics module
    3. (1) Manufacturer's Lighting Control Console spare parts package

PART 3 EXECUTION

3.01 SUPERVISION OF INSTALLATION
A. Manufacturer shall provide instruction and supervision to the Division 26 Contractor as it pertains to the installation of these systems. Provide the necessary personnel for coordination meetings and site visits as requested by the Division 26 Contractor.

3.02 COMMISSIONING
A. Manufacturer shall provide the services of a qualified on-site engineering representative who shall perform the following:
    1. Supervise and instruct equipment installer in all Manufacturer's requirements and specifications.
    2. Prior to system energization, inspect the finished installation and confirm that the installation conforms to manufacturer's requirements and specifications. Supervise correction of any deficiencies and retest deficient items.
    3. Manufacturer's engineering representative shall be present during energization of the system.
    4. In conjunction with the equipment installer, measure and adjust the full dimmer output voltage at each performance lighting receptacle. Typical voltage shall be uniform at each receptacle regardless of branch wiring length. Specific voltage requirements shall be determined by the Theatre Consultant or Electrical Engineer.
    5. Verify operation of all control devices and network wiring.
    6. Configure all hardware and software to a "show ready" state, including:
        a. Network device addressing
        b. Ethernet switches configured for industry standard control protocols
        c. Dimmer and relay patch, dimmer curves, dimmer output voltage, control priority and similar variables
        d. Panic preset and fade time
        e. House light control zones, presets, sequences, fade times, macros, timeclock events, and interfaced external systems

f. Lighting control console patched 1 to 1 for all control channels in system
g. Console accessories such as remote video, tracking backup, and hand-held remote configured to operate with main lighting control console
h. DMX node/gateway patch, priority, and soft labeling
i. Lighting system computer software

B. Provide to the Architect and Theatre Consultant a written report confirming that the system has been properly installed and successfully energized within fourteen (14) days of energization.

3.03 DEMONSTRATION AND ACCEPTANCE

A. The Architect and Theatre Consultant (or their representatives) shall witness a full demonstration by the Manufacturer of each feature of each piece of equipment in the system. Comply with the following conditions:
   1. The Manufacturer shall provide all necessary personnel and equipment, including lifts and ladders, to demonstrate fully the system's compliance to the specifications.
   2. Contractor's project representative shall be present during testing as required.
   3. Full and uninterrupted access to all areas shall be provided as necessary for complete testing and demonstration.
   4. All loose equipment provided under this Section shall be on site and available for testing.
   5. All architectural lighting fixtures circuited to the dimming system shall be installed and lamped.

B. Subject to satisfactory on-site demonstration, the Owner's representative shall accept the equipment on behalf of the Owner.

C. Should the demonstration prove unsatisfactory, the Theatre Consultant and the Architect shall inform the Manufacturer in writing, and the Manufacturer shall rectify the problems. Problems shall be rectified in the shortest time possible. During this period of remedial work, the Owner shall have beneficial use of the equipment. The Warranty period shall commence upon final acceptance by the Owner.

3.04 TRAINING

A. Provide a factory field service representative to offer instruction to the owner's staff in the proper operation and maintenance of the systems and software for at least 2 full days at a date and time convenient to the Owner.

END OF SECTION

SECTION 26 09 63
PERFORMANCE LIGHTING SYSTEMS INSTALLATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work of this Section includes all labor, materials, equipment and services necessary to install the electrical work associated with the Performance Lighting Systems, as described in Section 260961 and shown on the Drawings.

B. Related sections include the following:

1. Performance Lighting Systems
2. Common Work Results for Electrical
3. Architectural Lighting Fixtures
4. Rigging Systems and Controls

1.03 QUALITY ASSURANCE AND STANDARDS

A. References to code, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies will refer to the latest edition of such publications adopted and published prior to submittal of the bid. All such codes and standards will be considered a part of this specification as if they were fully included herein.

B. Work and materials shall comply with the rules and recommendations of:

1. Prevailing national, state and local building codes.
2. UL, ETL, cUL, CSA and CE Labels – where materials and equipment are available under the continuing inspection and labeling service of applicable independent product testing and certification services, provide such labels, materials, and equipment.
3. National Fire Protection Associate (NFPA) Publication: National Electrical Code, NFPA70 as applicable to installation and construction of performance lighting and control equipment.
4. NEMA Compliance pertaining to components of performance lighting equipment.
5. United States Institute for Theatre Technology, Inc. (USITT) DMX512/1990 (ANSI E1.11-2004).
6. ANSI/PLASA Remote Device Management (ANSI/PLASA E1.20 RDM) and Architecture for Control Networks (ANSI E1.17-2006, E1.31) standards.
7. Institute of Electrical and Electronics Engineers, Inc. (IEEE) 802.3af and 802.11n.

1.04 CERTIFICATIONS

A. The Contractor shall submit (as part of the Owner's Manual) certificates from the manufacturer stating that the installed system is operating properly and complies with the manufacturer's recommendations. This information shall be incorporated in the Owner's Manual, as described in 260961

B. The Contractor shall submit a certificate that the Ethernet system has been tested and complies with all IEEE 802.3, ISO/IEC 8802-3 and PLASA standards. This information shall be incorporated as an appendix to the Owner's Manual, as described in Theatrical Lighting Controls.

1.05 WARRANTY

A. In addition to the performance lighting controls manufacturer's warranty, provide warranty of the systems and equipment to be free of faulty workmanship or improper adjustment for a period of one year from the date of Owner's acceptance.
B. Replace items showing evidence of defective materials or workmanship within thirty days after notification. Make repairs without any cost to the Owner.
C. Resolve any conditions that might present a serious hazard to human life within 24 hours of notification by Owner.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials as specified under Division 26.

PART 3 EXECUTION

3.01 PROTECTION OF EQUIPMENT

A. Protect the equipment in this and Related Sections from damage and deterioration during all phases of the work, from the time of manufacture to the acceptance of the completed installation.
B. The Performance Lighting Systems equipment furnished under Section 260961 will become responsibility of the installer until Owner's final acceptance.

3.02 INSTALLATION

A. Install Performance Lighting Controls system as located on the drawings. Installation shall be in accordance with manufacturer's written instructions, recognized industry practice, and applicable requirements of the National Electrical Code and UL standards.
B. All load circuit conductors and data wiring for these systems shall be installed in metallic conduit, metal wireways, surface metal raceways, or other approved cable containment. Use of metal-sheathed or armored cable shall not be accepted without prior approval.
C. Voltage separation shall be maintained between line voltage, low voltage and data wiring.
D. All load circuit conductors shall be continuous from the dimmer room to the outlet devices or architectural fixture.
E. All dimmer rack load circuits must have individual neutral conductors. Neutral conductors must be routed directly adjacent to the live conductors of each circuit.
F. All data wiring shall be continuous from termination point to termination point; no splices or inline connectors shall be allowed.
G. Field terminations in these systems shall be as follows:
    1. Main feed wires shall terminate in pressure lugs on buss bars.
    2. Branch load wires shall terminate on screw terminals on barrier terminal blocks, circuit breakers and switches.
    3. Control wires shall terminate on screw terminals on barrier terminal blocks and switches, or as noted.
    4. Ethernet cables shall be installed and tested in compliance with all IEEE 802.3.ISO/IEC 8802-3 and ETSA standards.
H. Wire nuts and field soldered connections, except where noted, are not acceptable in these systems.
I. These systems shall be grounded, as shown on drawings and in accordance with applicable codes and regulations and/or at the advice of the Manufacturer.
J. Network Cabling

1. Performance Lighting System data cabling shown in Drawings to convey design intent only. Final quantities, types, and topologies shall be per the Manufacturer's approved shop drawings.
2. Provide Fiber Optic Cable as required for all runs greater than 90 meters (300') or as specifically shown in the Drawings.
    a. Confirm all cable routing distances to determine appropriate use of fiber runs.
    b. Cable shall be 62.5/125µm fiber optic cable as required to support network components.
    c. Cable shall exceed the IEEE802.3z Gigabit Ethernet Fiber specification for 62.5/125µm fiber.
    d. Cable shall exceed the TIA/EIA 568B Fiber specification.
3. Provide UTP Cable as required for all runs under 90 meters (300') unless specifically shown as Fiber Optic Cable in the Drawings.
    a. Copper cabling and connecting hardware shall fully comply with TIA/EIA 568B standards and with the standard installation of Category 6 products.

3.03 COMMISSIONING

A. Prior to energization of the system, perform the following tests and inspections following the instructions of the equipment Manufacturer's on-site engineering representative. Correct deficiencies and retest deficient items.
    1. Inspect each outlet, faceplate, device and loose equipment for defects, finish failure, corrosion, physical damage, correct labeling, and nameplate.
    2. Perform operational tests on mechanical parts and operable devices according to manufacturer's instructions or routine functional operation.
    3. Check tightness of electrical connections with torque wrench calibrated within the previous six (6) months using Manufacturer's recommended torque values.
    4. Perform continuity testing of each branch load circuit receptacle, determining correct polarity of wiring and correspondence between circuit numbers and labeling. Continuity Test Report shall be available upon request. Any problem(s), i.e. open circuit, short circuit, wrong termination, etc. shall be rectified in a timely manner and re-tested.
    5. Test and certify Ethernet network for compliance with all IEEE 802.3, ISO/IEC 8802-3 and ANSI/PLASA standards. Network Compliance Test Report shall be available upon request. Any problem(s), i.e. cable length exceeding standards, open circuit, short circuit, wrong termination, etc. shall be rectified in a timely manner and re-tested. Submit final test report data and letter of certification for inclusion as an appendix to the Manufacturer's Instruction and Maintenance Manual.
B. Energization of the system shall only commence following written approval of the Manufacturer, and shall take place in the presence of the Manufacturer's on-site engineering representative.
C. In conjunction with the Manufacturer's engineering representative, measure and adjust the full dimmer output voltage at each performance lighting receptacle. Typical voltage shall be uniform at each receptacle regardless of branch wiring length. Specific voltage requirements shall be determined by the Theatre Consultant or Electrical Engineer.

3.04 DEMONSTRATION AND ACCEPTANCE

A. The Architect and its representative shall witness a full demonstration of each feature of each piece of equipment in the system.
    1. Contractor shall provide all necessary personnel and equipment to demonstrate fully the system's compliance to the specifications.
    2. Contractor's project representative shall be present during testing as required.

3. Full and uninterrupted access to all areas shall be provided as necessary for complete testing and demonstration.
4. All loose equipment provided under this and Related Sections shall be on site and available for testing.
5. All architectural lighting fixtures circuited to the dimming system shall be installed and lamped.

B. Subject to the on-site demonstration being satisfactory, the owner's representative shall accept the equipment on behalf of the Owner.

C. Should the demonstration prove unsatisfactory, the Theatre Consultant and the Architect will inform the Contractor in writing, and the Contractor shall rectify the problems. Problems should be rectified in the shortest time possible. During this period of remedial work, the Owner shall have beneficial use of the equipment. The Warranty period shall commence upon final acceptance by the Owner.

END OF SECTION

SECTION 26 09 73
AUDIO VIDEO SYSTEMS INSTALLATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work of this Section includes all labor, materials, equipment and services necessary to install the following electrical work associated with the Audio / Video Systems, as described in Section 274117 and shown on the Drawings:
   1. A complete, pull-ready conduit system for installation of Audio / Video Systems wiring and devices, including, but not limited to:
      a. Conduit and raceways.
      b. Junction/pull boxes.
      c. Standard back boxes.
      d. Rack room terminal cabinets and “pull group” boxes.
      e. Fittings.
      f. Drag line (pull line)
      g. Electrical hardware, etc.
   2. Installation of nonstandard back boxes for Audio / Video Systems devices provided under Division 27 (to be concurrent with other electrical work).
   3. Electrical power service—including transformers, feeder cable, distribution panels, branch circuit panel-boards, and individual wall receptacles.
   4. Audio / Video Systems “sound system” isolated ground AC power network.
      a. Inter-rack AC power wiring, shall be the responsibility of Division 27. Single-point termination to the racks shall be conducted on-site by Division 26.

B. Electrical service for the above work is shown on the E-series drawings

C. The AV-series Contract Drawings provide block diagrams and equipment locations. The final design of the control systems is the responsibility of the respective Contractors, who will supervise the Electrical Contractor’s work.

END OF SECTION

DIVISION 26 SECTION 26 11 20
UTILITY-INCOMING SERVICE PROVISIONS
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 DESCRIPTION OF WORK 3
1.3 RELATED WORK SPECIFIED ELSEWHERE IN DIVISION 26 3
1.4 UTILITY COMPANY COORDINATION 3
1.5 SUBMITTALS 4
1.6 QUALITY ASSURANCE 4

PART 2 - PRODUCTS 5

2.1 ELECTRIC UTILITY COMPANY PROVISIONS 5
2.2 TYPICAL INCOMING SERVICE PROVISIONS 5

PART 3 - EXECUTION 6

3.1 INSTALLATION 6
3.2 UTILITY COMPANY ELECTRIC-METERING EQUIPMENT 6
3.3 PREPARATION 6
END OF SECTION 6

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SECTION 26 11 20
UTILITY INCOMING SERVICE PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the General Requirements, apply to the work specified in this Section.

B. Division 26 Section 260500, *Common Work Results for Electrical* sections apply to work of this section.

1.2 DESCRIPTION OF WORK

A. The Contractor shall provide all materials and labor required by the utility for service provisions.

1.3 RELATED WORK SPECIFIED ELSEWHERE IN DIVISION 26

A. Section 260500 *Common Work Results for Electrical*.

B. Section 260573 *Short Circuit Analysis, Coordination Study, and Arc Flash Hazard Analysis.*

C. Section 260533 *Raceways and Boxes*.

D. Section 262726 *Wiring Devices*.

E. Section 260543 *Underground Ductbanks*.

F. Section 260526 *Grounding and Bonding*.

1.4 UTILITY COMPANY COORDINATION

A. Contact *Miss Utility* (1-800-257-7777) prior to any excavation or underground work. The Contractor shall verify the location and depth of all utilities. Provide test pits to verify location and depth of all existing utilities crossing new incoming services.

B. Contact serving utility companies immediately upon award of Contract. Do not install related equipment until fully coordinated with appropriate utilities.

C. Provide all Construction Schedules, dates of requested services, outage windows, equipment locations, etc., necessary for utility work.

D. The Contractor shall ascertain, from the utility companies, the exact amount of work required in connection of the utilities. Work required which is not provided by the utility companies shall be provided by the Contractor.

E. Provide and coordinate all temporary services with utility companies.

F. The Contractor shall coordinate the required separation distances for all utilities.

G. The Contractor shall obtain all permits and permissions required.

1.5 SUBMITTALS

A. Certificate of Compliance: Contractor shall submit a documentation certifying that work complies with all utility company requirements including the following:

1. Construction Standards of each Utility Company.

2. Trench and cover Depth.

3. Spacing and Support of Utilities.

4. Installation of underground marking tape.

5. Pull cords and Mandrels.

B. Photographs: Contractor shall submit photographs of each utility installation at each of the above described levels of completion and attach photographs to Certificate of Compliance for verification. Submit a minimum of six (6) color 4-inch x 6-inch photographs for each utility service.

C. Submit Certificate of Compliance and photograph**s** to each utility company for verification and approval.

D. Include Certificate of Compliance**,** photographs, and utility company approvals in O&M Manual.

E. The Contractor shall provide and submit all required documentation to each utility company, including service application, site plan and coordination drawings.

1.6 QUALITY ASSURANCE

A. Comply with the requirements of Delmarva Power Electric Service Manual.

B. Comply with the requirements of NFPA 70, National Electrical Code.

C. Comply with the NECA Standard of Installation.

D. Comply with NFPA 70E, National Electrical Safety Code.

E. Contractor shall have experience with not less than 5 comparable projects for which the Contractor completed service provisions with each utility. Contractor shall be familiar with all current utility requirements and guidelines.

F. Obtain utility company inspector's approval for all work.

PART 2 - PRODUCTS

2.1 ELECTRIC UTILITY COMPANY PROVISIONS

A. The electric utility company is Delmarva Power.

B. Coordinate service entrance equipment and layout with power company prior to ordering or installing any service entrance equipment.

C. Furnish and install all incoming raceway.

D. Coordinate cable, conduit, lug sizes, etc., for proper interface between utility-owned/installed equipment and Contractor-installed equipment.

E. Provide grounding and clearances as required by the Utility.

F. Contact and coordinate service entrance equipment and layout with local power company prior to ordering or installing any service entrance equipment. Contractor shall furnish and install all incoming raceway and service entrance cables. If the power company plans to install cable and/or conduit, the Contractor is responsible for proper coordination of cable, conduit, lug sizes, etc., for proper interface between utility-owned/installed equipment and Contractor-installed equipment.

G. The Contractor shall ascertain from the utility companies, the available short circuit fault current.

H. Equipment for Utility Company's Electric Metering:

1. Comply with requirements of Delmarva Power.

2.2 TYPICAL INCOMING SERVICE PROVISIONS

A. Pull Wire: ¼-inch nylon pull cord with 500 lb. minimum tensile strength in each conduit.

B. Conduit, Elbows, and Couplings: UL Schedule 40, EB-35, DB-60, DB-120, or ANSI/ASTM F-512 as required by utility for the specific application.

C. Spacers: Every 4 feet of conduit.

D. Splice Boxes: Purchase from utility company. Provide as required.

E. Manholes: Purchase from utility company. Provide as required.

F. Underground Marking: Provide detectable warning tape over all conduits. Warning tape shall be as specified in Division 26 Section “Electrical Identification”.

G. Bends: Minimum 5 foot radius (horizontal) and 36-inch radius (vertical), unless otherwise noted.

H. Concrete for encasement: As specified in Division 26 Section, *Underground Ductbanks*.

I. Backfill: Virgin soil/select backfill only. Backfill shall be stone dust, rock-free earth, or top soil with no stones larger than 1-1/2-inches in diameter permitted.

J. Miscellaneous Materials: Provide bushings, bell ends, conduit plugs and other miscellaneous materials as required by utility companies.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mandrel: Contractor shall pull a mandrel (1/2-inch smaller in diameter than the conduit, and six inches long) through each conduit.

B. Pull Wires: Pull wires shall be left in all conduits, after mandrel pull.

C. Coordination: Coordinate location of telephone and CATV wall spaces, raceways, and boxes, as necessary, to interface installation of telephone and CATV systems with other work.

D. Bushings: Provide conduit bushing at each end of all conduits.

E. Bell Ends & Plugs: Provide Bell ends and plugs for each conduit.

F. Sealing Conduits: Provide duct sealant in each conduit after utility cable is installed.

3.2 UTILITY COMPANY ELECTRIC-METERING EQUIPMENT

A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company. Provide lugs as required by utility.

3.3 PREPARATION

A. Contractor shall provide conduits at all street or road crossings for all utility facilities.

B. Provide a level area at final grade for all utility equipment locations.

C. Coordinate utility line separation requirements between electric, water, sewer, gas, telephone and CATV.

D. Contractor shall clear area for all utility cables of rubble, debris, stumps, and other obstructions.

END OF SECTION

DIVISION 26 SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 SUBMITTALS 3
1.4 QUALITY ASSURANCE 4
1.5 DELIVERY, STORAGE, AND HANDLING 4
1.6 COORDINATION 5

PART 2 - PRODUCTS 5

2.1 MANUFACTURERS 5
2.2 GENERAL TRANSFORMER REQUIREMENTS 5
2.3 DISTRIBUTION TRANSFORMERS 5
2.4 BUCK-BOOST TRANSFORMERS 7
2.5 CONTROL AND SIGNAL TRANSFORMERS 7
2.6 IDENTIFICATION DEVICES 7
2.7 SOURCE QUALITY CONTROL 7

PART 3 - EXECUTION 7

3.1 EXAMINATION 7
3.2 INSTALLATION 8
3.3 CONNECTIONS 8
3.4 FIELD QUALITY CONTROL 8
3.5 ADJUSTING 9
3.6 CLEANING 10
END OF SECTION 10

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SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

2. Buck-boost transformers.

3. Control power transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Seismic Qualification Data: Certificates, for transformers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

4. Certification: Indicate that equipment meets Project seismic requirements.

D. Qualification Data: For Testing Agency.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Manufacturers: Square D Co./Group Schneider NA; Schneider Electric. Subject to compliance with requirements, provide products by one of the following:

1. Powersmiths.
2. Siemens Energy & Automation, Inc.
3. ABB-GE Electrification Equipment.
4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.

2. Coil Material: Aluminum or Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

E. Taps for Transformers Smaller Than 3 kVA: None.

F. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

I. Energy Efficiency: All transformers shall meet or exceed Department of Energy (DOE)) 2016 efficiency requirements per 110 C.F.R. &421/196 (2015).

J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to K-factor of 13.

2. Indicate value of K-factor on transformer nameplate

K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.

2. Include special terminal for grounding the shield.

3. Shield Effectiveness:

a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

L. Wall Brackets: Manufacturer's standard brackets.

M. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 BUCK-BOOST TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.

B. Enclosure: Ventilated, NEMA 250, Type 2.

1. Finish Color: Gray.

2.5 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. Description: Self-cooled, 2 windings.

2.6 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

C. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:

1. Visual and Mechanical Inspection.

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that any shipping brackets have been removed.
d. Verify the unit is clean.
e. Perform specific inspections and mechanical tests recommended by manufacturer.
f. Verify that as-left tap connections are as specified.
g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Measure resistance at each winding, tap, and bolted connection.
b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

DIVISION 26 SECTON 26 24 13
SWITCHBOARDS
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 ACTION SUBMITTALS 3
1.4 INFORMATIONAL SUBMITTALS 4
1.5 CLOSEOUT SUBMITTALS 4
1.6 MAINTENANCE MATERIAL SUBMITTALS 5
1.7 QUALITY ASSURANCE 5
1.8 DELIVERY, STORAGE, AND HANDLING 6
1.9 PROJECT CONDITIONS 6
1.10 COORDINATION 6
1.11 WARRANTY 7

PART 2 - PRODUCTS 7

2.1 MANUFACTURED UNITS 7
2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES 8
2.3 INSTRUMENTATION 10
2.4 CONTROL POWER 11
2.5 ACCESSORY COMPONENTS AND FEATURES 11
2.6 IDENTIFICATION 12

PART 3 - EXECUTION 12

3.1 EXAMINATION 12
3.2 INSTALLATION 12
3.3 IDENTIFICATION 13
3.4 FIELD QUALITY CONTROL 13
3.5 ADJUSTING 14
3.6 STARTUP SERVICES FOR MONITORING 14
3.7 PROTECTION 14
3.8 DEMONSTRATION 14
END OF SECTION 14

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SECTION 26 24 13
SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.

2. Disconnecting and overcurrent protective devices.

3. Instrumentation.

4. Control power.

5. Accessory components and features.

6. Identification.

B. Related Requirements:

1. Section 26 4343 "Surge Protection for Low Voltage Electrical Power Circuits."

2. Division 23 Section 23 0900 "Instrumentation and Controls of HVAC and Plumbing Systems" for interface between electricity meters and building automation system

1.3 ACTION SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.

2. Detail enclosure types for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.

4. Detail short-circuit current rating of switchboards and overcurrent protective devices.

5. Detail utility company's metering provisions with indication of approval by utility company.

6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

7. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

8. Include schematic and wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and testing agency.

B. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field Quality-Control Reports:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

3. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.9 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet (2000 m).

C. Dimensional Limitations:

1. The switchboard dimensions shall be 78” wide, 24” deep or smaller. Larger units will not be accepted. The utility C/T section shall be configured for a side entry near the bottom due to the configuration of the existing secondary ductbank.

1.10 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace circuit breakers that fail in materials or workmanship within five years from date of Substantial Completion, and all remaining components for two years from Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

B. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.

2. Branch Devices: Panel mounted.

3. Sections front and rear aligned.

C. Nominal System Voltage: As indicated on the Drawings.

D. Main-Bus Continuous: As indicated on the Drawings.

E. Indoor Enclosures: Steel, NEMA 250, Type 1.

F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

G. Customer Metering Compartment: Provide PowerLogic power meters (or equal). A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Provide for service entrance switchboard only.

H. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

I. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated,with tin-plated copper feeder circuit-breaker line connections.

2. Ground Bus: 1/4-by-2-inch- (6-by-50-mm), hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
3. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
4. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

J. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 100A through 225 A, field adjustable short time and continuous current settings for circuit-breaker frame sizes 250A through 400A.

2. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings for circuit breaker frame sizes 600A and larger:

   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.

3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
   c. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 26 0913 "Electricity Metering."
   d. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current. Provide for main circuit breaker(s) and where noted on the drawings.

1. Fixed circuit-breaker mounting.

2. Two-step, stored-energy closing.

3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

   a. Instantaneous trip.
   b. Long- and short-time time adjustments.
   c. Ground-fault pickup level, time delay, and I^2t response.

4. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

5. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

6. Accessories:

   a. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
   b. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
   c. Auxiliary Contacts: Two SPDT switches with “a” and “b” contacts; “a” contacts mimic circuit-breaker contacts, “b” contacts operate in reverse of circuit-breaker contacts.
   d. Phase loss protection. Provide Taylor Phase-Guard Model P phase failure relay with adjustable pick-up, adjustable time delay output undervoltage phase failure protection to include autopower shunt trip with self-contained battery assisted capacitor trip, for feeder breakers indicated on the drawings. The shunt trip device shall be fully operable and capable of tripping the circuit breaker off the line during electrical fault conditions, regardless of the available level of prevailing electric power system voltage. This particular voltage protective feature is not to trip on a clean 3 phase power break. The phase-guard relay shall reset automatically after a fault has occurred, immediately when normal voltage conditions are restored.

7. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
8. Control Voltage: 120-V ac.

C. Fuses are specified in Section 26 2813 "Fuses."

D. Provide an energy-reducing maintenance switch with local status indicator for all circuit breakers rated, or which can be adjusted to, 1200A and higher.

E. Provide ground fault protection for all circuit breakers rated 1200A and higher.

2.3 INSTRUMENTATION

A. Instrumentation Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type wit integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.

2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; would type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.

3. Control-Power Transformers: Dry type, mounted in separate compartments for unit larger than 3 kVA.

B. Multifunction Digital-Metering Monitor (provide for switchboard mains, and for feeders where indicated on the drawings): Microprocessor-based unit suitable for three- or four-wire systems. Provide Square D PowerLogic PM5000 series power meter (or approved equal) with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Current, each Phase and Neutral: Plus or minus 0.075 percent.
b. Current demand (present, peak, predicted): Plus or minus 0.075 percent.
c. Voltages (line-line, line-netural), per phase, min/max, unbalance: Plus or minus 0.075 percent.
d. Power: per-phase, total: Plus or minus 0.15 percent.
e. Power demand (present, peak, predicted): Plus or minus 0.15 percent.
f. Energy (real, reactive, apparent, in/out): ANSI 12.20 Class 0.2 and IEC 62053-22 Class 0.5S (real energy) and IEC 62053-23 Class 2 (reactive).
g. Power Factor (true and displacement, per phase, total, min/max): Plus or minus 0.2 percent from 0.5 leading to 0.5 lagging.
h. Frequency (present, min/max): Plus or minus 0.01 Hz.
i. Basic THD on voltage and current, per phase, min/max, custom alarming.
j. Individual harmonic magnitudes and angels on voltage and current,up to the 31st harmonic.
k. Onboard data and event logging, stored in nonvolatile onboard memory. Logging capacity shall be 80kB minimum with a battery-backed internal clock.
1) Minimum/maximum log: for all instantaneous readings, logs worst phase since last reset including date and time stamp.
2) Maintenance log: records date and time of energy, I/O and demand resets, firmware downloads, power outages and option module changes.
3) Alarm log: records all user-defined alarm conditions with date/time stamping to 1 second resolution.

4) Billing log and energy per interval: logs kWh in and total, kVARh in and total, kVAh total, PF total, kW and kVar demand. Logs at 1 minute, dailty and monthly intervals. Energy per interval log tracks usage and cost for up to three user-defined shifts per day.
5) Customizable data log which can record upt o 96 user-defined parameters.

l. Digital and analog inputs and outputs: provide a single digital status/counter input and digital (KY type) output on the meter unit, with two expansion modules (including loggin or communications modules). Expansion modules may be digial and analog I/O as required.
m. Alarm and Control Functions: over 50 definable alarm conditions with 1 second response time can be used to log critical events or to perform control functions. Trigger on over or under conditions on any measured parameters, phase unblanace, digital input changes and more. Multiple alarm scan be defined with each alarm individually configured with pickup setpoint, dropout setpoint and delay. Each alarm can be assigned one of four priority classes.
n. Communications: provide a PM8ECC Ethernet communications card: 10/100 Base-T UTP port supporting Modbus TCP/IP communications. Full-function embedded web server providing standard web brower access to meter data, and the ability to email on an alarm from the host meter. RS-485/232 prot, 2- or 4- wire, Modbus (ASCII and TRU) master port providing Ethernet-to-serial line gateway functionality. Supports Transparent Ready – Level 1 (TRE) functionality. Provide all components required to communicate with building energy management system.
o. Special Features
1) Hour counter: load running time in days, hours and minutes.
2) Downloadable firmware: meters can be updated with the latest features by downloading them from www.powerlogic.com.

2. Mounting: LCD display and control unit flush or semiflush mounted in instrument compartment door.

2.4 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

B. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

2.6 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices, surge protection devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Additional connections to metering systems, where applicable, shall be done in the field by the manufacturer's start-up service group.

H. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

3.6 STARTUP SERVICES FOR MONITORING

A. Engage a factory-authorized service representative to perform startup service.

B. Train Owner’s maintenance personnel on procedures and schedules for energizing and de-energizing, troubleshooting, servicing and maintaining equipment and schedules.

C. Verify that the meters are installed and connected according to the Contract Documents.

D. Verify that the electrical control wiring installation complies with manufacturer’s submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.

E. Complete installation and startup checks according to manufacturer’s written instructions.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units. Provide a minimum of 4-hours on-site training.

END OF SECTION

DIVISION 26 SECTION 26 24 16
PANELBOARDS
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1. RELATED DOCUMENTS 3
1.2. SUMMARY 3
1.3. SUBMITTALS 3
1.4. QUALITY ASSURANCE 4
1.5. EXTRA MATERIALS 4
1.6. DELIVERY, STORAGE, AND HANDLING 5
1.7. PROJECT CONDITIONS 5
1.8. COORDINATION 5
1.9. WARRANTY 6

PART 2 - PRODUCTS 6

2.1. GENERAL REQUIREMENTS FOR PANELBOARDS AND LOAD CENTERS 6
2.2. DISTRIBUTION PANELBOARDS 8
2.3. LIGHTING AND APPLICANCE PANELBOARDS 8
2.4. LOAD CENTERS 8
2.5. DISCONNECTION AND OVERCURRENT PROTECTIVE DEVICES 9
2.6. ACCESSORY COMPONENTS AND FEATURES 10
2.7. FUSIBLE DISTRIBUTION PANELBOARDS 10
2.8. FUSIBLE BRANCH CIRCUIT PANELBOARDS 12

PART 3 - EXECUTION 14

3.1. EXAMINATION 14
3.2. INSTALLATION 14
3.3. IDENTIFICATION 15
3.4. FIELD QUALITY CONTROL 16
3.5. ADJUSTING 16
3.6. PROTECTION 17

END OF SECTION 17

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SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2. SUMMARY

A. This Section includes distribution panelboards, lighting and power panelboards and fusible circuit breaker panelboards with associated auxiliary equipment rated 600 V and less.

B. Related Sections include the following:

1. Division 26 Section 264300, Surge Protection Devices.

1.3. SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

2. Detail enclosure types and details for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.

4. Short-circuit current rating of panelboards and overcurrent protective devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

6. Include wiring diagrams for power, signal, and control wiring.

7. Include time-current coordination curves for each type and rating of overcurrEnt protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Qualification Data: For qualified testing agency.

D. Field Quality-Control Reports:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

G. Time current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.4. QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.5. EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: 2 spares of each type for panelboard cabinet lock.

2. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6. DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7. PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet (2000 m).

1.8. COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9. WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1. GENERAL REQUIREMENTS FOR PANELBOARDS AND LOAD CENTERS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Enclosures: Flush- and surface-mounted cabinets. Piano hinged doors and covers.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 4X, stainless steel.
c. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X, stainless steel.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
f. Corrosive Locations: NEMA 250, Type 4X, polyester reinforced fiberglass.
g. Hazardous Areas: NEMA 250, Type 7.

2. Hinged Front Cover: Entire front trim piano hinged to box and with piano hinged door within hinged trim cover.

3. Skirt for Surface-Mounted Panelboards: Provide where indicated, same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

4. Finishes:

a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Same finish as panels and trim.

5. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

6. Multiple-Section Panelboards shall consist of two or more cabinets with identical interiors mounted under separate trims. Cabinets, trim, and doors shall be of the same size. Main lugs and busses of each section shall be rated as indicated on

the Drawings. Where main breakers are indicated in multi-section panelboards, the main breaker shall be contained in one section with through-feed lugs and sub-feed cables installed within panel, equal to the incoming feeder size. All busses and lugs shall have ampere capacity equal to or greater than the main breaker ampere rating. Loads shall be divided as evenly as practical between the sections, in addition to being balanced over the phases.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

3. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Main and Neutral Lugs: Compression type.

3. Ground Lugs and Bus-Configured Terminators: Compression type.

4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

6. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

I. Provide integral surge suppression device for each panel with SPD disconnect indicated in schedule on the drawings.

2.2. DISTRIBUTION PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:

1. ABB-GE Electrification Equipment
2. Eaton Corp.; Cutler-Hammer.
3. Siemens Energy & Automation, Inc.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Piano hinged doors and covers. Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches (914 mm high, provide two latches, keyed alike.

D. Mains: Circuit breaker or Lugs only, as indicated.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

2.3. LIGHTING AND APPLICANCE PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:

1. ABB-GE Electrification Equipment
2. Eaton Corp.; Cutler-Hammer.
3. Siemens Energy & Automation, Inc.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only, as indicated.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Piano hinged doors and covers. Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4. LOAD CENTERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:

1. ABB-GE Electrification Equipment
2. Eaton Corp.; Cutler-Hammer.
3. Siemens Energy & Automation, Inc.

B. Load Centers: Comply with UL 67.

C. Mains: Circuit breaker or lugs only, as scheduled.

D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.

F. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.5. DISCONNECTION AND OVERCURRENT PROTECTIVE DEVICES

B. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:

1. ABB-GE Electrification Equipment
2. Eaton Corp.; Cutler-Hammer.
3. Siemens Energy & Automation, Inc.

G. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 100A through 225A, field adjustable short-time and continuous current setting for frame sizes 250A and larger.
2. GFCI Circuit Breakers: Single-and two-pole configurations with Class A ground-fault protection (6-mA trip).
3. Ground Fault Equipment Protection (GFEP) Circuit Breakers; Class B Ground Fault Protection (30-mA trip).
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

g. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
i. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
j. Handle Clamp: Loose attachment for holding circuit breaker handle in ON position for breakers serving clocks, telephone, and communications equipment, refrigerators, exit signs, fire alarm systems, controls, etc., to prevent accidental operation.

2.6. ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation per manufacturer's recommendations.

B. Portable Test Set: Provide for testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

2.7. FUSIBLE DISTRIBUTION PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:

1. ABB-GE Electrification Equipment
2. Eaton Corp.; Cutler-Hammer.
3. Siemens Energy & Automation, Inc.

B. Interior

1. Shall be rated for 600 Vac or 250 Vdc. Continuous main current ratings are indicated on associated schedules, not to exceed 1200 amperes maximum. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.
2. Short circuit current ratings shall be provided as indicated on the associated schedules, not to exceed the lowest interrupting capacity rating, at the supply voltage of any fusible switch installed with a maximum of 200,000 rms symmetrical amperes at 600 Vac. Main switch and main lug panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230.VI and VII
3. The panelboard bus material shall be plated copper. Bus bar plating shall run the entire length of the bus bar. The bussing shall be fully rated allowing high ampacity switches to be mounted in any position throughout the interior.
4. Main lugs and solid neutral shall be mounted in the mains compartment. Main lugs compartment shall be isolated by a bolted cover to shield user from energized parts. Branch mounted main lug kits will not be acceptable. Main lugs

or main switch interiors shall be field convertible for top or bottom incoming feed.

5. A solidly bonded copper equipment ground bar shall be provided.

6. Solid neutral shall be equipped with a full capacity bonding strap for service entrance applications. Gutter mounted solid neutral will not be acceptable.

7. Nameplates shall contain system information and catalog number or factory order number.

C. Fusible Switches

1. The operating mechanism shall be spring driven, with quick-make, quick-break action. Operating handles shall be flange mounted, as an integral part in the operating mechanism. Switch contact shall be knife-blade and jaw construction. Switch shall include visible blades as a visual verification of blade position. There shall be a visible air gap between the switch jaws and the knife-blade with the switch in the OFF (open) position.

2. Switches shall be secured to the bus with spring reinforced jaw assemblies.

3. Fusible switch units shall be equipped with all required mounting brackets and guides.

4. Switch shall have dual mechanical cover interlocks to prevent the opening of the cover when the switch is in the ON position. The cover interlock shall also prevent the switch from being turned ON with the cover open. A manual interlock override shall be provided for testing purposes. Switch cover shall include a hasp by which the cover can be padlocked in the closed position. The operating handle shall have lock-off means with provisions for three (3) .375-inch padlocks.

5. There shall be two forms of visible ON/OFF indication: A dual-color operating handle and an ON/OFF nameplate with international markings. The universal nameplate shall be readable regardless of the switch orientation. Each nameplate shall include an easily removable circuit directory card.

6. Switch fuse clips shall accept [Class R] [Class J] [Class H] fuses through 600 amperes and Class L from 601 amperes through 800 amperes. Fusible switches shall have built-in fuse pullers on 30 through 100 ampere switches as standard construction. Fuse pullers shall disengage the line side of fuse only.

7. Fusible switches shall accept the following UL Listed field installable accessories: Compression lugs, Copper mechanical lugs, and Electrical interlocks.

D. Enclosures

1. Type 1 Boxes

a. Boxes shall be hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements. Unpainted galvannealed steel is not acceptable.

b. Boxes shall have removable blank endwalls and interior mounting studs. Zinc-coated galvannealed steel will not be acceptable.

c. Maximum enclosure shall not exceed 38” wide and 18” deep.

2. Type 1 Trim Fronts

a. Front shall meet strength and rigidity requirements per UL 50 standards. Front shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.

b. Front shall be standard 4-piece surface. Optional door shall have rounded corners and edges free of burrs. A clear plastic directory card holder shall be mounted on the inside of the door.

c. Trim front with door shall have cylindrical tumbler type lock. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock.

3. Type 3R, 5, and 12

a. Enclosures shall be constructed in accordance with UL 50 requirements. Endwalls shall be welded and sealed. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.

b. All doors shall be gasketed and be equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners. A clear plastic directory card-holder shall be mounted on the inside of door. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock.

c. Maximum enclosure dimensions shall not exceed 39” wide and 14.95” deep.

2.8. FUSIBLE BRANCH CIRCUIT PANELBOARDS

A. Basis of Design Product: Combination circuit breaker and fusible branch circuit panelboards shall be Mersen Fused Coordination Panelboard type MFCP or approved equal.

B. Panelboard Ratings

1. Panelboards shall be labeled with a short-circuit current rating (SCCR) equal to or greater than that indicated on the associated schedules or drawings.
2. Non-service and service entrance rated panelboards shall be UL listed.
3. Panelboards shall be rated 600Vac and have a current rating as indicated on the associated schedules or drawings.
4. Panelboard overcurrent protective device interrupting ratings shall be UL listed and rated for the maximum available fault current.
5. Current ratings, configuration of poles and number of circuits shall be indicated on associated schedules or drawings.Mersen Fused Coordination Panelboard Specifications.

C. Construction

1. Panelboard branch circuits shall incorporate overcurrent protection using fuse types that are manufactured by at least three independent companies to assure replacement availability.
2. Interiors shall be factory assembled.
3. Bus bars shall be tin-plated copper with sufficient cross sectional area to meet UL 67 temperature rise requirements.
4. 200 ampere rated neutral shall be standard, 400 ampere rated neutral shall be provided where indicated in the associated schedules or drawings.
5. Bonded neutral shall be provided where specified in associated drawings.
6. Isolated or non-isolated equipment ground bar shall be provided as indicated in the associated schedules or drawings.
7. Where a service-entrance rated panelboard is indicated in associated schedules or drawings, a bonded neutral and non-isolated equipment ground bar shall be provided by the manufacturer.
8. Main lug conductor terminations:
a. MLO terminations shall be rated for 60/75°C, Cu-Al
b. Main disconnect terminations shall be rated for 75°C, Cu Only
9. Where specified on drawings, NEMA 1 and NEMA 3R panelboards shall be for top or bottom incoming feed.
10. Where specified on drawings and specifications, the panelboards shall meet seismic zone ratings based upon third party testing.

D. Main Disconnect

1. Where specified in the drawings, permanently installed lockout means shall be provided on the main disconnect for lock out tagout (LOTO) procedures.
2. Main disconnect shall be quick-make, quick-break type.

E. Branch Circuit Overcurrent Protection

1. Both circuit breaker and fuse shall have visible circuit ON/OFF indication.
2. Fuse holder shall provide open fuse indication via permanently installed neon indicating light where included in the plans and specifications.
3. Overcurrent protective devices shall be UL Listed, with voltage adnd short-circuit current ratings meeting the available voltage and short current shown on the drawings. The combination circuit breaker and fuse shall have amperage ratings and number of poles as indicated on the panelboard schedule.
4. Circuit breakers and fuses shall be finger-safe components with trim installed.
5. Fuse holder shall be designed so as not to allow fuse removal while fuse terminals are energized.
6. No special tools shall be required for fuse removal.
7. breakers and fuses shall be clearly marked with device amperage.
8. Circuit breakers and fuses shall be clearly marked with device amperage.
9. Branch overcurrent protective devices shall minimize the types and rating of fuses to only 30A, 60A and 100A for simple maintenance.
10. Branch circuit load terminations shall be UL listed for one and two wires per terminal.

11. Multipole branch circuit overcurrent protection devices shall trip on an overcurrent of any pole to prevent single-phasing of the load.
12. Branch circuit overcurrent protection devices shall be "Bolt In.'
13. Branch circuit overcurrent protection devices shall be resettable without replacing fuses for overcurrents for at least twice their rating.
14. Short circuits shall be cleared within ½ cycle to prevent sensitive equipment disruptions.

F. Main and Branch Overcurrent Protection

1. All fuse protective devices shall have a minimum interrupting rating of 200kA.
2. Branch circuit overcurrent protection shall be UL Listed for the voltages specified on the drawings.
3. Main overcurrent protective devices shall be UL Listed for the voltages specified on the drawings.

G. Enclosure

1. NEMA 1 enclosures shall be surface or flush mount as indicated in associated schedules or drawings. NEMA 3R enclosures shall be surface mount only.
2. Boxes with 60A and less branch circuits shall be a nominal 20 inches wide and 6 inches deep with wire bending space per the National Electrical Code®.
3. Panelboard trim shall be supplied with lockable door covering all circuit breaker and disconnect handles.
4. Panelboard trim shall be dead-front construction covering all energized parts.
5. Enclosures shall be NEMA Type 1 or Type 3R as indicated in associated schedules or drawings.
6. Door-in-door type trim shall be provided for NEMA 1 enclosures where it is specified in the associated schedules or drawings.
7. Front trim shall be lockable. All lock assemblies shall be keyed alike.
8. Surge Protection shall be internally installed as indicated in associated schedules and drawings.

H. Provide 20% or minimum of three fuses of each rating and type of fuse installed, in a spare fuse cabinet mounted in the same room(s) as the fusible panelboard(s).

PART 3 - EXECUTION

3.1. EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

D. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

E. Install filler plates in unused spaces.

F. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

H. Comply with NECA 1.

I. Air distribution panels shall be installed on galvanized formed steel channels designed to distribute the weight on the supporting wall.

J. Conduits entering the tops and bottoms of flush panels shall be located back from the front ledge of the panels to allow approximately 2-inches between the finished wall and the edge of the conduits.

K. Where panelboard is mounted flush in a wall or partition, provide 3/4-inch empty conduit, from panelboard to ceiling space for each three or less spare single pole breakers and/or spaces in the panel unless otherwise noted on the drawings.

L. Surge protective device units shall be installed immediately above or below panelboard enclosure, per manufacturer’s recommendations, connected to circuit breaker disconnecting means with lead length of conductors less than 18 inches.

3.3. IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4. FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5. ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
5. Set field-adjustable circuit-breaker trip ranges as specified in Section 260.

3.6. PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

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DIVISION 26 SECTION 26 25 50
MANUAL TRANSFER SWITCH/GENERATOR DOCKING STATION
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 SUBMITTALS 3
1.4 QUALITY ASSURANCE 3
1.5 WARRANTY 4

PART 2 - PRODUCTS 5

2.1 MANUFACTURERS 5
2.2 MANUAL TRANSFER-SWITCH PRODUCT REQUIREMENTS 5
2.3 MANUAL TRANSFER SWITCH OPERATION 7
2.4 ACCESSORIES 8
2.5 CONTROL WIRING MONITORING 9
2.6 SOURCE QUALITY CONTROL 9

PART 3 - EXECUTION 9

3.1 INSTALLATION 9
3.2 CONNECTIONS 10
3.3 FIELD QUALITY CONTROL 10
3.4 DEMONSTRATION 13
END OF SECTION 13

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SECTION 26 25 50
MANUAL TRANSFER SWITCH/GENERATOR DOCKING STATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Non-Automatic (Manual) transfer switches with integrated quick connects and disconnect switches for portable generator and/or load bank testing.

B. Related Sections include the following:

1. Division 26 Section "Transfer Switches."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

C. Qualification Data: For manufacturer and testing agency.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.

2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than four hours from time of notification.

B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

C. The manufacturer shall be certified to ISO 9001: 2008 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001: 2008.

D. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

E. Source Limitations: Obtain transfer switches through one source from a single manufacturer.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

G. Comply with NEMA ICS 1.

H. Comply with NFPA 70.

I. Comply with NFPA 110.

J. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Basis of Design is ASCO Series 300 3MGQ manual transfer switch (MTS) with dual quick connects and portable generator breaker. Subject to compliance with requirements, provide products by Russell Electric.

2.2 MANUAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. The transfer switch unit shall be manually operated and mechanically held. The switch shall be mechanically interlocked to ensure only one of three possible positions, Source 1, Source 2, or Center Off Fused disconnect type switches shall not be acceptable.

B. The switch shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.

C. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented blow-on construction for high withstand current capability and be protected by separate arcing contacts.

D. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors.

E. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

F. Where neutral conductors must be switched, the MTS shall be provided with fully- rated neutral transfer contacts.

G. Where neutral conductors are to be solidly connected, a neutral terminal plate with fully-rated AL-CU pressure connectors shall be provided.

H. The MTS shall be tested in accordance with UL 1008 for transfer switches. Switch ratings of 260 amperes and less shall have endurance rating of 6000 cycles, 400 ampere shall have endurance rating of 4000 cycles, and 600 – 3000 ampere shall have endurance rating of 3000 cycles.

I. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.

3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

K. Withstand and Closing Ratings

1. The MTS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the MTS terminals with the type of overcurrent protection shown on the plans.

2. Source 1 WCR MTS ratings @ 480v shall be as follows when used with specific circuit breakers or current limiting fuses:

MTS Size	Source 1 Withstand & Closing Rating MCCB	Source 1 W/CLF
150A – 600A	50,000A	200,000A
800A – 1200A	65,000A	200,000A
1600A – 3000A	100,000A	200,000A

3. Source 2 WCR MTS ratings @ 600v shall be as follows when used with any molded case circuit breaker:

MTS Size	*Source 2 Withstand & Rating MCCB at Source Wired to Quick Connects
150A – 600A	22,000A
800A – 1200A	22,000A
1600A – 3000A	100,000A

L. Enclosures: General-purpose NEMA 250, Type 3R, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

1. Enclosures shall be free standing, floor mounted.

2. Enclosures shall be code gauge steel as per UL 50 with ANSI #61 powder coat finish.

3. Outdoor enclosures shall be 316 stainless steel.

4. Provide strip heater with thermostat for Type 3R enclosure requirements.

2.3 MANUAL TRANSFER SWITCH OPERATION

A. The transfer switch shall be arranged for manually actuated manual operation.

B. The manual transfer shall be actuated via a mechanical operating mechanism.

C. The manual operating handle shall be capable of external operation without opening the enclosure door.

D. It shall have the same contact to contact speed as automatic operation.

E. There shall be three positions for manual operation:

1. Connected to Source 1 (preferred)

2. Connected to Source 2 (alternate)

3. Connected to center off (disconnected position)

F. Switch position when connected to Source 1, or Source 2 shall be pad – lockable.

G. Mechanical position indicators (yellow) visible to the operator shall be included for Source 1 (preferred), Source 2, (alternate), and Center Off (disconnected).

H. LED indicators shall be available for Source 1 (preferred), and Source 2 (alternate).

I. Auxiliary position indicating contacts, rated 10 amps, 250 Vac shall be provided consisting of one closed when the MTS is connected to Source 1 (preferred), and one contact closed when the MTS is connected to Source 2 (alternate)

J. A form A contact shall be provided to indicate switch is in the Center Off (disconnected) position.

K. Manual Transfer Switch with Integrated Quick Connects contains 16 Series quick connects which provides a connecting means for connecting a portable generator.

L. Quick connects are generally located on Source 2 (emergency) side of this MTS.

1. For 400A and below models, there shall be one (1) row of up to five (5) series single pole connections.
2. For 600A - 800A models, there shall be two (2) rows of up to five (5) single pole connections.
3. For 1000A-1200A models, there shall be three (3) rows of up to 5 single pole connections.
4. For 1600A-2000A models, there shall be three (5) rows of up to 5 single pole connections.
5. For 2600A-3000A models, there shall be three (8) rows of up to 5 single pole connections

M. All electrical connectors shall be 16 Series cam type single pole connectors, available color coded as per industry standard practice:

1. 240V and below: phase 1 = black, phase 2 = red, phase 3 = blue (if required).

2. 480V: phase 1 = brown, phase 2 = orange, phase 3 = yellow.

3. Ground shall always be green.

4. Neutral shall always be white.

2.4 ACCESSORIES

A. Enclosure Heater(s):

1. A 120v strip heater with thermostat and terminal block shall be provided for outdoor installations where type 3R, enclosures are specified. External 120v power source required. (This feature shall be equal to ASCO accessory 44A).

2. A 125 watt enclosure heater with transformer and thermostat (adjustable from 30° to 140 °F) shall be provided for outdoor installations where type 3R, enclosures are specified. (This feature shall be equal to ASCO accessory 44G, and shall be capable of being added to existing switches).

B. Surge Suppression – An SPD with a surge current rating of 65kA shall be provided with individually matched fused metal oxide varistors (MOVs). It shall include LED status indication of normal operation, under voltage, power loss, phase loss or component failure. Shall include form C dry contacts for external alarm or monitoring. The unit shall be enclosed in a Noryl housing rated NEMA 4, 12, and 4X. Shall comply with UL 1449 3rd edition. (This feature shall be equal to ASCO accessory 73).

C. Accessory 170 Base Package Bundle – Two form C contacts shall be connected to customer terminal block that operate when Source 1 and Source 2 voltage is present at transfer switch terminals. The following indicators shall be provided:

1. Load Connected to Source 1 (Green).
2. Load Connected to Source 2 (Red).
3. Source 1 Available (Green).
4. Source 2 Available (Red).
5. Load Disconnect (Yellow)

D. Phase Rotation Monitor.

E. Maintained Engine Start Switch and Common Alarm LED/Contact.

F. I/O Module.

2.5 CONTROL WIRING MONITORING

A. Provide ASCO 5101 Engine Start Modules, or approved equal, for monitoring of engine start circuit integrity from each ATS and MTS to generator, including Fire Pump ATS furnished under Division 23. Provide a 5101-ATS Engine Start Module at each ATS and a single 5101-GEN Engine Start Module capable of monitoring eight (8) ATS's. Modules shall utilize standard engine control wiring. ATS module shall be compatible with and wire into any contact-based engine start signal.

B. Provide visual and audible annunciation of circuit faults at ATS remote annunciator.

C. Automatically start generator(s) when fault occurs on control wiring circuit(s).

2.6 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for emergency and legally required systems, and critical operations power systems. Include results of test for the following conditions:

a. Overvoltage.
b. Undervoltage.
c. Loss of supply voltage.
d. Reduction of supply voltage.
e. Alternative supply voltage or frequency is at minimum acceptable values.
f. Temperature rise.
g. Dielectric voltage-withstand; before and after short-circuit test.
h. Overload.
i. Contact opening.
j. Endurance.
k. Short circuit.
l. Short-time current capability.
m. Receptacle withstand capability.
n. Insulating base and supports damage

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
3. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
4. Provide workspace and clearances required by NFPA 70.

B. Annunciator and Control Panel Mounting: Flush in wall, or wall-mount, unless otherwise indicated on Drawings.

C. Identify components according to Division 26 Section "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

E. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

F. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections:

1. After installing equipment, test for compliance with requirements according to NETA ATS.

2. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with Drawings and Specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and required clearances.
d. Verify that the unit is clean.
e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
f. Verify that manual transfer warnings are attached and visible.
g. Verify tightness of all control connections.
h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

i. Perform manual transfer operation.
j. Verify positive mechanical interlocking between normal and alternate sources.
k. Perform visual and mechanical inspection of surge arresters.
l. Inspect control power transformers.
1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:

a. Perform insulation-resistance tests on all control wiring with respect to ground.
b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
c. Verify settings and operation of control devices.
d. Calibrate and set all relays and timers.
e. Verify phase rotation, phasing, and synchronized operation.
f. Perform automatic transfer tests.
g. Verify correct operation and timing of the following functions:
1) Normal source voltage-sensing and frequency-sensing relays.
2) Engine start sequence.
3) Time delay on transfer.
4) Alternative source voltage-sensing and frequency-sensing relays.

5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

   a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
   e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
   f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
   g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

   a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

C. Coordinate this training with that for generator equipment.

END OF SECTION

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DIVISION 26 SECTION 26 27 16
COMMERCIAL PEDESTALS
TABLE OF CONTENTS

PART 1 GENERAL 3

1.1. RELATED DOCUMENTS 3
1.2. SCOPE 3
1.3. RELATED WORK 3
1.4. QUALITY ASSURANCE 3
1.5. SUBMITTALS 4
1.6. PROJECT RECORD DOCUMENTS 4
1.7. DELIVERY, STORAGE, AND HANDLING 4
1.8. COORDINATION 5

PART 2 PRODUCTS 5

2.1. MANUFACTURERS 5
2.2. COMMERCIAL PEDESTALS 5

PART 3 EXECUTION 6

3.1. EXCAVATION 6
3.2. PREPARATION 6
3.3. INSTALLATION 6
3.4. GROUNDING 7
3.5. FIELD QUALITY CONTROL 7
3.6. CLEANING 9
END OF SECTION 9

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SECTION 26 27 16
COMMERCIAL PEDESTALS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section.

1.2. SCOPE

A. Section includes pad-mounted, weatherproof electrical enclosures with custom configurations of electrical equipment including but not limited to circuit breakers, transformers, load centers, photocells, etc.

B. Provide all labor, materials, equipment, and services necessary to provide commercial pedestals as indicated herein and on the Contract Drawings.

1.3. RELATED WORK

A. Division 26 Section 26050, “Common Work Results for Electrical”, for requirements for concrete equipment pads for commercial pedestals.

B. Division 25 Section 260526, “Grounding and Bonding for Electrical Systems”, for grounding and bonding materials.

C. Division 26 Section 260543, “Underground Ducts and Raceways for Electrical Systems”, for ductbanks serving commercial pedestals.

D. Division 26 Section 262726, “Wiring Devices”, for requirements for wiring devices in commercial pedestals.

1.4. QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm experienced in manufacturing utility structures of types and sizes required and similar to those indicated for this Project. Firm must have a minimum of a 3-year record of successful in-service performance.

B. Comply with NFPA 70: Electrical Code and ANSI C2 National Electrical Safety Code for components and installation.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms Listed and Labeled: As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications; A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

D. Coordinate layout and installation of pedestals with final arrangement of other utilities as determined in the field.

E. Coordinate elevations of ductbank entrances into pedestals with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions.

1.5. SUBMITTALS

A. Submit shop drawings and product data under provisions of General Conditions of the Contract and Division 26.

B. Indicate material specifications, dimensions, capacities, size and location of openings, reinforcing details, and accessory locations.

C. Provide product data for pedestal type, and accessories.

D. Submit Shop Drawings, including the following:

1. Drawings for each commercial service pedestal configuration.

E. Submit manufacturer's installation instructions under provisions of General Conditions of the Contract.

F. Qualification data for firms and persons specified in Quality Assurance Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architect and Owner, and other information specified.

G. Field test reports indicating and interpreting test results relative to compliance with performance requirements of Field Quality Control Article in Part 3 of this Section.

1.6. PROJECT RECORD DOCUMENTS

A. Submit under provisions Division 26 Section 260500, “Common Work Results for Electrical”.

B. Accurately record actual locations of each pedestal.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Division 26 Section 260500, “Common Work Results for Electrical”.

B. Accept products on site. Inspect for damage.

C. Lift and support units only at designated lifting or supporting points.

1.8. COORDINATION

A. Obtain all available information on underground utilities before starting excavation. If underground utilities interfere with shown location of pedestals, bring this to the attention of the Engineer as soon as possible. Pedestal locations shall be revised or relocated only with the approval of the Architect and Engineer.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering the specified products that may be incorporated in the work include, but are not limited to, the following:

1. Commercial Pedestals:

a. Milbank Manufacturing (Basis of Design)
b. Myers Pedestals
c. Tesco Controls, Inc.
d. VIT Products

2.2. COMMERCIAL PEDESTALS

A. Description: Pad-mounted, weatherproof electrical enclosures for site power distribution.

B. Construction:

1. External construction shall comply with UL50 requirements and shall be of G90 galvanized steel with Federal Specification 595 polyurethane industrial grade powder paint of 1.7 mil minimum thickness, unless otherwise indicated.

2. Internal construction shall be G90 galvanized steel and 1.7 mil minimum thickness polyurethane industrial grade powder coat painted. No fasteners except sealing screws shall be removable by external access. Hinges shall be stainless steel and of the continuous piano hinge type.

C. Mounting: The pedestal mounting bolts shall not be externally accessible. The pedestal shall be offered with an optional base designed to be embedded in concrete in place of anchor bolts. Either pedestal mounting base or anchor bolt kit is required for installation.

D. Features:

1. Compartment door to be hinged on the left-hand side.

2. A stainless steel pad-lockable hasp provided to secure compartment.

3. A door keeper provided to keep the door in an open position.

4. A print pocket on the inside of the door shall hold all wiring schematics, circuit

directories and instructions in a clear, weatherproof sleeve.

5. Required UL labeling shall be located on the inside of the compartment door.

6. All stainless steel external hardware (screws, bolts, hinges, handles, hasps, and sealing screws).

7. Distribution and control equipment shall be behind an internal dead-front door with a quarter-turn securing latch and be hinged to open more than 90 degrees.

8. The dead-front door shall be hinged on the same side as the compartment door.

9. All distribution and control equipment shall be factory wired using 600 volt wire sized to NEC and UL requirements.

E. Electrical: Pedestals shall contain molded-case circuit breakers, panelboards, sealed transformers, and/or lighting control devices as indicated on the Contract Drawings. See Contract Drawings for additional information.

1. Circuit breakers shall comply with requirements of Division 26 Section 262816, “Enclosed Switches & Circuit Breakers”.

F. Ratings: The service pedestal shall be rated for operation at 10K minimum (AIC) amps interrupting capacity. The provided documentation shall list circuit breaker combinations and those to be used for de-rated operation for series ratings. Circuit breakers shall be permanently labeled with engraved name plates.

G. Finish: Architect/Owner shall select finish from standard factory finish options.

H. Listings: Pedestals shall be of NEMA Type 3R rainproof construction and shall be UL listed as “Enclosed Industrial Control Equipment”.

PART 3 - EXECUTION

3.1. EXCAVATION

A. Provide responsibility for all demolition, excavation and backfilling required to install foundations for commercial pedestals.

B. After completion of pedestal installation, return all ground and pavement surfaces to original condition or to condition as indicated on the drawings. This includes all sidewalks, curbs, streets, parking areas, lawns, shrubs, etc.

3.2. PREPARATION

A. Excavate, install base material, and compact base material.

3.3. INSTALLATION

A. Identify pedestals according to Division 26 Section 260533, “Identification for Electrical Systems”.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

C. Install pedestals as indicated on the Drawings, in accordance with Manufacturer's published instructions.

D. Provide working clearances in conformance with NFPA 70.

E. Provide minimum 6-inch high concrete pad for outdoor pedestals. Refer to Division 26 Section 260500, "Common Work Results for Electrical", for installation requirements. Use manufacturer-approved mounting brackets for securing pedestals to concrete equipment pads.

F. Set pedestals plumb and level.

G. Seal conduits turning up into pedestals with foam duct sealant specified in Division 26 Section 260500, "Common Work Results for Electrical".

3.4. GROUNDING

A. Comply with Division 26 Section 260526, "Grounding and Bonding for Electrical Systems", for materials and installation requirements.

B. Provide ground rod(s) for each pedestal as detailed on the Contract Drawings.

C. Ground and bond separately derived systems (i.e. transformers) per National Electrical Code Article 250.30. Provide supply-side bonding jumper from transformer to first disconnecting means or overcurrent device after the transformer.

3.5. FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection:

1. Inspect for defects and physical damage, labeling, and compliance with requirements of drawings and schedules.

2. Clean pedestals using Manufacturer's approved methods and materials.

3. Verify that equipment nameplates are installed and accurate.

4. Verify that phase identification nameplates are installed.

5. Verify that arc flash hazard labels are installed.

6. Check mounting, area clearances, and alignment and fit of components.

7. Check tightness of bolted electrical connections with calibrated torque wrench.

8. Refer to manufacturer's instructions for proper torque values.

9. Verify that neutral bar is bonded to ground bar with appropriately sized bonding jumper.

10. Verify that equipment ground bar is bonded to pedestal enclosure.

11. Test Labeling: On satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.

B. Electrical Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Testing Agency: Provide services of a qualified independent testing agency to perform specified testing. Provide set of Contract Documents to test organization. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in the original Contract Documents.

2. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.

3. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 486B.

4. Protective Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system configuration and parameters. Where discrepancies are found, recommend final protective device ratings and settings. Use accepted ratings or settings to make the final system adjustments.

5. Make continuity tests of each circuit. Refer to Division 26 Section 260519, “Low-Voltage Electrical Power Conductors and Cables” for testing specific to feeder conductors.

6. Perform ground resistance test on system and equipment ground connections

7. Test main and branch over-current protective devices.

8. Infrared Scanning: Perform an infrared scan of all electrical connections in each pedestal, as follows:

a. Remove equipment covers so terminations are accessible to scanner.
b. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values.
c. Provide calibration record for device.
d. Compare test results with specified performance or manufacturer’s data. Correct deficiencies identified by tests and retest.
e. Prepare reports certified by testing agency identifying equipment checked and describing results of tests. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

9. Test Labeling: On satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.

10. Submit all test reports to the Architect for review and approval.

11. Provide copy of all test reports in the O&M manual.

3.6. CLEANING

A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

B. Remove debris from pedestals and ensure complete installation is left in neat and finished condition.

END OF SECTION

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DIVISION 26 SECTION 26 27 26
WIRING DEVICES
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 DEFINITIONS 3
1.4 SUBMITTALS 4
1.5 QUALITY ASSURANCE 4
1.6 COORDINATION 4

PART 2 - PRODUCTS 4

2.1 MANUFACTURERS 4
2.2 STRAIGHT BLADE RECEPTACLES 4
2.3 GFCI RECEPTACLES 5
2.4 ISOLATED-GROUND RECEPTACLES 5
2.5 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES 6
2.6 TWIST-LOCKING RECEPTACLES 6
2.7 PENDANT CORD-CONNECTOR DEVICES 6
2.8 CORD AND PLUG SETS 6
2.9 TOGGLE SWITCHES 7
2.10 WALL PLATES 8
2.11 RETRACTABLE CORD REEL W/DUPLEX OUTLET BOX AND GFCI PROTECTION 9
2.12 EMERGENCY PUSHBUTTONS 10
2.13 FINISHES 11
2.14 PROTECTIVE WIRE GUARDS 12
2.15 TELE/POWER POLES 13
2.16 POKE-THROUGH ASSEMBLIES 13

PART 3 - EXECUTION 14

3.1 INSTALLATION 14
3.2 GFCI RECEPTACLES 15
3.3 IDENTIFICATION 15
3.4 CONNECTIONS 16
3.5 FIELD QUALITY CONTROL 16
END OF SECTION 17

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SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Hazardous (classified) location receptacles
3. Twist-locking receptacles.
4. Pendant cord-connector devices.
5. Cord and plug sets.
6. Toggle switches.
7. Wall plates.
8. Emergency pushbuttons.
9. Protective wire guards.
10. Tele/power poles
11. Poke-thru assemblies.

B. Related sections include the following:

1. Section 260923 – Lighting Control Devices.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements manufacturers offering products that may be incorporated into the work include, but are not limited to, the following available manufacturers' names:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).

2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

3. Leviton Mfg. Company Inc. (Leviton).

4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, Tamper-Resistant 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Hubbell; BR20*.
    b. Leviton; 5362-SG*.
    c. Pass & Seymour; TR5262*.

2.3 GFCI RECEPTACLES

A. General Description:

1. Straight blade, non-feed-through type.

2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.

3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. GFCI Convenience Receptacles, Tamper-Resistant 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Hubbell; GFTR20.
    b. Pass & Seymour; 2095TR.

2. Receptacle(s) shall also be weather-resistant type for exterior applications.

2.4 ISOLATED-GROUND RECEPTACLES

A. Description: Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Two pole, three wire, and self-grounding.

1. Configuration: NEMA WD 6, Configuration 5-20R.

2. Standards: Comply with UL 498 and FS W-C-596.

3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
    b. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
    c. Leviton Mfg. Company Inc. (Leviton).
    d. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.5 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Available Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1203.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper Crouse-Hinds.
b. EGS/Appleton Electric.
c. Killark; a division of Hubbell Inc.

2. Description: Straight blade receptacle with matching connector, unless otherwise noted.

3. Class I, unless otherwise noted.

a. Division: 2, unless otherwise noted.

4. Raintight.

2.6 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper; L520R.
b. Hubbell; HBL2310.
c. Leviton; 2310.
d. Pass & Seymour; L520-R.

2.7 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade, or as noted on the Drawings.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.9 TOGGLE SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Lighted Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Hubbell HBL1221ILC (single pole) or approved equal.

2. Description: Handle illuminated when switch is off.
3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

D. Pilot Light Switches, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper; 2221PL for 120 V and 277 V.
b. Hubbell; HPL1221PL for 120 V and 277 V.
c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
d. Pass & Seymour; PS20AC1-PLR for 120 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

E. Key-Operated Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

    a. Cooper; 2221L.
    b. Hubbell; HBL1221L.
    c. Leviton; 1221-2L.
    d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

F. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

    a. Wattstopper; LVS-1.
    b. Cooper; 1995.
    c. Hubbell; HBL1557.
    d. Leviton; 1257.
    e. Pass & Seymour; 1251.

G. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

    a. Wattstopper; LVS-1K-G.
    b. Cooper; 1995L.
    c. Hubbell; HBL1557L.
    d. Leviton; 1257L.
    e. Pass & Seymour; 1251L.

2.10 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting.
3. Material for Shop Areas: 0.035-inch- (1-mm-) thick, satin-finished stainless steel.
4. Material for Unfinished Spaces: Galvanized steel.
5. Color: Matches wiring device, except as otherwise indicated.
6. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Material for Damp Locations: Heavy-duty die-cast zinc/aluminum construction listed and labeled for use in "wet locations." All components shall have baked-on electrostatic,

polyester, power paint finish for superior corrosion resistance. Covers for receptacles shall be equipped with one or more lift cover(s) equipped with stainless steel springs. Covers for toggle switches shall be equipped with actuating levers and shall mount directly over the switch.

1. Duplex Receptacle, 2 Self-Closing Lids – Pass & Seymour Model No. CA8GH (Horizontal) or approved equal.

2. GFCI Receptacle, 1 Self-Closing Lid – Pass & Seymour Model No. CA26GH (Horizontal) and Pass & Seymour Model No. CA26GV (Vertical), or approved equal.

3. Toggle Switch – Pass & Seymour Model No. CA1GL or approved equal.

4. Toggle switch, lockable cover – Crouse-Hinds Model No. DS185, or approved equal.

C. Material for Wet Locations: Heavy-duty die-cast zinc/aluminum construction with gasketed, hinged lockable lid, designed to be weatherproof while the device is in use, and listed and labeled for use in "wet locations." All components shall have baked-on electrostatic, polyester, power paint finish for superior corrosion resistance. Covers for receptacles shall be self-closing per UL514C42.3, be equipped with stainless steel springs, and shall have a cam action latch for secure closure. Covers for toggle switches shall be equipped with actuating levers and shall mount directly over the switch.

1. Duplex/GFCI Receptacle - Pass & Seymour Model No. WIUCAST1 or approved equal.

2. Toggle switch – Pass & Seymour Model No. CA1GL, or approved equal.

3. Toggle switch, lockable cover – Crouse-Hinds Model No. DS185, or approved equal.

D. Provide jumbo size plates for outlets installed in masonry walls.

2.11 RETRACTABLE CORD REEL WITH DUPLEX OUTLET BOX AND GFCI PROTECTION

A. Description: Factory-fabricated retractable cord reel with DUPLEX receptacle outlets and the following features:

1. Cord: Type "SJEOOW" with (3) #12 AWG conductors, 45 foot length.

2. Receptacle outlet: Nylon body with three (3) NEMA S-15R grounded receptacles.

3. Integral GFCI protector on word.

4. Steel frame and steel reel sides.

5. Factory-assembled, modular type collector ring and brush block assembly.

6. Lifetime lubricated bearings.

7. Removable cover(s) for access to springs and ring/brush assembly.

8. Adjustable, four-roller cord outlet guide.

9. Built-in cord locking ratchet to hold cord at desired length. Ratchet can be disengaged to provide constant cord tension.

B. Basis of Design: Hubbell HBL45123GF20Y. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Reelcraft L4545

2. Cooper Crouse-Hinds.

3. EGS/Appleton Electric.

2.12 EMERGENCY PUSHBUTTONS

A. General:

1. Emergency pushbuttons shall be Stopper Station with Bopper Stopper cover, as manufactured by Safety Technology International, Inc. (STI), or approved equal.

B. Features:

1. Button activation shall be Push-to-Activate, Turn-to-Reset.

2. Interchangeable or replaceable Normally Open (N.O.) or Normally Closed (N.C.), Single-Pole, Single-Throw (SPST) gold-plated contact blocks rated for three (3) amps at 600 VAC or one (1) amp at 250VDC.

3. Standard switch shall include one N.O. and one N.C. contact.

4. Switch shall hold up to three (3) sets of isolated contacts.

C. Construction:

1. Housing shall be molded of polycarbonate rated for temperature range of -40 degrees to 250 degrees Fahrenheit.

2. Housing color shall be yellow, unless otherwise indicated.

3. Pushbutton shall be provided with stainless steel backplate and matching polycarbonate spacer (as required), both having a 5VA flammability rating.

D. Labeling:

1. Pushbuttons shall be provided with a vinyl label that is customized to suit each application, including, but not limited to the following:

    a. "Emergency Power Off"
    b. "Water Heater Shut-Down"
    c. "Emergency Utilities Off" (used when shutting off multiple utilities, i.e. power, air, water, and/or gas)

E. Cover

1. Pushbutton covers shall have the following features:

    a. Molded from thick clear polycarbonate material.
    b. UV stabilized.
    c. 94V-2 flammability rating.
    d. Stainless steel torsion spring to maintain cover in a closed position.
    e. Mounting hardware and gasket.
    f. Lifetime guarantee against breakage of polycarbonate from normal use.

F. Quality Assurance

1. Pushbuttons shall be tested and approved or listed by:

    a. Underwriter Laboratories (UL) and Canadian Underwriter Laboratories No. S7255.
    b. Complies with UL 2017.
    c. UL listed for indoor and outdoor use, when used with appropriate weather cover.

2. Pushbuttons shall be ADA Compliant.

G. Warranty

1. Pushbuttons shall be provided with lifetime guarantee against breakage of polycarbonate in normal use.

2. Pushbuttons shall be provided with one year guarantee on electro-mechanical and electronic components.

2.13 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices: White, or as specified by architect, unless otherwise indicated or required by NFPA 70 or device listing.

2. Wiring Devices Connected to Emergency Power System, including legally required standby and optional standby: Red.

3. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

2.14 PROTECTIVE WIRE GUARDS

A. Provide protective wireguards over devices subject to physical damage. All devices installed in the gymnasium, in mechanical and electrical rooms, in shop classrooms and on the exterior of the building shall be provided with protective guards. Protective guards shall be manufacturer's recommended product for the device being protected or a suitable guard as manufactured by American Time & Signal Company (800-328-8996), Safety Technology International (STI) (800-888-4784), or Institutional Systems Services Corporation (800-524-0537).

B. Devices to be provided with protective guards include, but are not limited to, the following:

1. Lighting Fixtures
2. Clocks
3. Bells
4. Fire Alarm Pull Stations
5. Thermostats
6. Smoke/Heat Detectors
7. Speakers
8. Fire Alarm Audio/Visual Devices (Strobe, Horn, etc…)
9. Exit Signs
10. Emergency Lights
11. Telephones
12. Data Outlets
13. Security Devices/Motion Detectors
14. Wiring Devices
15. Emergency Shut-Off Stations
16. Other Devices as required by Owner

C. Guard shall be fabricated from ¼-inch (9-gauge) cold-rolled steel rods, welded together with mounting tabs. Guard shall be finished with a powder-based epoxy to protect against corrosion. Finish color shall match the finishes for the area being installed, except guards for fire alarm devices shall be red finish color.

D. Protective Devices shall be considered incidental to the product installed in an area subject to damage as indicated on the drawings and shall be provided at no additional cost to the Owner.

2.15 TELE/POWER POLES

A. Dual-Channel Tele/power Poles

1. Basis of Design: Legrand. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Hubbell.

2. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.

3. Poles: cross-section area as required for back to back device mounting as detailed, with height adequate to extend from floor to at least 6 inches (150 mm) above ceiling, and with separate channels for power wiring and voice and data communication cabling.

4. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.

5. Material: Aluminum.

6. Finishes: Satin-anodized aluminum.

7. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, balanced twisted pair data communication cables.

8. Power Receptacles: Two duplex, 20-A, straight-blade receptacles per side complying with requirements in this Section.

9. Data Communication Outlets: Blank insert with bushed cable opening per side.

2.16 POKE-THROUGH ASSEMBLIES

A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.

B. Basis of Design: Legrand. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Hubbell.

C. Standards: Comply with scrub water exclusion requirements in UL 514.

D. Service-Outlet Assembly: Flush type with four simplex receptacles as detailed.

E. Size: Selected to fit nominal 4-inch (100-mm) cored holes in floor and matched to floor thickness.

F. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.

G. Closure Plug: Arranged to close unused 4-inch (100-mm) cored openings and reestablish fire rating of floor.

H. Wiring Raceways and Compartments: For a minimum of eight No. 12 AWG conductors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Division 16 Section "Identification for Electrical Systems."

1. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate. Light

switches shall be labeled as to lights controlled and with circuit number and panel identification.

2. Receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes. Protect label from damage during construction. Replace all damaged and unclear labels.

3. Mark all conductors with the panel and circuit number serving the device at the device.

4. Mark the panel and circuit number serving the device on the back side of the device plate with a permanent marking system, machine-generated, that does not show through the front of the plate.

3.4 CONNECTIONS

A. Connect wiring device grounding terminal to outlet box with bonding jumper.

B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.

C. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.

D. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.

2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.

3. Ground Impedance: Values of up to 2 ohms are acceptable.

4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

5. Using the test plug, verify that the device and its outlet box are securely mounted.

6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

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DIVISION 26 SECTION 26 28 13
FUSES
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 PERFORMANCE REQUIREMENTS 3
1.4 SUBMITTALS 3
1.5 QUALITY ASSURANCE 4
1.6 EXTRA MATERIALS 4

PART 2 - PRODUCTS 4

2.1 MANUFACTURERS 4
2.2 CARTRIDGE FUSES 5
2.3 SPARE FUSE CABINET 5

PART 3 - EXECUTION 5

3.1 EXAMINATION 5
3.2 FUSE APPLICATIONS 6
3.3 INSTALLATION 7
3.4 IDENTIFICATION 7
END OF SECTION 7

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SECTION 26 28 13
FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Fuses.

2. Spare Fuse Cabinet.

B. The Electrical Contractor shall provide a complete set of fuses for all fusible equipment on the project as indicated on the Contract Documents. Final test and inspections shall be made prior to energizing the equipment.

1.3 PERFORMANCE REQUIREMENTS

A. Select fuses to provide appropriate levels of short circuit and overcurrent protection for components such as wire, cable, bus structures, and other equipment. Provide system to ensure that component damage is within acceptable levels during a fault.

B. Select fuses to coordinate with time-current characteristics of other overcurrent protective elements, such as other fuses, circuit breakers, and protective relays. Provide system to ensure that device closest to fault operates.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product Data for each fuse type specified. Include the following:

1. Descriptive data and time-current curves.

2. Let-through current curves for fuses with current-limiting characteristics

3. Coordination charts and tables and related data.

C. Field test reports indicating and interpreting test results.

D. Maintenance data for tripping devices to include in the Operation and Maintenance Manual specified in Division 01.

E. Record the equipment nameplate rating and actual fuse rating and location of fuses on the record drawings.

F. Provide a complete short circuit coordination study report as required to select fuses to protect equipment.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from one source and by a single manufacturer.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide fuses specified in this Section that are listed and labeled.

1. The terms *Listed* and *Labeled* as defined in the National Electrical Code, Article 100.

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

3. Comply with National Electrical Manufacturer's Association NEMA FU-1 *Low Voltage Cartridge Fuses.*

4. Comply with IEC269.

5. Comply with CANENA Standard 248.

6. Comply with UL 198.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Spare Fuses: Furnish quantity equal to 20 percent of each 600 ampere and small fuse type and size installed, but not less than one (1) set of three (3) of each type and size. (Provide three (3) of each 601 Ampere and larger fuse type and size installed.)

2. Fuse Pullers: Furnish two (2) fuse pullers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering fuses that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Industries Inc. Bussmann Div.

2. Eagle Electric Mfg, Co. Inc.

3. Ferraz Corp

4. General Electric Co; Wiring Devices Div.

5. Gould Shawmut.

6. Tracor, Inc; Littelfuse, Inc. Subsidiary

B. All fuses shall be of the same manufacturer to assure coordination.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU-1, nonrenewable cartridge fuse; class as specified or indicated; current rating as indicated; voltage rating consistent with circuit voltage.

2.3 SPARE FUSE CABINET

A. Cabinet: Wall mounted, 0.05 inch (1.27) mm) thick steel unit with full length, recessed piano-hinged door with key coded cam lock and pull, and circuit voltage.

1. Size: Adequate for orderly storage of spare fuses specified with 15 percent spare capacity minimum.

2. Size: Adequate for orderly storage of spare fuses specified with 15 percent spare capacity minimum.

3. Finish: Gray, baked enamel.

4. Identification: Provide engraved nameplate to read “SPARE FUSES” in 1/2-inch letters on door. Refer to Division 26 Section, “Electrical Identification” for nameplate requirements.

5. Fuse Pullers: For each size fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.

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

3.2 FUSE APPLICATIONS

A. Main Service: Class L, fast acting, 600 Volt, 601-6000 Amp, and 300 kA interrupting rating.

B. Main Feeders: Class J, time delay, 600Volt, 0-600 Amp, and 300 kA interrupting rating.

C. Motor Branch Circuits: Class RK1, time delay, 250 Volt Class J Time Delay 600 Volt, 0-600 Amp, and 300 kA interrupting rating. Time delay fuses shall hold 500% of rated current for a minimum of 10 seconds.

D. Other Branch Circuits: Class RK1, non-time delay, 250 Volt, Class J Time Delay 600 Volt, 0-600 Amp, and 300 kA interrupting rating.

E. Provide fuses of type and rating recommended by equipment manufacturer for packaged and/or specialized equipment.

F. Motor, transformer, feeder, and main service protection - 250 Volts or less:

1. Six hundred (600) ampere and less in interrupter switches, Class RK1, dual elements, time delay, 300 kA interrupting rating.

2. Four hundred (400) to six hundred (600) ampere in bolted pressure switches, Class J, 300 kA interrupting rating.

G. Motor, transformer, feeder, and main service protection - 600 volts or less; 600 ampere and less - Class RK-1, dual element, time delay, 300 kA interrupting rating.

H. Six hundred (600) ampere to six thousand (6000) ampere fuses used for protection of services, mains and feeders, Class L, current-limiting, time delay, 300 kA interrupting rating, rms symmetrical. Fuses shall be time delay and shall hold 500 percent of rated current for a minimum of four (4) seconds, clear 20 times rated current in 0.01 second or less, UL listed.

I. Six hundred ampere or less, installed ahead of breaker: Class RK1, time delay.

J. Six hundred ampere or less, for general power circuits: Class J, time-delay, dual element, 300 kA interrupting rating. Time-delay fuses shall hold 500 percent of rated current for a minimum of 10 seconds and shall be UL listed.

K. Fuse sizes for motor protection shall be chosen from fuse manufacturers published data and recommendations.

L. Control circuits and lighting: Class CC, current limiting rejection type, rated 0-30 amperes, 600 volts, and 200- kA interrupting rating.

M. Motor Circuits: All individual motor circuits with full-load ampere ratings (FLA) of 480 amperes or less shall be protected by Dual-Element Time-Delay Fuses. The following guidelines apply for motors protected by properly sized overload relays: Fuses for motors with a marked service factor not less than 1.15 shall be installed in ratings of 125% of motor full-load current (or next size larger if 125 percent does not correspond to a fuse size), except where high ambient temperatures prevail, or where the motor drives a heavy revolving part

which cannot be brought up to full speed quickly, such as large fans. Under such conditions, the fuses may be 150 percent to 175 percent of the motor full-load current. For all other motors, (such as 1.0 service factor motors) fuses shall be sized in ratings of 115 percent of the motor full load current (or next size larger if 115 percent does not correspond to a fuse size) except as noted above. The following guidelines apply where fuses are used as the only overload protection for the motor:

1. For motors with a 1.15 service factor or more, fuses should be sized at 125 percent of motor full-load current (or next size smaller if 125 percent does not correspond to a fuse size).

2. For all other motors, fuses should be sized at 115 percent of motor full-load current (or next size smaller, if 115 percent does not correspond to a fuse size.

N. Motor Controllers: NEMA and IEC Style motor controllers shall be protected from short-circuits by Dual-Element Time-Delay fuses in order to provide testing agency-witnessed Type 2 coordination for the controller. This provides *no damage* protection for the controller, under low and high level fault conditions, as required by IEC Publication 947-4. For IEC style controller, the fuses shall be installed in ratings to coordinate with the overload relays, such that the relay/fuse curves cross over at 7-10 times the IEC contactor current rating.

O. Panelboards: The manufacturer shall supply equipment utilizing fully-rated and listed components. This equipment shall be tested, listed, and labeled for the available short-circuit current.

3.3 INSTALLATION

A. Fuses shall not be installed until equipment is ready to be energized. This measure prevents fuse damage during shipment of the equipment from the manufacturer to the job site, or from water that may contact the fuse before the equipment is installed. Final tests and inspections shall be made prior to energizing the equipment. This shall include a thorough cleaning, tightening, and review of all electrical connections and inspection of all grounding conductors. All fuses shall be furnished and installed by the electrical contractor. All fuses shall be of the same manufacturer.Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.

B. Install spare fuse cabinet where indicated.

C. Provide fuse clips as required.

3.4 IDENTIFICATION

A. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

END OF SECTION

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DIVISION 26 SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 DEFINITIONS 3
1.4 SUBMITTALS 3
1.5 QUALITY ASSURANCE 4
1.6 PROJECT CONDITIONS 5
1.7 COORDINATION 5
1.8 EXTRA MATERIALS 5

PART 2 - PRODUCTS 5

2.1 GENERAL REQUIREMENTS 5
2.2 FUSIBLE SWITCHES 5
2.3 NONFUSIBLE SWITCHES 6
2.4 SHUNT TRIP SWITCHES 7
2.5 MOLDED-CASE CIRCUIT BREAKERS 8
2.6 ENCLOSURES 9

PART 3 - EXECUTION 9

3.1 EXAMINATION 9
3.2 INSTALLATION 10
3.3 IDENTIFICATION 10
3.4 FIELD QUALITY CONTROL 10
3.5 ADJUSTING 13
END OF SECTION 13

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SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.

2. Nonfusible switches.

3. Molded-case circuit breakers (MCCBs).

4. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.

2. Current and voltage ratings.

3. Short-circuit current ratings (interrupting and withstand, as appropriate).

4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field quality-control reports.

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).

2. Altitude: Not exceeding 6600 feet (2010 m).

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

2.2 FUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. ABB-GE Electrification Equipment.

3. Siemens Energy & Automation, Inc.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses,

lockable handle with capability to accept three padlocks, lockable in either open or closed positions, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary. Contacts would reactivate before blades open as indicated on the Drawings.

5. Lugs: Compression type, suitable for number, size, and conductor material.

6. Accessory Control Power Voltage: Remote-mounted and powered; 120-VAC. Provide as required with auxiliary contact kit.

2.3 NONFUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. ABB-GE Electrification Equipment.

3. Siemens Energy & Automation, Inc.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, lockable in either open or closed position, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contacts, arranged to activate before switch blades open, where indicated in the Drawings.

4. Lugs: Compression type, suitable for number, size, and conductor material.

5. Accessory Control Power Voltage: Remote mounted and powered; 120 VAC. Provide as required with auxiliary contact kit.

2.4 SHUNT TRIP SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. ABB-GE Electrification Equipment.

3. Siemens Energy & Automation, Inc.

B. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 600-V ac, ampacity as indicated on the drawings; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

C. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: 600-V ac, ampacity as indicated on the drawings; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, pilot, indicating and control devices.

E. Accessories:

1. Oiltight key switch for key-to-test function.

2. Oiltight green ON pilot light.

3. Isolated neutral lug; 100 percent rating.

4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.

5. Form C alarm contacts that change state when switch is tripped.

6. Three-pole, double-throw, fire-safety and alarm relay; 24-V ac coil voltage, unless otherwise indicated on the drawings.

7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

8. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

9. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

10. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.

11. Hookstick Handle: Allows use of a hookstick to operate the handle.

12. Lugs: Compression type, suitable for number, size, and conductor material.

13. Service-Rated Switches: Labeled for use as service equipment.

2.5 MOLDED-CASE CIRCUIT BREAKERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. ABB-GE Electrification Equipment.

3. Siemens Energy & Automation, Inc.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact, as indicated on the drawings.

5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts, where indicated on the drawings.

7. Alarm Switch: One NO contact that operates only when circuit breaker has tripped, where indicated on the drawings.

8. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac, as required.

9. Provide with lockable handle, lockable in either open or closed position.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 4X, stainless steel.

3. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.

4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4. 4X, stainless steel.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

6. Hazardous Areas: NEMA 250, Type 7.

7. Corrosive Locations: NEMA 250, Type 4X, polyester reinforced fiberglass.

B. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

C. Operating Mechanism: The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

D. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

E. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

D. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that the unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.

g. Inspect bolted electrical connections for high resistance using one of the two following methods:
   1) Use a low-resistance ohmmeter.
      a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
      a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
   d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
   e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

E. Tests and Inspections for Molded Case Circuit Breakers:

   1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that the unit is clean.
e. Operate the circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the two following methods:
    1) Use a low-resistance ohmmeter.
        a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

    2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
        a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

e. Determine the following by primary current injection:
   1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.

g. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.

h. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

1. Test procedures used.

2. Include identification of each enclosed switch and circuit breaker tested and describe test results.

3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

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DIVISION 26 SECTION 26 29 13
ENCLOSED CONTROLLERS
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 SUBMITTALS 3
1.4 QUALITY ASSURANCE 4
1.5 DELIVERY, STORAGE, AND HANDLING 5
1.6 COORDINATION 5
1.7 EXTRA MATERIALS 5

PART 2 - PRODUCTS 5

2.1 MANUFACTURERS 5
2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS 6
2.3 ENCLOSURES 6
2.4 ACCESSORIES 7
2.5 FACTORY FINISHES 7

PART 3 - EXECUTION 7

3.1 EXAMINATION 7
3.2 APPLICATIONS 7
3.3 INSTALLATION 8
3.4 IDENTIFICATION 8
3.5 CONTROL WIRING INSTALLATION 8
3.6 CONNECTIONS 8
3.7 FIELD QUALITY CONTROL 8
3.8 ADJUSTING 10
3.9 DEMONSTRATION 10
END OF SECTION 10

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SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:

1. Across-the-line, manual and magnetic controllers.

2. Multispeed controllers.

B. Related Sections include the following:

1. Mechanical Divisions for “Variable Speed Drives” and “Power Factor Correction Capacitors”.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Nameplate legends.
c. Short-circuit current rating of integrated unit.
d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show

support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For manufacturer and testing agency.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

G. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.6 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

C. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.

2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; a brand of Schneider Electric or comparable product by one of the following:

1. Eaton Corporation; Cutler-Hammer Products.

2. ABB-GE Electrification Equipment.

3. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.

4. Siemens/Furnas Controls.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer source of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity. Control power transformers shall have primary and secondary fuse protection.

2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to homeplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

1. Non-fusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch unless otherwise noted on the drawings.

2. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.

3. MCP Disconnecting Means: UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.3 ENCLOSURES

A. Description: Surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 4X, stainless steel.

3. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.

4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4. 4X, stainless steel.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

6. Hazardous Areas: NEMA 250, Type 7.

7. Corrosive Locations: NEMA 250, Type 4X, polyester reinforced fiberglass.

B. Provide lockable handle for combination starter and disconnects that accepts three padlocks and interlocks with cover in closed position.

2.4 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Push-to-Test Red “Power Available” and Green “Running” non-incandescent, Pilot Lights, and Hand-Off-Automatic Selector Switches: NEMA ICS 2, heavy-duty type.

C. Control Relays: Two (2) NO/NC auxiliary contacts and adjustable time-delay relays as required by automatic control sequence.

D. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

C. Install Power Factor Correction Capacitors furnished under Mechanical Divisions with disconnects, overcurrent protection, wire, conduit and ground for capacitor enclosure, all in accordance with the recommendations of the capacitor manufacturer and the National Electric Code.

D. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

3.4 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Section 260553 "Identification for Electrical Systems."

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.

2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.

3. Report results in writing.

C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

D. Perform the following field tests and inspections and prepare test reports:

1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.

2. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with drawings and specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify the unit is clean.
e. Inspect contactors:
   1) Verify mechanical operation.
   2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.

f. Motor-Running Protection:
   1) Verify overload element rating is correct for its application.
   2) If motor-running protection is provided by fuses, verify correct fuse rating.

g. Inspect bolted electrical connections for high resistance using one of the two following methods:
   1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

3. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.

b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

c. Test motor protection devices according to manufacturer's published data.

d. Test circuit breakers as follows:

1) Operate the circuit breaker to ensure smooth operation.

2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.

e. Perform operational tests by initiating control devices.

4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.8 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

DIVISION 26 SECTION 26 32 13
ENGINE GENERATORS
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 DEFINITIONS 3
1.4 ACTION SUBMITTALS 3
1.5 INFORMATIONAL SUBMITTALS 4
1.6 CLOSEOUT SUBMITTALS 5
1.7 MAINTENANCE MATERIAL SUBMITTALS 5
1.8 QUALITY ASSURANCE 5
1.9 WARRANTY 5
1.10 PERMITS, FILINGS AND MISCELLANEOUS REGULATORY REQUIREMENTS 6

PART 2 - PRODUCTS 6

2.1 MANUFACTURERS 6
2.2 PERFORMANCE REQUIREMENTS 6
2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION 7
2.4 ENGINE 8
2.5 GAS FUEL-OIL SYSTEM 11
2.6 CONTROL AND MONITORING 11
2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION 17
2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR 18
2.9 OUTDOOR ENGINE GENERATOR ENCLOSURE 19
2.10 VIBRATION ISOLATION DEVICES 19
2.11 FINISHES 20
2.12 SOURCE QUALITY CONTROL 20

PART 3 - EXECUTION 21

3.1 EXAMINATION 21
3.2 INSTALLATION 21
3.3 CONNECTIONS 22
3.4 IDENTIFICATION 23
3.5 FIELD QUALITY CONTROL 23
3.6 MAINTENANCE SERVICE 26
3.7 DEMONSTRATION 26
END OF SECTION 26

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SECTION 26 32 13
ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes packaged engine generators for emergency use with the following features:

1. Natural Gas engine.
2. Gas fuel system.
3. Control and monitoring.
4. Generator overcurrent and fault protection.
5. Generator, exciter, and voltage regulator.
6. Load bank.
7. Outdoor engine generator enclosure.
8. Vibration isolation devices.
9. Finishes.

B. Related Requirements:

1. Section 26 3600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.3 DEFINITIONS

A. EPS: Emergency power supply.

B. EPSS: Emergency power supply system.

C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.

4. Include fuel consumption in gallons per hour (liters per hour) at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
6. Include airflow requirements for cooling and combustion air in cubic feet per minute (cubic meters per minute) at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F (35, 27, 21, and 10 deg C). Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer and testing agency.

B. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails, identify center of gravity and total weight, including full fuel tank, supplied enclosure, silencer, skid-mounted load bank, and each piece of equipment not integral to the engine generator, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control reports.

E. Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
b. Operating instructions laminated and mounted adjacent to generator location.
c. Training plan.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five (5) years from date of Substantial Completion.

1.10 PERMITS, FILINGS AND MISCELLANEOUS REGULATORY REQUIREMENTS

A. File for and obtain all required Federal, State and local environmental, air quality, and other specialty permits, registrations, and other regulatory requirements for the installation of the generator, generator exhaust system, generator fuel supply and storage system, and other generator system components at each site. All such filings shall be made on behalf of and in the name of the County. Provide copies of all such submissions to the County.

B. Compile all such submissions and certifications in a separate 3-ring binder for each site. Binders shall be similar to those used for the project Operation and Maintenance Manuals. Include a schedule of required resubmission and renewal dates for each site for the County's guidance and information. This shall include all required forms, and the agency, including proper filing address, to which the renewals must be submitted. The schedule shall be for a minimum duration of five (5) years from the date of project Substantial Completion.

C. All costs for such regulatory filings shall be included in the project bid.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Basis of Design for a single generator is Cummins. Basis of Design for two generators with on-board paralleling is Generac. Subject to compliance with requirements, provide products by one of the following:

1. Onan/Cummins Power Generation; Industrial Business Group.
2. Generac Power Systems.
3. MTU/Spectrum Detroit Diesel.
4. Alban/CAT
5. Kohler

B. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

C. Alternate manufacturers shall provide generator sizing calculations and generator sized as required to suit load profile, but not less than rating indicated on the drawings.

D. A self-contained paralleled generator solution is acceptable if the performance requirements and dimensional requirements of the single generator are met. All required accessories, modifications and connections shall be provided for a complete and functional system.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Engine generator housing, sub-base tank, day tank, engine generator, batteries, battery racks, silencers, load banks, sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."
2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst-case normal levels.
3. Component Importance Factor: 1.0.

B. B11 Compliance: Comply with B11.19.

C. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 110 requirements for Level 1 EPSS.

D. UL Compliance: Comply with UL 2200.

E. Engine Exhaust Emissions: Comply with EPA requirements and applicable state and local government requirements.

F. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator, including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

G. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 104 deg F (Minus 15 to plus 40 deg C).
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to 1000 feet (300 m).

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Power Rating: Standby.

D. EPSS Class: Engine generator shall be classified as Class 2 according to NFPA 110.

E. Service Load: As indicated on the drawings.

F. Power Factor: 0.8, lagging.

G. Frequency: 60 Hz.

H. Voltage: As indicated on the drawings.

I. Phase: Three-phase, four-wire wye.

J. Induction Method: Naturally aspirated or Turbocharged.

K. Governor: Adjustable isochronous, with speed sensing.

L. Mounting Frame: Structural-steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

M. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

N. Engine Generator Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-

load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

    a. Provide permanent magnet excitation for power source to voltage regulator.

10. Start Time:

    a. Comply with NFPA 110, Type 10 system requirements.

O. Parallel Engine Generators:

1. Automatic reactive output power control and load sharing between engine generators operated in parallel.
2. Automatic regulation, automatic connection to a common bus, and automatic synchronization, with manual controls and instruments to monitor and control paralleling functions.
3. Protective relays required for equipment and personnel safety.
4. Paralleling suppressors to protect excitation systems.
5. Reverse power protection.
6. Loss of field protection.

2.4 ENGINE

A. Fuel: Natural gas.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skid mounted.

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Pump circulation type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and with UL 499.

E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump. The radiator will be suitable up to 50 Deg C ambient temperature with 0.5” WC external static restriction.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant, from cold start to 110 percent load condition.

3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant-system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.

    a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and non-collapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be 78 dBA or less.

G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

H. Starting System: 24-V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle, with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Lead Acid, with adequate capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F (10 deg C) regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for batteries supplied. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 to 140 deg F (minus 40 to plus 60 deg C) to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.5 GAS FUEL-OIL SYSTEM

A. Natural Gas Piping: Comply with requirements in Section 231123 "Facility Natural Gas Piping."

B. Gas Train: Comply with NFPA 37.

C. Engine Fuel System:

D. Natural Gas, Vapor-Withdrawal System:

1. Carburetor.
2. Secondary Gas Regulators: One for each fuel type, with atmospheric vents piped to building exterior.
3. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves; one for each fuel source.
4. Fuel Filters: One for each fuel type.
5. Manual Fuel Shutoff Valves: One for each fuel type.
6. Flexible Fuel Connectors: Minimum one for each fuel connection.

2.6 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator

starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Provide minimum run-time control set for 30 minutes, with override only by operation of a remote emergency-stop switch.

C. Comply with UL 508A.

D. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.

E. Control and Monitoring Panel:

1. Digital controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2. Instruments: Located on the control and monitoring panel and viewable during operation.

    a. Engine lubricating-oil pressure gage.
    b. Engine-coolant temperature gage.
    c. DC voltmeter (alternator battery charging).
    d. Running-time meter.
    e. AC voltmeter for each phase, connected to a phase selector switch.
    f. AC ammeter for each phase, connected to a phase selector switch.
    g. AC frequency meter.
    h. Generator-voltage adjusting rheostat.

3. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication as required by NFPA 110 for Level 1 system, and the following:

    a. Cranking control equipment.
    b. Run-Off-Auto switch.
    c. Control switch not in automatic position alarm.
    d. Overcrank alarm.
    e. Overcrank shutdown device.
    f. Low water temperature alarm.
    g. High engine temperature pre-alarm.
    h. High engine temperature.
    i. High engine temperature shutdown device.
    j. Overspeed alarm.
    k. Overspeed shutdown device.
    l. Low fuel main tank.

1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for duration required for the indicated EPSS class.

m. Coolant low-level alarm.
n. Coolant low-level shutdown device.
o. Coolant high-temperature prealarm.
p. Coolant high-temperature alarm.
q. Coolant low-temperature alarm.
r. Coolant high-temperature shutdown device.
s. EPS supplying load indicator.
t. Battery high-voltage alarm.
u. Low-cranking voltage alarm.
v. Battery-charger malfunction alarm.
w. Battery low-voltage alarm.
x. Lamp test.
y. Contacts for local and remote common alarm.
z. Remote manual-stop shutdown device.

F. Connection to Datalink:

1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
2. Provide connections for datalink transmission of indications to remote data terminals via ModBus."

G. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated. Locate in Main Emergency Electrical Room unless otherwise indicated.

1. Overcrank alarm.
2. Low water-temperature alarm.
3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Lamp test.

18. Low-cranking voltage alarm.
19. Generator overcurrent-protective-device not-closed alarm.

H. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

I. Remote Emergency-Stop Switch: Flush; wall mounted in Main Emergency Electrical Room unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

J. Control Panel: The control panel shall be mounted on the generator set. It shall have integral vibration isolation and shall be prototype and reliability tested to ensure operation in the conditions encountered. The control panel will have 7.0" TFT color touchscreen.

1. Hardware Requirements

   a. A three position selector switch or touchscreen buttons for OFF, AUTO and RUN.
   b. Emergency Stop Switch. The controller mounted, latch type remote stop switch shall be red in color with a "mushroom" type head. Depressing the stop button will immediately stop the generator set and lockout the generator set for any automatic remote starting.
   c. Alarm Horn. The controller shall provide an alarm horn that sounds when any faults or warnings are present. The horn shall also sound when the controller is not in the AUTO mode.
   d. Alarm Off. This button will silence the alarm horn when the unit is in AUTO.
   e. The digital display shall be a vacuum fluorescent display with two lines of 20 alphanumeric data characters viewable in all light conditions. The display shall display status of all faults and warnings.
   f. For ease of use, an operating guide shall be printed on the controller faceplate.
   g. A keyed switch shall be supplied for locking and unlocking of controller functions.

2. Codes and Standards

   a. The generator set controller shall meet NFPA 110 Level 1 requirements and shall include an integral alarm horn as required by NFPA.
   b. The controller shall meet NEC requirements.
   c. The controller shall be UL 6200 listed.

3. Functional Requirements
   The generator controller shall display and monitor the following engine and alternator functions and allow adjustments of certain parameters at the controller:

a. Field-programmable time delay for engine start. Adjustment range 0-5 minutes in 1 second increments.
b. Field-programmable time delay engine cool down. Adjustment range 0-10 minutes in 1 second increments.
c. Capability to start and run at user-adjustable idle speed during warm-up for a selectable time period (0-10 minutes), until engine reaches preprogrammed temperature, or as supported by ECM-equipped engine.
d. Real-time clock and calendar for time stamping of events.
e. Programmable cyclic cranking that provides up to 30 seconds of cranking and up to 60 seconds rest with up to 6 cycles.
f. To reduce controller current battery draw, the controller display should turn off automatically after the controller is inactive for 5 minutes.
g. Control logic with alternator protection for overload and short circuit matched to each individual alternator and duty cycle.
h. Control logic with RMS digital voltage regulation. The system shall have integral microprocessor based voltage regulator system that provides +/- 0.25% voltage regulation no-load to full load with three phase sensing. A separate voltage regulator is not acceptable.
i. The capability to exercise the generator set by programming a running time into the controller.
j. Alternator thermal overload protection. The system shall have UL6200 listed integral alternator overload and short circuit protection matched to each alternator for the particular voltage and phase configuration.
k. The controller will also have the maintenance mode per NEC240.87
l. Generator warning alarms:
    1) Alternator protection activated
    2) Auto synch disabled
    3) Battery charger failure
    4) Circuit breaker open/close fault
    5) Dead bus sensing fault
    6) De-rate active
    7) Emergency power system (EPS) supplying load
    8) External circuit breaker trip
    9) Ground fault detected
    10) High battery voltage
    11) High coolant temperature
    12) High oil temperature
    13) Key switch locked/unlocked
    14) Load shed activated
    15) Loss of AC sensing
    16) Low battery voltage
    17) Low coolant temperature
    18) Low oil pressure
    19) Low fuel level or pressure
    20) Maintenance due
    21) Master switch in auto
    22) NFPA 110 common alarms
    23) Overcurrent
    24) Speed sensor fault
    25) Underfrequency

m. Generator shutdown alarms:
   1) Alternator protection
   2) Critical overvoltage
   3) Emergency stop
   4) Field overvoltage
   5) High coolant temperature
   6) High oil temperature
   7) Locked rotor
   8) Loss of AC sensing
   9) Loss of ECM communication
   10) Loss of field
   11) Low coolant level
   12) Low coolant temperature
   13) Low oil pressure
   14) NFPA 100 fault
   15) Overcrank
   16) Overspeed
   17) Overcurrent
   18) Over/Under frequency
   19) Over/Under voltage
   20) Phase selection error
   21) Remote shutdown

4. Metering Requirements

   a. Output voltages – line to line, and line to neutral, 0.25% accuracy
   b. Single phase and three phase currents, 0.25% accuracy
   c. Frequency, 0.25% accuracy
   d. Power factor by phase with leading/lagging indication
   e. Total kilowatt loading and kilowatts per phase, 0.5% accuracy
   f. kVARS total and per phase, 0.5% accuracy
   g. kVA total and per phase, 0.5% accuracy
   h. kW hours
   i. A display of percent generator set duty level (actual kW loading divided by the kW rating)
   j. Event snapshot: The controller will capture 15 seconds of critical data around the time of fault or warning. This data will be viewable io the controller and downloadable for further analysis

5. Engine parameters listed below shall be monitored:

   a. Coolant temperature both in English and metric units
   b. Oil pressure in English and metric units
   c. Battery voltage
   d. RPM

6. Communications

   a. Industry standard Modbus communication shall be available.

b. The controller shall not require any additional hardware to support Modbus TCP, SNMP and BACnet communication via RJ45 ports
c. A Modbus master shall be able to monitor and alter parameters, and start/stop the generator.
d. Communications shall be available for serial, CAN, and Ethernet bus networks.
e. Generator and transfer switch controls shall be equipped with communications modules capable of connecting to the same communication network.
f. The controller shall be capable of communicating controller to controller, without additional inputs from an external source.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Disconnect Switches: Molded-case type; 100 percent rated, LSI trip unit.

1. Trip Rating: Matched to generator output rating.
2. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms. Contacts shall be available for load shed functions.

2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.

3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.

4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70 Article 700, "Emergency System" signals for ground fault.

1. Indicate ground fault with other engine generator alarm indications.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Range: Provide broad range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.

2. Maintain voltage within 15 percent on one step, full load.

3. Provide anti-hunt provision to stabilize voltage.

4. Maintain frequency within 10 percent and stabilize at rated frequency within two seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.

2.9 OUTDOOR ENGINE GENERATOR ENCLOSURE

A. Description: Vandal-resistant, sound-attenuating, weatherproof steel wind resistant. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

1. Sound Attenuation Level: 75dBA maximum sound level measured on all four sides of enclosure, at 23 feet (7 meters) with generator running at full load.

B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 100 mph (160 km/h).

C. Hinged Doors: With padlocking provisions.

D. Space Heater: Thermostatically controlled and sized to prevent condensation.

E. Lighting: Provide weather-resistant LED lighting with 30 fc (330 lx) average maintained.

F. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.

G. Muffler Location: Within enclosure.

H. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.

1. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

2. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

I. Interior Lights with Switch: Factory-wired, vapor-proof luminaires within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.

2. DC lighting system for operation when remote source and generator are both unavailable.

J. Convenience Outlets: Factory-wired, GFCI. Arrange for external electrical connection.

2.10 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates

of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Bridge-bearing neoprene, complying with AASHTO M 251 separated by steel shims.

2. Shore A Scale Durometer Rating: 50, or as recommended by manufacturer.

3. Number of Layers: Three.

4. Minimum Deflection: 1 inch (25 mm)

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment-mounting and -leveling bolt that acts as blocking during installation.

2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Minimum Deflection: 1 inch (25 mm)

C. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for vibration isolation and flexible connector materials for steel piping.

D. Comply with requirements in Section 233113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.

E. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.11 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.

2. Test generator, exciter, and voltage regulator as a unit.

3. Full-load run.

4. Maximum power.

5. Voltage regulation.

6. Transient and steady-state governing.

7. Single-step load pickup.

8. Safety shutdown.

9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections to verify actual locations of connections before packaged engine generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.

C. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete.

2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

3. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1-inch (25 mm) on 4-inch- (100-mm-) high concrete base. Secure enclosure to anchor bolts installed in concrete bases.

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.

1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
2. Install flexible connectors and steel piping materials according to requirements in Section 232116 "Hydronic Piping Specialties."

3. Insulate muffler/silencer and exhaust system components according to requirements in Section 230719 "HVAC Piping Insulation."

F. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

G. Gaseous Fuel Piping:

1. Natural gas piping, valves, and specialties for gas distribution are specified in Section 231123 "Facility Natural Gas Piping."

2. LP gas piping, valves, and specialties for gas piping are specified in Section 231126 "Facility Liquefied-Petroleum Gas Piping."

H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect engine exhaust pipe to engine with flexible connector.

D. Gaseous Fuel Connections:

1. Connect fuel piping to engines with a gate valve and union and flexible connector.

2. Install manual shutoff valve in a remote location to isolate gaseous fuel supply to the generator.

3. Vent gas pressure regulators outside building a minimum of 60 inches (1500 mm) from building openings.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

G. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.4 IDENTIFICATION

A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.

a. Visual and Mechanical Inspection:
   1) Compare equipment nameplate data with Drawings and the Specifications.
   2) Inspect physical and mechanical condition.
   3) Inspect anchorage, alignment, and grounding.
   4) Verify that the unit is clean.

b. Electrical and Mechanical Tests:
   1) Perform insulation-resistance tests according to IEEE 43.
      a) Machines Larger Than 200 hp (150 kW): Test duration shall be 10 minutes. Calculate polarization index.
      b) Machines 200 hp (150 kW) or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.

2) Test protective relay devices.
3) Verify phase rotation, phasing, and synchronized operation as required by the application.
4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
5) Perform vibration test for each main bearing cap.
6) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test. Provide load bank for testing as required.

3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.

6. Exhaust Emissions Test: Comply with applicable government test criteria.
7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
8. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
9. Load Bank Tests:

   a. The load bank shall be fully tested using a test specification written by the supplier. Tests shall include electrical functional testing, verifying conformance to assembly drawings and specifications. Each load step shall be cold resistance checked to verify proper calibration of resistive load steps and proper ohmic value.
   b. The manufacturer shall maintain this data on file for inspection purposes by the purchaser. Tests using high potential equipment shall be performed to ensure isolation of the load circuits from the control circuits and to determine isolation of the load circuits from the load bank frame.

Tests of all safety circuits shall be performed to verify conformance to the specification

c. All electrical circuits shall have a high potential insulation resistance test performed at twice rated voltage plus 1000 VAC to assure insulation integrity.

d. All quality control test equipment shall be regularly maintained and calibrated to traceable national standards.

e. The Company's Quality System shall be at least ISO9001:2015 Certified.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels, so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

L. Contractor shall provide full diesel fuel tank prior to testing, and tank shall be refilled at the conclusion of testing.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION

DIVISION 26 SECTION 26 36 00
TRANSFER SWITCHES
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 SUBMITTALS 3
1.4 QUALITY ASSURANCE 4
1.5 WARRANTY 4

PART 2 - PRODUCTS 5

2.1 MANUFACTURERS 5
2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS 5
2.3 AUTOMATIC TRANSFER SWITCHES 6
2.4 TRANSFER SWITCH ACCESSORIES 8
2.5 NONAUTOMATIC (MANUAL) TRANSFER SWITCHES 9
2.6 CONTROL WIRING MONITORING 9
2.7 SOURCE QUALITY CONTROL 10

PART 3 - EXECUTION 10

3.1 INSTALLATION 10
3.2 CONNECTIONS 11
3.3 FIELD QUALITY CONTROL 11
3.4 DEMONSTRATION 14
END OF SECTION 14

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SECTION 26 36 00
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.

2. Non-Automatic (Manual) transfer switches.

3. Remote annunciation systems.

B. Related Sections include the following:

1. Division 26 Section "Engine Generator".

2. Division 26 Section Manual Transfer Switch/Generator Docking Station

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

C. Qualification Data: For manufacturer and testing agency.

D. Seismic Qualification Data: Certificates, for transfer switches, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.

2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than four hours from time of notification.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain automatic transfer switches, remote annunciators and packaged engine generator through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NEMA ICS 1.

F. Comply with NFPA 70.

G. Comply with NFPA 110.

H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Basis-of-Design Product: Subject to compliance with requirements, provide Emerson; ASCO Power Technologies, LP or comparable product by one of the following:

a. Russell Electric.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Short-time withstand capability for 30 cycles.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.

2. Switch Action: Double throw; mechanically held in both directions.

3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

I. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

J. Battery Charger: For generator starting batteries.

1. Float type rated 10A.

2. Ammeter to display charging current.

3. Fused ac inputs and dc outputs.

K. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

L. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.

3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

4. Accessible via front access.

M. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

G. Automatic Transfer-Switch Features:

1. Controller operates through a period of loss of control power.

2. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

3. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

4. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

5. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

6. Test Switch: Simulate normal-source failure.

7. Switch-Position Pilot Lights: Indicate source to which load is connected.

8. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

   a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
   b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

9. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

13. Provide load add and load shed capability for ATSs indicated on the drawings and as required for interface with paralleling switchgear controls.

14. Connect auxiliary and control contacts in ATS to paralleling switchgear or the engine-generator control panel. For emergency generator applications, control conductors installed between the transfer switch and paralleling switchgear or the generator shall be as follows:

    a. Control wire installation shall comply with NEC Article 700.10 (D)(3).
    b. The control conductors shall be kept entirely independent of all other wiring and shall meet the conditions of NEC Article 700.10
    c. The integrity of the generator remote start (ATS) circuit shall be monitored for broken, disconnected, or shorted wires. Loss of integrity shall start the generator(s).

2.4 TRANSFER SWITCH ACCESSORIES

A. Remote Annunciator System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.

2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.

3. Annunciation panel display shall include the following indicators:

    a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Switch position.
    c. Switch in test mode.
    d. Failure of communication link.

4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

a. Indicating Lights: Grouped for each transfer switch monitored.
b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
d. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.5 NONAUTOMATIC (MANUAL) TRANSFER SWITCHES

A. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

B. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.

C. Nonautomatic Transfer-Switch Accessories:

1. Pilot Lights: Indicate source to which load is connected.

2. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternate-source sensing circuits.

a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
b. Emergency Power Supervision: Red light with nameplate engraved "Alternate Source Available."

D. Unassigned Auxiliary Contacts: One set of normally closed contacts for each switch position, rated 10 A at 240-V ac.

E. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double throw; mechanically held in both directions.

2. Contacts: Silver composition or silver alloy for load-current switching.

3. Conductor Connectors: Suitable for use with conductor material and sizes.

4. Material: Hard-drawn copper, 98 percent conductivity.

5. Main and Neutral Lugs: Compression type.

6. Ground bar.

7. Connectors shall be marked for conductor size and type according to UL 1008.

2.6 CONTROL WIRING MONITORING

A. Provide ASCO 5101 Engine Start Modules, or approved equal, for monitoring of engine start circuit integrity from each ATS to generator(s), including Fire Pump ATS furnished

under Division 23. Provide a 5101-ATS Engine Start Module at each ATS and a single 5101-GEN Engine Start Module capable of monitoring eight (8) ATS's. Modules shall utilize standard engine control wiring. ATS module shall be compatible with and wire into any contact-based engine start signal.

B. Provide visual and audible annunciation of circuit faults at ATS remote annunciator and at paralleling switchgear.

C. Automatically start generator(s) when fault occurs on control wiring circuit(s).

2.7 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for emergency and legally required systems, and critical operations power systems. Include results of test for the following conditions:

a. Overvoltage.
b. Undervoltage.
c. Loss of supply voltage.
d. Reduction of supply voltage.
e. Alternative supply voltage or frequency is at minimum acceptable values.
f. Temperature rise.
g. Dielectric voltage-withstand; before and after short-circuit test.
h. Overload.
i. Contact opening.
j. Endurance.
k. Short circuit.
l. Short-time current capability.
m. Receptacle withstand capability.
n. Insulating base and supports damage

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

3. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

4. Provide workspace and clearances required by NFPA 70.

B. Annunciator and Control Panel Mounting: Flush in wall, or wall-mount, unless otherwise indicated on Drawings.

C. Identify components according to Division 26 Section "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

E. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

F. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."

G. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches (457 mm) in length.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. Visual and Mechanical Inspection:

    a. Compare equipment nameplate data with Drawings and Specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding, and required clearances.
    d. Verify that the unit is clean.
    e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    f. Verify that manual transfer warnings are attached and visible.
    g. Verify tightness of all control connections.
    h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

    i. Perform manual transfer operation.
    j. Verify positive mechanical interlocking between normal and alternate sources.
    k. Perform visual and mechanical inspection of surge arresters.
    l. Inspect control power transformers.

        1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
        2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
        3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:

    a. Perform insulation-resistance tests on all control wiring with respect to ground.
    b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
    c. Verify settings and operation of control devices.
    d. Calibrate and set all relays and timers.
    e. Verify phase rotation, phasing, and synchronized operation.
    f. Perform automatic transfer tests.
    g. Verify correct operation and timing of the following functions:
        1) Normal source voltage-sensing and frequency-sensing relays.
        2) Engine start sequence.
        3) Time delay on transfer.
        4) Alternative source voltage-sensing and frequency-sensing relays.

5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

   a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
   e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
   f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
   g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

   a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

C. Coordinate this training with that for generator equipment.

END OF SECTION

DIVISION 26 SECTION 26 41 13
LIGHTNING PROTECTION SYSTEM
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 SUBMITTALS 3
1.4 QUALITY ASSURANCE 4
1.5 COORDINATION 4

PART 2 - PRODUCTS 4

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS 4

PART 3 - EXECUTION 5

3.1 INSTALLATION 5
3.2 CORROSION PROTECTION 6
3.3 FIELD QUALITY CONTROL 6
END OF SECTION 6

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SECTION 26 41 13
LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes a UL Master Label lightning protection system for the buildings and associated structures, to be provided under Alternate #13.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Include layouts of the lightning protection system, with details of the components to be used in the installation.

2. Include raceway locations needed for the installation of conductors.

3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.

4. Include roof attachment details, coordinated with roof installation.

5. Calculations required by NFPA 780 for bonding of metal bodies.

C. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lightning protection cabling attachments to roofing systems and accessories.

2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.

3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.

D. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

E. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

F. Field quality-control reports.

G. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D

H. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Ground rods.

2. Down conductors.

3. Surge Protection Devices.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL and LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.

B. System Certificate:

1. UL Master Label.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.5 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

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

1. East Coast Lightning Equipment Inc.

2. ERICO International Corporation.

3. Harger.

4. Heary Bros. Lightning Protection Co. Inc.

5. Independent Protection Co.

6. Preferred Lightning Protection.

7. Robbins Lightning, Inc.

8. Thompson Lightning Protection, Inc.

B. Comply with UL 96 and NFPA 780 requirements for Class I buildings.

C. Roof-Mounted Air Terminals: NFPA 780, Class I, aluminum unless otherwise indicated.

1. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.

2. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in Division 07 roofing Sections.

3. Provide protection caps on air terminal located at high traffic roof areas, walkways and service areas.

D. Main and Bonding Conductors: Aluminum, except down conductors will be Copper.

E. Ground Loop Conductor: The same size and type as the main conductor except tinned.

F. Ground Rods: Copper-clad steel; 3/4 inch (19 mm) in diameter by 10 feet (3 m) long.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within 200 feet (60 m) of building. Comply with requirements for concealed systems in NFPA 780.

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.

2. Install conduit where necessary to comply with conductor concealment requirements.

D. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.

1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

F. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

B. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Perform inspections as required to obtain a UL Master Label for system.

C. Prepare test and inspection reports and certificates.

END OF SECTION

DIVISION 26 SECTION 26 43 13
SURGE PROTECTIVE DEVICES
TABLE OF CONTENTS

PART 1. GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 DEFINITIONS 3
1.4 REFERENCES 4
1.5 SUBMITTALS 4
1.7 WARRANTY 5

PART 2. PRODUCTS 6

2.1 MANUFACTURERS 6
2.2 SURGE PROTECTIVE DEVICES 6

PART 3. EXECUTION 7

3.1 INSTALLATION 7
3.2 FIELD QUALITY CONTROL 8
3.3 STARTUP SERVICE 8
3.4 DEMONSTRATION 8
END OF SECTION 8

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SECTION 26 43 13
SURGE PROTECTIVE DEVICES

PART 1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions and Division 01 Specification Sections apply to this section.

1.2 SUMMARY

A. Description: This section describes the materials and installation requirements for integral and stand alone Surge Protective Devices (SPDs) for the protection of all AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching. SPD's shall be installed integral with equipment unless otherwise indicated.

B. Refer to Division 26 Section 262413, *Switchboards* for SPDs installed within electrical switchboards.

1.3 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: air of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. NRTL: Nationally recognized testing laboratory.

F. OCPD: Overcurrent protective device.

G. SCCR: Short-circuit current rating.

H. SPD: Surge protective device.

I. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.

J. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.

K. VPR: Voltage protection rating.

1.4 REFERENCES

A. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits.

B. ANSI/EEE C62.45 - IEEE Recommended Practice on Surge Suppressor Testing.

C. FIPS Pub 94 (1983) - Guide on Electrical Power for ADP Installation.

D. National Electrical Code - Article 285

E. National Fire Protection Association - NFPA-20, NFPA-70, NFPA-75, NFPA-78.

F. NEMA LS-1 Low Voltage Surge Protection Devices.

G. NEMA 250 - Enclosures for Electrical Equipment.

H. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.

I. UL 1283 - Electromagnetic Interference Filters.

J. UL 1449, Fourth Edition - Surge Protective Devices.

1.5 SUBMITTALS

A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated. Indicate overcurrent protection requirements.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

C. Maintenance Data: For surge protective devices to include in the maintenance manuals specified in Division 01.

D. Warranties: Special warranties as specified in this Section.

E. The submittals shall include:

1. UL 1449, Fourth Edition Listing documentation verifying:

a. Short Circuit Current Rating (SCCR)
b. Voltage Protection Ratings (VPRs) for all modes
c. Maximum Continuous Operating Voltage (MCOV) rating
d. I-nominal (I-n) rating
e. Type 1 Device listing

2. VPR, MCOV, I-n and Type 1 information is posted at www.UL.com, under Certifications. SCCRs are posted in manufacturer's UL documents.

3. UL Standard 1283 Listing, documentation.

4. UL data and visual inspection take precedence over manufacturer's published documentation.

F. Submittals shall include shop drawings including the following:

1. Manufacturer's installation instruction manual and line drawings detailing dimensions and weights of enclosure.

2. Internal wiring diagram illustrating all modes of protection in each type of SPD required.

3. Wiring diagram showing all field connections and manufacturer's recommended wire and circuit breaker sizes.

G. Upon request, an encapsulated but complete SPD shall be presented for visual inspection. MOV type & quantity shall reflect kA ratings on product data sheets, verification of diagnostic monitoring, thermal & overcurrent protection, etc.

1.6 QUALITY ASSURANCE

A. Listing and Labeling: Provide electrically operated equipment specified in this Section that is listed and labeled.

1. The Terms *Listed* and *Labeled*: As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* as defined in OSHA Regulation 1910.7.

3. Comply with NFPA-70.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the contract Documents and shall be in addition to, and run concurrent with, other warranties made under requirements of the Contract Documents.

B. Special Warranty: A written warranty, executed by manufacturer, agreeing to repair or replace components of Surge Protective Devices that fail in materials or workmanship within the specified warranty period.

1. Warranty Period: Five (5) years (minimum) from date of Substantial Completion.

PART 2. PRODUCTS

2.1 MANUFACTURERS

A. Provide integral SPD from equipment manufacturer that meets the following requirements. For external devices, the following listed manufacturers provide units of acceptable quality. Verify that all proposed units meet the specified requirements.

1. Advanced Protection Technologies, Inc.
2. EFI Electronics Corporation.
3. Liebert Corporation.
4. Current Technology, Inc.
5. LEA Dynatech, Inc.

2.2 SURGE PROTECTIVE DEVICES

A. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per NEC 285.6.

B. SPD shall be UL labeled as Type 1 (verifiable at UL.com), intended for use without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal over-temperature controls. SPDs relying upon external or supplementary installed safety disconnects do not meet the intent of this specification.

C. SPD shall be UL labeled with 20kA I-nominal (I-n) (verifiable at UL.com) for compliance to UL 96A Lightning Protection Master Label and NFPA 780.

D. Suppression components shall be heavy duty ‘large block’ MOVs, each exceeding 30mm diameter.

E. Minimum surge current capability (single pulse rated) per phase shall be:

Service Entrance or Transfer Switch:	300kA
Distribution Panelboards & MCC:	200kA
Branch Panelboards:	100kA

F. SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.

G. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G
208Y/120	700V	700V	1200V	700V
480Y/277	1200V	1200V	1800V	1200V

(Mode VPRs verifiable at UL.com. Numerically lower is allowed/preferred; old-style Suppressed Voltage Ratings (SVRs) shall not be submitted, nor evaluated due to outdated less-strenuous testing)

H. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V
480Y/277	15%	320V

I. SPD shall include a serviceable, replaceable module (excluding Branch).

J. SPD shall have UL 1283 EMI/RFI filtering with minimum attenuation of -50dB at 100kHz.

K. SPD shall include visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED. SPD shall include an audible alarm with on/off silence function and diagnostic test function (excluding branch).

L. SPD shall be provided with the following options:

1. One (1) set of NO/NC dry contacts
2. Surge event counter with back-up power source
3. Integral disconnect switch.

2.3 ENCLOSURES

A. Mount integral in panel enclosure unless otherwise indicated. For applications where stand alone mounting is indicated or required, provide the following enclosures:

1. Indoor Enclosures: NEMA 250, Type 1.
2. Outdoor Enclosures: NEMA 250, Type 4X.

PART 3. EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.2 FIELD QUALITY CONTROL

a. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.

2. Before energizing electrical circuitry, verify that the unit voltage and connecting equipment voltage is the same.

3. Inspect anchorage, alignment, grounding, and clearances.

4. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

b. An SPD will be considered defective if it does not pass tests and inspections.

c. Prepare test and inspection reports.

3.3 STARTUP SERVICE

a. Complete startup checks according to manufacturer's written instructions. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

b. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

c. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

a. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION

DIVISION 26 SECTION 26 51 00
INTERIOR LIGHTING
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 DEFINITIONS 3
1.4 SUBMITTALS 4
1.5 QUALITY ASSURANCE 5
1.6 COORDINATION 5
1.7 WARRANTY 5
1.8 EXTRA MATERIALS 6

PART 2 - PRODUCTS 6

2.1 MANUFACTURERS 6
2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS 6
2.3 EXIT SIGNS 7
2.4 EMERGENCY LIGHTING UNITS 8
2.5 LED LAMPS/LUMINAIRES 8
2.6 INTEGRAL EMERGENCY LIGHTING POWER UNITS 9
2.7 LIGHTING FIXTURE SUPPORT COMPONENTS 10
2.8 GENERAL: 10
2.9 INSTALLATION 11
2.10 IDENTIFICATION 12
2.11 FIELD QUALITY CONTROL 12
2.12 STARTUP SERVICE 12
2.13 ADJUSTING 12

PART 3 - EXECUTION (NOT USED) 13
END OF SECTION 13

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SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior lighting fixtures.
2. LED lamps and drivers.
3. Emergency lighting units.
4. Exit signs.
5. Integral Emergency Lighting Power Units.
6. Lighting fixture supports.

B. Related Sections:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Division 26 Section "Wiring Devices" for snap switches and wall switches.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. Fixture: See “Luminaire.”

D. IP: Ingress Protection or International Protection Rating.

E. LED: Light emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, driver, reflector, and housing.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.

2. Emergency lighting units including battery and charger.

3. Drivers, including energy-efficiency data.

4. Energy-efficiency data.

5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, for each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project. Comply with IES LM-79, IES LM-80.

a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, and mounting and attachment details.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples: For each lighting fixture indicated in the Interior Lighting Fixture Schedule. Each Sample shall include the following:

1. Lamps and drivers, installed.

2. Cords and plugs.

D. Installation instructions.

E. Product Certificates: For each type of driver for bi-level and dimmer-controlled fixtures, from manufacturer.

F. Field quality-control reports.

G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

H. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products and complying with applicable IES testing standards.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

2. Warranty Period for Emergency Battery Pack and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for Drivers: Manufacturer’s standard form in which driver manufacturer agrees to repair or replace drivers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Drivers: Five years from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

3. Battery and Charger Data: One for each emergency lighting unit.

4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

5. LED Modules (light engine and driver): Furnish at least (1) of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Basis of Design Product: The design of each item of interior luminaire is based on the product named. Subject to compliance with requirements, provide either the named product or an approved equal.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

    a. Lens Thickness: At least 0.125-inch (3.175 mm) minimum unless otherwise indicated.
    b. UV stabilized.

2. Glass: Annealed crystal glass unless otherwise indicated.

F. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and ballast characteristics:

    a. "USE ONLY" and include specific lamp type.
    b. Lamp diameter, shape, size, wattage and coating.
    c. CCT and CRI for all luminaires.

G. Recessed luminaires shall comply with NEMA LE 4.

2.3 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.

2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

    a. Battery: Sealed, maintenance-free, nickel-metal hydride type.
    b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
    f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.4 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, nickel-cadmium type.

2. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.

7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.5 LED LAMPS/LUMINAIRES

A. LED Luminaires: A LED luminaire consists of LED light engine and driver, heat-sink, fixture housing, and optic assembly where applicable.

1. Temperature: Minimum starting temperature of -30 deg C (-22 deg F), minimum 40 deg C (104 deg F) ambient temperature rating.

2. Life and Lumen Maintenance: L70 lamp life of 50,000 hours.

3. CRI and CCT: 3500 deg K (+/- 275 K) CCT and greater than 80 CRI.

4. Transient Voltage Protection: Rated to withstand 2.5 kV of transient line surge.

5. Photometric Data and Test Reports: Comply with IESNA LM-79-19, IESNA LM-80-15, and ANSI C78.377-17.

6. Radio Frequency Interference: Comply with CAP 106B Telecommunications (Control of Interference) Regulations.

7. Luminaires and components thereof shall comply with UL 8750 Standard of Safety.

8. Five-year warranty on luminaire including LED light engine and driver.

9. Power Factor: 90 percent minimum.

10. Total Harmonic Distortion Rating: Less than 20 percent.

11. RoHS compliant.

12. Sound Rating: Class A.

13. Overload, short circuit, and thermal protection.

14. Comply with UL 1598-14 NMX-J-307/1-ANCE/C22.2 NO.250-0-14, *Luminaires, LEDs.*

2.6 INTEGRAL EMERGENCY LIGHTING POWER UNITS

A. Provide emergency lighting power supply units for fixtures indicated on the drawings with integral emergency battery unit as specified herein.

1. Each fixture indicated to be provided with an emergency driver shall be provided with an emergency power supply unit which consists of a package assembly containing a high-temperature maintenance-free lithium ion battery, a rectifier/battery charger, a DC to AC inverter contained in one metal enclosure. Emergency drivers shall be provided in conjunction with the AC LED driver provided with the fixture, compatible with the driver output current (max 5A). The battery shall have a normal life expectancy of 10 to 15 years with sufficient capacity to operate the lamp load at full normal brightness for 90 minutes. Units shall be UL approved for compliance with UL Standard 924 “Emergency Lighting and Power Equipment.”

2. Each unit shall be unconditionally guaranteed for a period of three years, with an additional three year pro-rated guarantee on the storage battery.

B. Operating Modes

1. Each emergency power supply unit shall automatically operate the lamp in the event of an AC power system failure for 90 minutes. When AC power is restored, the emergency power supply unit shall automatically return to the charging mode.

a. MODE 1: Lamp is controlled by a switched AC ON/OFF circuit. Lamp automatically turns ON when AC power is lost. The unit is shipped from the factory connected for this mode of operation.
b. MODE 2: Same as MODE 1 except lamp does not automatically turn ON when AC power is lost. This mode is established by adding a jumper between the AUTO and GND terminals.

c. MODE 3: The unit can be used to provide continuous unswitched, uninterruptible light. A switched AC circuit is not used for this mode. To establish this mode of operation, connect a jumper between the OVER and GND terminals.

d. MODE 4: The unit can be used to provide an unswitched light which is normally OFF but which automatically turns on when AC power is lost. This mode of operation is established by connecting only the unswitched AC circuit to the power supply unit.

e. MODE 5: Lamp is turned on by external switch or relay contacts. The switched AC ON/OFF circuit is optional in this mode. The switch contacts "override" the (optional) switched AC circuit to turn the lamp on. In order for the lamp to be OFF, the external switch contacts must be open AND the switched AC circuit (if used) must be OFF. This mode is established by connecting the switch contacts to OVER and GND. In this mode, the lamp will also be automatically turned ON in the event of AC power failure, unless this feature is disabled by connecting a jumper between the AUTO and GROUND terminals.

C. Power supply units for emergency lighting shall be provided with remote test switch to be mounted flush in ceiling adjacent to fixture. Power supply units shall be Bodine 10W BSL10T3U series self-testing/self-diagnostic Class 2 output, Emergi-Lite (unless otherwise noted), or the same manufacturer of the lighting fixture as noted in the Lighting Fixture Schedule.

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge (2.68 mm).

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge (2.68 mm).

F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug EXECUTION.

2.8 GENERAL

A. Comply with NECA/IESNA 500-2006 “Standard for Installing Indoor Commercial Lighting systems.”

2.9 INSTALLATION

A. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.

2. Install lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Remote Mounting of Drivers: Distance between the driver and fixture shall not exceed that recommended by driver manufacturer. Verify, with driver manufacturers, maximum distance between driver and luminaire.

D. Integral Emergency Lighting Power Units:

1. Power supply units for emergency lighting shall be mounted on the top of the fixture housing as recommended by the manufacturer. If required, the units shall be permitted to be remote mounted up to 50 feet from the fixture per manufacturer's distant limitations, mounted on the building structure above the ceiling space. Where units are remote mounted, the final four-foot length of connecting raceway shall be Greenfield flexible metallic conduit to facilitate fixture removal.

2. Note that wherever an emergency lighting power supply unit is used in a circuit controlled by a light switch, a four wire connection to the AC power source is required - the switched wire, the hot wire, the neutral and ground.

E. Lay-in Ceiling Luminaire Supports: Use grid as a support element.

1. Install ceiling support system wires (Solid#12AWG safety wire), independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.

2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.

F. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.

2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide

damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.

3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

2.10 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

2.11 FIELD QUALITY CONTROL

A. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

B. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

C. Luminaire will be considered defective if it does not pass operation tests and inspections.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

2.12 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 260923 “Lighting Control Devices.”

2.13 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.

2. Parts and supplies shall be manufacturer’s authorized replacement parts and supplies.

3. Adjust aimable luminaires in the presence of Architect.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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DIVISION 26 SECTION 26 56 00
EXTERIOR LIGHTING
TABLE OF CONTENTS

PART 1 - GENERAL 3

1.1 RELATED DOCUMENTS 3
1.2 SUMMARY 3
1.3 DEFINITIONS 3
1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION 4
1.5 ACTION SUBMITTALS 4
1.6 QUALITY ASSURANCE 5
1.7 DELIVERY, STORAGE, AND HANDLING 6
1.8 WARRANTY 6
1.9 EXTRA MATERIALS 6

PART 2 - PRODUCTS 7

2.1 MANUFACTURERS 7
2.2 LUMINAIRES, GENERAL REQUIREMENTS 7
2.3 LED LAMPS/LUMINAIRES 9
2.4 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS 9
2.5 STEEL POLES 10

PART 3 - EXECUTION 11

3.1 GENERAL: 11
3.2 LUMINAIRE INSTALLATION 11
3.3 POLE INSTALLATION 12
3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES 12
3.5 CORROSION PREVENTION 12
3.6 GROUNDING 13
3.7 FIELD QUALITY CONTROL 13
3.8 DEMONSTRATION 13
END OF SECTION 13

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SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Exterior luminaires, materials, and finishes.

2. LED lamps and drivers.

3. Luminaire-mounted photoelectric relays.

4. Poles and accessories

B. Related Sections include the following:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

2. Section 265100 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. EPA: Equivalent projected area.

D. Fixture: See “Luminaire.”

E. IP: Ingress Protection or International Protection Rating.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, driver, reflector, and housing.

H. LED: Light-emitting diode.

I. Pole: Luminaire support structure.

J. Standard: Same definition as “Pole” above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-6-M.

B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-6-M.

C. Ice Load: Load of 3 lbf/sq. ft. (143.6 Pa), applied as stated in AASHTO LTS-6-M.

D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-6-M.

1. Wind speed for calculating wind load for poles 50 feet (15 m) or less in height is 80 mph (129 km/h).

1.5 ACTION SUBMITTALS

A. Product Data: For each luminaire and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, weights, effective projected area, and verification of indicated parameters.

2. Details of attaching luminaires and accessories.

3. Details of installation and construction.

4. Luminaire materials.

5. Photometric data and adjustment factors based on laboratory tests of each luminaire type, complete with indicated lamps, drivers, and accessories. Comply with IES LM-79, IES LM-80.

a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. Photoelectric relays.

7. Drivers, including energy-efficiency data.

8. Lamps, including life, output (lumens, CCT, and CRI), and energy-efficiency data.

9. Materials, dimensions, and finishes of poles.

10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

11. Anchor bolts for poles.

12. Manufactured pole foundations.

B. Shop Drawings:

1. Include plans, elevations, sections and mounting and attachment details.

2. Include details of luminaire assemblies. Indicate dimensions, weights loads, required clearances, method of field assembly, and location and size of each field connection.

3. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

4. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.

5. Wiring Diagrams: Power, signal, and control wiring.

6. Lighting Calculations: Point-by-point calculations for fixtures shown on the Site Plan and noted on the Lighting Fixture Schedule. Calculation grid shall be maximum 10’-0” on center, horizontal.

C. Samples for Verification: For products designated for sample submission in Exterior Lighting Fixture Schedule. Each sample shall include lamps and drivers. Finish samples shall be provided upon request.

D. Pole and Support Component Certificates: Signed by manufacturers, certifying that products are designed for indicated load requirements in AASHTO LTS-6-M and that load imposed by luminaire has been included in design.

E. Qualification Data: For agencies providing photometric data for lighting fixtures.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products and complying with applicable IES testing standards.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C2, "National Electrical Safety Code."

F. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.

2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.

3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

4. Warranty Period for Lamps: Replace lamps and fuses that fail within 24 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 24 months from date of Substantial Completion.

5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than five years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

2. Glass, Acrylic and Plastic Lenses, Covers, and Other Optical Parts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

3. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

4. LED Modules (light engine and driver): Furnish at least (1) of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

B. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product named. Subject to compliance with requirements, provide either the named product or an approved equal.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit maintenance without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during maintenance and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect driver when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As selected from manufacturer's standard catalog of colors.

N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

2.3 LED LAMPS/LUMINAIRES

A. LED Luminaires: A LED luminaire consists of LED light engine and drive, heat-sink, fixture housing, and optic assembly where applicable.

1. Temperature: Minimum starting temperature of -30 deg C (-22 deg F), minimum 40 deg C (104 deg F) ambient temperature rating.

2. Life and Lumen Maintenance: L70 lamp life of 50,000 hours.CRI and CCT: 3000 deg K (+/- 275 K) CCT and greater than 70 CRI.

3. Transient Voltage Protection: Rated to withstand 10 kV of transient line surge.

4. Photometric Data and Test Reports: Comply with IESNA LM-79-08, IESNA LM-80-08, and ANSI C78.377-08.

5. Radio Frequency Interference: Comply with CAP 106B Telecommunications (Control of Interference) Regulations.

6. Luminaires and components thereof shall comply with UL 8750 Standard of Safety.

7. Five-year warranty on luminaire including LED light engine and driver.

8. Power Factor: 90 percent minimum.

9. Total Harmonic Distortion Rating: Less than 20 percent.

10. RoHS compliant.

11. Sound Rating: Class A.

12. Overload, short circuit, and thermal protection.

2.4 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-6-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.

2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.

2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.

3. Anchor-Bolt Template: Plywood or steel.

D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

2.5 STEEL POLES

A. Poles: Comply with ASTM A500/A500M, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.

1. Shape: Round, straight; Square, straight.

2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.

3. Match pole material and finish.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches (65-by-130-mm) with cover secured by stainless-steel captive screws.

E. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

G. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

H. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As selected by Architect from manufacturer's full range.

I. Powder-Coat Finish: Comply with NAAMM’s "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

2. Powder Coat: Comply with AAMA 2604.

a. Electrostatic-applied powder coating; single application and cured to a minimum 2.5- to 3.5-mils (64- to 89-um) dry film thickness. Coat interior and exterior of pole for equal corrosion protection.
b. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with NECA/IESNA 501-2006 “Standard for Installing Exterior Lighting Systems”.

3.2 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.3 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).

2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).

3. Trees: 15 feet (5 m).

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer’s written instructions.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.

2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.

3. Install base covers, unless otherwise indicated.

4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Raise and set poles using web fabric slings (not chain or cable).

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top minimum 6 inches (100 mm) above finished grade or surface at luminaire location, unless otherwise noted. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole, unless otherwise indicated.

2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.7 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires. Refer to Division 01 Section that includes Demonstration and Training.

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SECTION 26 60 10
RIGGING SYSTEMS ELECTRICAL WORK

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work of this Section includes all labor, materials, equipment, and services necessary to complete the Stage Rigging and Draperies installation, as shown on the drawings and specified herein, including, but not limited to, the following:
   1. Capstan winch
      a. Provide backbox, conduit, wire, and termination.
      b. Receptacle provided by Rigging Contractor.
   2. Motorized fire curtain
   3. Orchestra lift
   4. Motorized chair wagon system
   5. Motorized speaker hoists

B. The Contractors for the above work will furnish the control system components. The Electrical Contractor shall install the system components, provide conduit and wire runs between components, and perform all terminations.

C. Electrical service for the above work is shown on the E-series drawings.

D. The TR-series Contract Drawings provide block diagrams and equipment locations. The final design of the control systems is the responsibility of the respective Contractors, who will supervise the Electrical Contractor’s work.

1.03 PRACTICES AND PROCEDURES

A. Practices and procedures for the work in this Section shall conform to applicable Sections in this Division.

END OF SECTION