



# READING FIRE DEPARTMENT ENGINE 7

## MCKNIGHT & SPRING

### GENERATOR REPLACEMENT

FOR:

DEPARTMENT OF PUBLIC WORKS, CITY OF READING

BERKS COUNTY, CITY OF READING, PENNSYLVANIA

SEPTEMBER 2020



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**SECTION 03 30 53****CONCRETE FOR UTILITY CONSTRUCTION****PART 1 GENERAL****1.1 DESCRIPTION**

- A. The Work of this section includes, but is not limited to:
1. Cast-in-place Cement Concrete Construction

**1.2 REFERENCES**

- A. Pennsylvania Department of Transportation (PennDOT): Publication 408 Specifications.
- B. American Society for Testing and Materials (ASTM):
1. ASTM A615 - Deformed and Plain Billet - Steel Bars for Concrete Reinforcement
  2. ASTM C31 - Methods of Making and Curing Concrete Test Specimens in the Field
  3. ASTM C39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens
  4. ASTM C42 - Methods of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
  5. ASTM C94 - Ready Mixed Concrete
  6. ASTM C143 - Test Method for Slump of Portland Cement Concrete
  7. ASTM C172 - Method of Sampling Fresh Concrete
  8. ASTM C173 - Test Method for Air Content of Freshly Mixed Concrete - Volumetric Method
  9. ASTM C231 - Test Method for Air Content of Freshly Mixed Concrete - Pressure Method

**1.3 SUBMITTALS**

- A. Submit certification from the concrete producer attesting that the cement concrete conforms to the State Specifications for the class of concrete being used.
- B. Submit certified results of compressive strength tests performed by an independent testing laboratory.
- C. Submit detailed shop drawings of reinforcing steel.

**PART 2 PRODUCTS****2.1 CEMENT CONCRETE**

- A. Ready-mixed, conforming to Section 704, cement concrete, Pub. 408 Specifications.
- B. Requirements for State approved batch plants, design computations and plant inspection shall not apply; the acceptability of concrete will be based on conformance with the Cement Concrete Criteria specified below and the results of the specified tests.
- C. Cement Concrete Criteria:
1. Class A:
    - a. 28-day compressive strength: 3300 psi
    - b. Slump: 1 to 3 inches
    - c. Air content: 5% ± 1%
  2. Class C:
    - a. 28-day compressive strength: 2000 psi
    - b. Slump: 2 to 6 inches
    - c. Air content: 5% ± 1%
  3. High Early Strength:
    - a. 3-day compressive strength: 3000 psi

- b. Slump: 1 to 3 inches
- 4. Cement Factor and Maximum Water-Cement Ratio conforming to Table A, Section 704.1(b), Pub. 408 Specifications.

## **2.2 REINFORCEMENT STEEL**

- A. Reinforcement Bars:
  - 1. New billet-steel bars conforming to ASTM A615.
  - 2. Deformed, Grade 60.
- B. Steel Wire Fabric: Conforming to Section 709.3, Pub. 408 Specifications.

## **PART 3 EXECUTION**

### **3.1 GENERAL**

- A. Comply with applicable paragraphs of Section 1001, Pub. 408 Specifications for construction requirements including formwork, curing, protection and finishing of cement concrete.
- B. Support pipe, valves and fittings at the required elevation with brick or concrete block. Do not use earth, rock, wood, or organic material as supports.
- C. Proper grade markers or stakes shall be used by Contractor to establish grades for platforms.

### **3.2 CONSTRUCTION**

- A. Construct cast-in-place miscellaneous reinforced structures of Class A concrete; Class A concrete shall be central-plant-mixed.
- B. Construct miscellaneous mass concrete of Class C concrete; Class C concrete may be from a mobile cement concrete plant or truck-mixed.
- C. Concrete Pads:
  - 1. pads shall be Class A air entrained concrete
    - a. Pads of thickness indicated on the Contract Drawings.
  - 2. Subgrade shall be properly prepared and thoroughly wetted before placing concrete.
- D. Provide spacers, chairs, bolsters, ties and other devices for properly placing, spacing, supporting and fastening reinforcement in place.
- E. Do not backfill structures until concrete has achieved its initial set, forms are removed, and concrete work is inspected by the Architect.
- F. Perform backfilling and compaction as specified in Section 31 23 17 - Trenching, Backfilling and Compacting.

### **3.3 FINISHING**

- A. Integral Finishes: Obtain finishes on concrete slabs without applying separate topping coat, as follows:
  - 1. Broom Finish: Draw stiff broom over previously floated finish, to obtain non-slip finish, on exterior sidewalks, ramps, stairs, pads and similar locations.

### **3.4 FIELD TESTS OF CONCRETE DURING CONSTRUCTION**

- A. Perform compressive strength, slump and air content tests for each 50 cubic yards of each class of structural concrete placed, or fraction thereof.
- B. Testing is not required for non-structural applications.

- C. Retain an independent testing laboratory to test cylinders.
- D. Keep a slump cone and an air meter in close proximity to all concrete placements.
- E. Sample concrete in accordance with ASTM C172.
- F. Determine slump in accordance with ASTM C143.
- G. Determine air content in accordance with ASTM C231 or ASTM C173 as applicable.
- H. Test Cylinders:
  - 1. Cast at least 5 cylindrical test specimens for each batch.
  - 2. Test two cylinders at 7 days; test two cylinders at 28 days.
  - 3. Hold the remaining cylinder in reserve for testing in the event that any of the other cylinders are damaged prior to testing.
  - 4. Prepare and cure test cylinders in accordance with ASTM C31.
  - 5. Determine concrete compressive strength in accordance with ASTM C39.
  - 6. Compute and evaluate in accordance with ASTM C94.
- I. If test cylinders fail to meet compressive strength requirements, the Architect may require additional core tests in accordance with ASTM C42 at the expense of the Contractor.

**END OF SECTION 03 30 53**

**SECTION 26 01 00****GENERAL ELECTRICAL REQUIREMENTS****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 general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements as defined by Part 1 paragraph "Related Documents" :

1. General.
  - a. Definitions.
  - b. Abbreviations.
  - c. Regulations.
  - d. Drawings and Specifications.
  - e. Familiarity with Contract Requirements.
  - f. Submittals.
  - g. Substitutions.
  - h. Electronic Drawings.
  - i. Quality Control.
  - j. Delivery, Storage And Handling.
  - k. Extra Materials.
2. Administrative Submittals.
  - a. Schedule of Values (Detailed Breakdown).
  - b. Record Documents.
  - c. Operation and Maintenance (O&M) Manuals.
3. Execution.
  - a. General Requirements.
  - b. Rough-In.
  - c. Electrical Installations.
  - d. Mounting Heights.
  - e. Cutting and Patching.
  - f. Continuity of Service.
  - g. Protection of Work, Materials, and Equipment.
  - h. Recycling and Disposal of Hazardous/Contaminated Material.
  - i. Start-up and Testing.
  - j. Clean Up.
  - k. Project Safety.
  - l. Instructions for the Owner's Personnel.

- B. Related Sections: See other Division 26 and related Sections for related electrical Work.

**1.3 DEFINITIONS**

- A. Approved Equal: The term "approved equal", "approved", "equal", "equivalent", etc. shall mean equal in all respects in the opinion of the Engineer.

- B. As Required: The term "as required" refers to making final connections to and/or coordinating with the appropriate authorities regarding the installation of the indicated equipment.
- C. Contract Document(s): The term "contract document(s)" shall mean the entire body of specifications, drawings, addenda, bulletins, response to request for information (RFIs), change orders (CO), construction directives, and other definitive data including correspondence issued during Bidding and after Contract signing as a clarification / change to the Project.
- D. Contractor: The term "Contractor", "this Contractor" or "Electrical Contractor" when used in the Contract Documents refers to the Contractor responsible for all work specified in Division 26 and other divisions and as indicated on the Contract Drawings.
- E. Directed: Terms such as "directed," "requested," "authorized," "selected," and "permitted" when used separately without referencing any authority, shall mean directed by the Engineer, requested by the Engineer, and similar phrases.
- F. Finished/Unfinished Space: The term "finished space" shall mean areas where one or more of the following are applicable: wall coverings (i.e. plaster/gypsum board, wallboard, wall paper, vinyl, trim, etc.) are installed and/or walls are painted, or where floors are polished and/or coverings (i.e. tile, vinyl, carpet, trim, etc.) are installed on the floor, or where ceiling coverings (i.e. plaster/gypsum board, suspended A.C.T., trim, etc.) are installed and/or ceilings are painted. The term "unfinished space" refers to any area that does not meet one of the definitions for a "finished space" as specified above. Mechanical rooms, electrical rooms, garages, etc. are typically considered "unfinished spaces" unless they also double as an office, clean storage, etc.
- G. Furnish: The term "furnish" when used separately, shall mean to supply and deliver to the Project site, ready for assembly, installation, and similar operations by others. Furnishing operations at the Project site shall include, but may not be limited to, the actual unloading, temporary storage, and unpacking of the furnished items.
- H. Indicated: The term "indicated", "shown," "noted," "scheduled," and "specified" refers to graphic representations, notes, or schedules on the Drawings; or to other paragraphs or schedules in the Specifications and similar requirements in the Contract Documents.
- I. Install: The term "install" when used separately, shall mean to mount in place, connect and make operable. Installation operations at the Project site shall include, but may not be limited to, the actual unloading, temporary storage, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- J. Project: The term "project" when used in these Contract Documents includes the entire project under the total of all Contracts.
- K. Provide: The term "provide" when used in these specifications, shall mean to furnish and install, complete and ready for the intended use. See above definitions for additional requirements.
- L. Regulations: The term "regulations" includes laws, ordinances, codes, industry standards, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- M. Subcontractor: The term "Subcontractor" when used in these Contract Documents refers to an experienced installer (i.e. manufacturer, vendor, etc.) whom has successfully completed a minimum of five (5) previous projects similar in size and scope to this Project; being familiar with the special requirements indicated; and having complied with requirements of authorities having jurisdiction. Any reference to, or letting of work contained in these Contract Documents to any Subcontractor does not



relieve this Contractor of his/her responsibility for all work, material and equipment indicated in these Contract Documents.

- N. Work: The term "work" refers to all labor and materials provided by the Contractor and/or Subcontractor to make a complete and operable system.

#### **1.4 ABBREVIATIONS**

- A. Abbreviations and Names: The following acronyms or abbreviations as referenced in the Contract Documents are defined to mean the following:
1. A.D.A - Americans with Disabilities Act
  2. A.N.S.I. - American National Standards Institute, Inc.
  3. A.S.T.M. - American Society for Testing and Materials
  4. E.C. - Electrical Contractor
  5. G.C. - General Contractor or
  6. H.C. - Mechanical Contractor, HVAC Contractor, Heating Contractor
  7. I.E.E.E. - Institute of Electrical and Electronic Engineers
  8. I.P.C.E.A. - Insulated Power Cable Engineers Association
  9. I.S.A. - Instrument Society of America
  10. N.E.C. - National Electrical Code of National Fire Protection Association
  11. N.E.M.A. - National Electrical Manufacturers Association
  12. N.E.S.C. - National Electrical Safety Code
  13. N.F.P.A. - National Fire Protection Association
  14. P.C. - Plumbing Contractor

#### **1.5 PROJECT REQUIREMENTS**

- A. General: All items of labor, materials and equipment, not specified in detail or shown on drawings but necessary for complete installation and proper operation of Work described or implied, shall be furnished and installed.
- B. Testing: Test all electrical conductors, after completion of installation of wiring and apparatus, to insure continuity, proper splicing, freedom from grounds, except "made grounds" and those required for protection and insulation resistance. Use testing instruments (i.e., megger). Activation of each circuit will be required as final test. Testing shall be done at no additional expense to the Owner.
- C. Documents: Drawings are indicative of Work to be installed but do not indicate all bends, fittings, boxes, etc. that will be required in this Contract. The structural and finished conditions of the Project shall be investigated prior to construction.
- D. Coordination: Coordinate Work with other trades to avoid interference between piping, ducts, equipment, architectural or structural features. In case of interference, the Engineer shall determine which work is to be relocated, regardless of which was first installed.
- E. Equipment Pads: All equipment pads located in areas receiving a floor finish (i.e., tile, paint) shall be painted. Type of paint shall be approved for concrete application. Color shall be as selected by the Engineer.
- F. Quality: All electrical equipment or apparatus of any one system shall be of the same quality as produced by one or more manufacturers, suitable for use in a unified system. The term "manufacturer" shall be understood as applying to a reputable firm who assumes full responsibility for its products.
- G. Products: When more than one name of manufacturer is listed in the Division 26 and other division Specifications, the first manufacturer and catalogue number determine the style and quality. Other manufacturers named have been included based on their ability to furnish (fabricate, construct and

test) equipment that will provide similar quality and performance. Products from these “other” manufacturers will be reviewed by the Engineer providing the physical and performance attributes provide equivalence to those of the first named manufacturers. The Engineer shall provide sole determination to this equivalency. If such products are acceptable to the Engineer but differ from those named in the Specification or on the Drawings to the extent that their proper incorporation into the Work requires changes to the structural piping, mechanical, electrical, instrumentation, or any other changes of whatsoever nature, the Contractor shall be responsible for such changes. See Part 1 “Submittals” and “Substitutions” specified elsewhere for additional requirements.

## 1.6 REGULATIONS

- A. All regulations (e.g., federal and state laws, municipal/local ordinances, codes and industry standards adopted by the authority having jurisdiction) bearing on the conduct of the Work or referenced by these Contract Documents are hereby incorporated and made a part of these specifications. Each entity engaged in construction on the Project shall be familiar with the regulations applicable to its construction activity. Where copies of the regulations are needed to perform a required construction activity, the Contractor shall obtain copies directly from the publication source. Regulations applicable to this Project but are not limited to the following:
1. Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities (ADAAG).
  2. International Code Council (ICC) Codes (i.e. International Building Code - IBC, International Electrical Code - IEC, International Energy Conservation Code - IECC, International Fire Code - IFC, International Mechanical Code - IMC, International Fuel Gas Code - IFGC, etc.)
  3. Pennsylvania Department of Environmental Protection (PA DEP) (i.e. Administration of the Storage Tank and Spill Prevention Program; etc.)
  4. Pennsylvania Department of Labor and Industry (PA L&I) (i.e. Building Energy Conservation Standards; Uniform Construction Code; Lighting; etc.)
  5. National Fire Protection Association (NFPA) (i.e. NFPA 70 “National Electric Code”, NFPA 90A “Installation of Air-Conditioning and Ventilating Systems”, NFPA 101 “Life Safety Code”, etc.)
  6. National Electrical Safety Code - ANSI C2.
  7. Owner’s Insuring Agency.
- B. Should any change in the drawings and/or specifications be required to conform to the codes, ordinances, regulations or laws mentioned above, the Engineer shall be notified prior to the time of submitting bids. After signing of the Contract, each Contractor will be responsible for the completion of all work necessary to meet the above-written requirements without additional expense to the Owner.
- C. The Contractor shall comply with all rules, regulations and recommendations of any public utility serving this Project.
- D. The entire electrical system shall be installed in accordance with the latest edition of the National Electrical Code, approved by the governmental body having jurisdiction, including amendments thereto.
- E. All electrical equipment and its components and materials shall meet all applicable UL criteria and bear the appropriate label of the Underwriters' Laboratory. All control panels, motor controller sections, etc. shall bear the UL-508A listing. All complete assemblies shall be UL listed.
- F. The electrical Work on this Project shall be inspected by local AHJ. The Contractor shall pay for all costs relative to the inspections. Any work failing to pass inspection shall be corrected and re-inspected at no additional cost to the Owner. Final wiring certificates shall be in triplicate and shall be delivered to the Engineer for review. The Contractor shall formally file for this inspection within twenty (20) days of signing the Contract.

**1.7 DRAWINGS AND SPECIFICATIONS**

- A. The drawings are generally diagrammatic and indicative of the Work to be installed. Exact locations of equipment and points of termination shall be reviewed with the Engineer. Should it be found that any system or equipment cannot be installed as shown on the drawings; the Engineer shall be consulted before installing or making changes to the layout.
- B. The drawings and specifications are intended to function as a common set of documents. Anything shown on the drawings but not in the specifications, or mentioned in the specifications and not shown on the drawings, shall be equally binding as if both noted on the drawings and called for in the specifications.
- C. No measurement of a drawing by scale shall be used as a working dimension. Working measurements shall be taken from figured dimensions and through cooperation with all other Subcontractors.
- D. This Contractor shall carefully examine all Project Contract Drawings and Specifications (electrical and non-electrical). If any discrepancies occur between the drawings or between the drawings and specifications, the discrepancies shall be reported to the Engineer in writing and obtain written instructions as to the manner in which to proceed. No departures from the Contract Drawings shall be made without prior written instructions from the Engineer. Where conflicts exist between drawings, specifications, and equipment schedules, the most stringent shall apply.
- E. All items of labor, material and equipment not specified in detail or shown on the drawings but incidental to or necessary for the complete and proper installation and proper operation of the several branches of the Work described herein or reasonably implied in connection therewith, shall be furnished as if called for in detail by the specifications or drawings.

**1.8 FAMILIARITY WITH CONTRACT REQUIREMENTS**

- A. It is the responsibility of the Contractor, prior to submitting a bid on this Project, to satisfy himself as to the nature and location of the work, the conformation of the ground, soil characteristics, the character, quality and quantity of the materials which will be required, the character of equipment and facilities needed preliminary to and during the prosecution of the work, the general and local conditions, and of all other matters which can in any way affect the work under this Contract.
- B. Failure to make an on-site inspection prior to submitting a bid, or failure to comply with any or all of the above requirements will not relieve this Contractor from the responsibilities of properly estimating the requirements or costs of successful completion of the work nor from the responsibility for the faithful performance of the provisions of this Contract.
- C. The Electrical Contractor shall confer with all other sub-contractors and shall apply for detailed and specific information regarding the location of all equipment as the final location may differ from that indicated on the drawings. Outlets, equipment or wiring improperly placed because of the Electrical Contractor's failure to obtain this information shall be relocated and reinstalled by the Electrical Contractor without additional expense to the Owner.

**1.9 SUBMITTALS**

- A. General: Follow the procedures as defined by Part 1 paragraph "Related Documents" Division 01 "Submittals" and as indicated below:
  - 1. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.

- a. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information using arrows and/or highlighting on all copies. Include the following information:
  - 1) Manufacturer's printed recommendations.
  - 2) Compliance with trade association standards.
  - 3) Compliance with recognized testing agency standards, especially UL.
  - 4) Application of testing agency labels and seals.
  - 5) Notation of dimensions verified by field measurement.
  - 6) Notation of coordination requirements.
  - 7) Manufacturer's clearance requirements for operation, maintenance and replacement of operating equipment devices.
  - 8) Compliance with all pertinent specification and drawing requirements shall be indicated on the manufacturer's drawings.
2. Engineer's Action Stamp: Each submittal will be marked and stamped by the Engineer to indicate the appropriate action to be taken by the Contractor. Appropriate action will be as follows:
  - a. Final Unrestricted Release: When the Engineer marks a submittal "No Exceptions Taken," the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents.
  - b. Final-But-Restricted Release: When the Engineer marks a submittal "Make Corrections Noted, Resubmittal Not Required," the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents.
  - c. Returned for Resubmittal: When the Engineer marks a submittal "Make Corrections Noted and Resubmit," do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the notations; resubmit without delay. Repeat if necessary to obtain different action mark.
    - 1) The entire submittal shall be corrected and resubmitted for review. Incomplete resubmissions will be returned to the Contractor for the inclusion of missing items and/or information. A resubmission will be considered incomplete when items and/or information submitted previously are not included in the resubmittal regardless of whether the items and/or information were required to be revised/corrected or not.
    - 2) Do not use, or allow others to use, submittals marked "Make Corrections Noted and Resubmit " at the Project Site or elsewhere where Work is in progress.
  - d. Not Permitted to be Used: When the Engineer marks a submittal "Rejected," do not proceed with Work covered by the submittal. Do not resubmit the same manufacturer or type of material, depending upon comments by the Engineer. Prepare a new submittal according to the notations; resubmit without delay. Repeat if necessary to obtain different action mark.
    - 1) The entire submittal shall be resubmitted for review. Incomplete resubmissions will be returned to the Contractor for the inclusion of missing items and/or information.
    - 2) Do not use, or allow others to use, submittals marked "Rejected - See Remarks" at the Project Site or elsewhere where Work is in progress.
  - e. Other Action: Where a submittal is for information or record purposes or special processing or other activity, the Engineer will return the submittal marked "Review Not Required."
3. Sample Submittals: Refer to individual Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
  - a. Color Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
  - b. Number of Samples: Submit one (1) complete set of sample products that are proposed to be installed in the Project.

- c. Review of Samples: A transmittal letter verifying receipt of the submitted samples will be returned to the Contractor indicating the action taken by the Engineer. At the discretion of the Engineer, the samples may or may not be returned with the transmittal letter to the Contractor. If samples are returned, the submitted samples are not guaranteed to be in useable condition and suitable for installation in the Project.
  - d. Ownership of Samples: All submitted samples not returned to the Contractor shall become the property of the Engineer and may be disposed of at the Engineer's discretion. Samples returned to the Contractor and not indicated as the property of the Owner shall become the property of the Contractor.
  - e. Return Policy: Contractor may request the submitted samples be returned within ten (10) days after receiving the above indicated transmittal letter. If acceptable to the Engineer, the Contractor will be responsible for retrieving the samples from the Engineer's office during regular office hours. After the Contractor has notified the Engineer of his request to retrieve the submitted samples, the Contractor shall have 10 days to remove the samples from the Engineer's office. (Samples will not be mailed.) All samples not removed within the allotted time shall become the property of the Engineer and may be disposed of at the Engineer's discretion.
  - f. Installation of Samples: Submitted samples may be incorporated into the Work but such samples shall be in an undamaged condition at time of use and/or installation.
4. Unsolicited Submittals: A transmittal letter verifying receipt of the unsolicited submittal (which may include samples) will be marked "Review Not Required" and returned to the Contractor. The Engineer may or may not return unsolicited submittals and associated samples with the transmittal letter to the Contractor at the Engineer's discretion. See "Sample Submittals" paragraph above for return policy.
- B. The submissions are the Contractor's documents, and the Engineer's approval constitutes an acknowledgment that the documents have been submitted and nothing more. It is the Contractor's responsibility to check his/her own submissions for compliance with Contract Documents and the Project conditions.
  - C. If the Contractor submits a product of a manufacturer which appears as a second or third name without corresponding catalogue numbers and/or the manufacturer is not listed by name, the submittal shall include a Compliance Report. See "Substitutions" article specified elsewhere in Part 1 for Compliance Report requirements and additional substitution requirements.
  - D. This Contractor shall submit to the Engineer copies of shop drawings, catalogue cuts, data sheets, etc. of all equipment and materials as called for herein. Shop drawings shall be corrected as directed by the Engineer and resubmitted until satisfactory. No work shown on any shop drawing shall be executed until such shop drawings are reviewed.
  - E. All drawings, etc., submitted for approval shall be marked with the Name of the Project and shall bear the stamp of approval of the Contractor as evidence that the material has been checked by the Contractor. Any drawings, etc., submitted without this stamp of approval will not be considered and will be returned to the Contractor for resubmission.
  - F. Additional copies may be required by individual sections of these Specifications.
  - G. The Engineer, Owner, and the authority having jurisdiction (AHJ) reserve the right to request additional shop drawings and product data to clarify previously submitted material.
  - H. No appurtenances shall be installed in the Work or orders placed for same until product data and shop drawing approval has been given by the Engineer. See "Division 26 and other Division Submittals Chart" at the end of this Section for required submissions.

**1.10 SUBSTITUTIONS**

- A. General: In order to establish standards of quality and performance, all types of materials listed hereinafter by manufacturer's names and/or manufacturer's catalogue number shall be provided as specified. Unless specifically stated otherwise, or separately priced in Division 01 or Division 26 and other Division Sections "Alternate Bids", the Contractor shall provide the materials or products as specified. If this Contractor desires to substitute an item, he/she shall comply with the following administrative and procedural requirements that are included in this Section to expand the requirements as defined by Part 1 paragraph "Related Documents".
- B. Substitutions will be permitted only on products specified with the phrase "or approved equal", "or as approved", "or equal", "or equivalent", etc. and the burden shall be upon the bidder to prove such equality. If the Contractor elects to prove such equality, he/she must request the Engineer's approval in writing to substitute such item for the specified item, and shall submit supporting data, and samples if required, to permit a fair evaluation of the proposed substitution with respect to quality, serviceability and warranty.
- C. When the phrase "or approved equal", "or as approved", "or equal", "or equivalent", etc. appears and the Contractor desires to furnish equipment of a manufacturer other than that specified or intended, he/she shall include a complete specification of the substituted item, along with each submission copy of shop drawings, indicating the necessary modifications to the substituted product to satisfy the requirements of the Contract Documents.
1. Compliance Report: Along with each submission copy of the product data and/or shop drawing, the manufacturer shall indicate the necessary modifications to the product and/or system to satisfy the requirements of the Contract Documents. Each paragraph including all subparagraphs shall bear the same paragraph number as the contract specification so that a close comparison can be made to the manufacturer specified herein by catalog number(s).
    - a. Each paragraph for the substituted product/system shall be identified as follows:
      - 1) Comply: The term "comply" shall only be used when the product/system indicated by the paragraph is completely equal in all respects to the type of material used, functionality, programmability, size, accessories to be provided, future capabilities, mounting, etc. to that which was specified. Anything less is not to be considered as complying and shall not be indicated as "Comply".
      - 2) Exception: The term "exception" shall be used when the product/system indicated by the paragraph does not meet the definition of "comply" as indicated above. The manufacturer shall provide a brief, clear and non-technical description of why the product/system does not meet the requirements of the specification and why it is not necessary to provide the specified materials, components, features, etc.
      - 3) Deviate: The term "deviate" shall be used when the product/system indicated in the paragraph does not fully comply but the manufacturer is willing to provide all the necessary materials, components, features, accessories, future capabilities, etc. to meet the intent of the Contract Documents as determined by the Engineer. The manufacturer shall provide a brief, clear and non-technical description of what additional items are to be provided and how these items affect the product/system.
    - b. Compliance report may be submitted prior to the submission of the substituted product data and/or shop drawings but the Engineer reserves the right to request that certain product data, shop drawings, wiring diagrams, certificates, etc. be included as requested.
  2. All costs involved in changes in the building, to the equipment, to the arrangement of equipment, or to the Work performed or to be performed under other sections of the specifications, due to the substitution of equipment in lieu of that shown on the drawings or specified, shall be borne by the Contractor making such substitutions, and shall include, but not necessarily be limited to,

costs or fees in connection with resubmission of drawings for approval, if required, by the State, local authorities or insuring agencies having jurisdiction over the Work.

### **1.11 ELECTRONIC DRAWINGS**

- A. CAD Files: If the Contractor wishes to purchase the Engineer's CAD files to prepare a submittal, drawings in electronic format will be distributed in accordance with the following procedures:
1. Contractor shall submit a written request to the Engineer indicating the sheet numbers to be provided in electronic format for his/her use.
  2. A basic service fee of \$50 will be charged to the Contractor for each drawing requested. This fee must be paid by the Contractor prior to delivery of the electronic files and/or media. Full set of drawings might be purchased at a fixed fee if desired by Contractor. Coordinate with Engineer during construction.
  3. Drawings
    - a. Binding and Purging: Upon receipt of payment for the electronic files, the drawings will be bound and purged of all legal and proprietary information not relevant to the Contractor's requested use. This legal information may include, but may not be limited to, the professional seal(s), trademark(s), border(s), engineering calculation(s), etc.
    - b. Format: Drawings will be formatted for use with Autodesk's AutoCAD (2016). The Contractor shall be responsible for making sure that his/her hardware/software is compatible with the electronic files. The Engineer will not be responsible for providing the necessary hardware/software to the view and/or use the electronic files.
    - c. Electronic Media Disclaimer Note: Each drawing will include the following Electronic Media Disclaimer Note or something similar:
      - 1) Although Buchart Horn transmits this electronic media for your assistance, it remains the sole property of the Buchart Horn. Buchart Horn reserves the right to modify or reclaim this information at our discretion. The Recipient assumes responsibility for use of this electronic media and for coordination of any updated or additional information and/or data. Buchart Horn is not responsible to the Recipient (or any other Users allowed to use this electronic media by the Recipient) for compatibility with the Recipient's hardware and/or software. The Recipient shall scan this electronic media for virus contamination prior to its use.
      - 2) Unauthorized reproduction or distribution of this electronic media, or any portion thereof, may result in severe civil and criminal penalties, and will be prosecuted to the maximum extent possible under the law.
      - 3) By using the data contained in this electronic file, the Recipient indicates that he/she has read this Electronic Media Disclaimer Note and agrees to the above terms and conditions for the use of this electronic media."
  4. Conditions of Use
    - a. Changes to Bid Documents: The requested electronic file(s) may or may not incorporate all changes to the Contract Documents that have been issued as addenda, bulletins, change orders, clarifications, etc. The Contractor shall be responsible for including all such changes not incorporated in the electronic file(s).
    - b. Verification: Contractor shall verify that the requested electronic file(s) are identical to the Contract Documents less items issued as addenda, bulletins, change orders, clarifications, etc. If discrepancies are found between the electronic file(s) and the Contract Documents, the Contractor shall notify the Engineer immediately so that the electronic file(s) can be corrected/updated and forwarded to the Contractor in a timely manner.
    - c. No Discrepancies: If there are no discrepancies between the electronic file(s) and the Contractor's Contract Documents less the items indicated above, the Contractor shall provide a letter to the Engineer indicating that the electronic file(s) are acceptable.

- d. Notification: If the Contractor does not notify the Engineer within seven (7) days after receipt of the file(s) as to whether or not the file(s) are acceptable, the Engineer will assume that the file(s) have been accepted by the Contractor and any request for additional file(s) after this period of time will be considered as separate purchase request.
5. Indemnification: The Contractor shall hold harmless the Engineer against all damages, liabilities or costs, including legal fees and defense costs, arising from the use of these electronic file(s).
6. Interpretation: The Engineer is the sole interpreter of these electronic file(s). By use the electronic file(s), the Contractor shall not be relieved of his/her duty to fully comply with the Contract Documents, including, but not limited to, the need to check, confirm, and coordinate the Contractor's Work with that of other Contractors for the Project.

### **1.12 QUALITY ASSURANCE**

- A. General: All work whether it be architectural, structural, mechanical, or electrical in nature shall be installed in a first class, neat and workmanlike manner by mechanics skilled in the trade involved.
- B. Quality of Workmanship: Electrical appurtenances shall be installed in a neat and workmanlike manner as required by the National Electrical Code Article 110.12. and shall be in compliance with NECA 1-2010 "Standard Practices for Good Workmanship in Electrical Contracting" as a minimum. See other Division 26 and other Division specification sections for more stringent requirements.
- C. Final Approval: The quality of workmanship shall be subject to the approval of the Engineer. Any work found by the Engineer to be of inferior quality and/or workmanship shall be replaced and/or reworked until approval of the Engineer is obtained.
- D. Cost: Any cost involved in obtaining said approval shall be the responsibility of the Electrical Contractor.

### **1.13 DELIVERY, STORAGE AND HANDLING**

- A. Deliver, store, protect and handle products in accordance with the requirements as defined by Part 1 paragraph "Related Documents".
- B. Properly identify products with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- C. Protect all unfinished installations, construction materials and equipment to the satisfaction of the Engineer and the Owner.

### **1.14 EXTRA MATERIALS**

- A. General: The extra materials specified in this Article shall be in addition to those extra materials specified in other Division 26 and other Division Sections. Contractor shall include in his bid all costs associated with furnishing and installing the indicated extra material.

## **PART 2 PRODUCTS (ADMINISTRATIVE SUBMITTALS)**

### **2.1 GENERAL**

- A. Prepare electrical administrative submittals in accordance with the requirements as defined by Part 1 paragraph "Related Documents". In addition to the requirements referenced in the "Related Documents" paragraph and Division 01, prepare these administrative submittals to meet the minimum requirements as specified herein.



**2.2 SCHEDULE OF VALUES (DETAILED BREAKDOWN)**

- A. A Schedule of Values (Detailed Breakdown) for the Electrical Work of this Project shall be prepared by the Contractor using forms provided by the Engineer. Where a Schedule of Values is not required by the Division 01 Specification Sections, the Contractor shall request a sample form from the Engineer.
- B. The Schedule of Values shall have a level of detail equal to or greater than the example form provided by the Engineer or Engineer and as indicated below:
1. General: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each electrical Specification Section and as indicated below:
    - a. Bond and insurance.
    - b. Mobilization and supervision.
    - c. Inspection.
    - d. Temporary electric.
    - e. Demolition and cleanup.
    - f. Removal and Disposal of Hazardous/Contaminated Material: Provide breakdown for each type of material disposed of.
    - g. Record documents and operation and maintenance manuals.
    - h. Utility Charges.
      - 1) Power.
    - i. Excavation and backfill.
    - j. Ductbank and Concrete encasement.
    - k. Conductors: 120V to 15kV.
      - 1) #12 to #8 wire.
      - 2) #6 to #1 wire.
      - 3) #1/0 to #4/0.
      - 4) 250 kcmil to 1000 kcmil.
    - l. Cables: Provide breakdown for each type specified.
    - m. Surface Raceway: Metal and plastic.
    - n. Conduit: Metallic and PVC.
      - 1) ¾" to 1".
      - 2) 1 ¼" to 2".
      - 3) 2 ½" to 3".
      - 4) 3 ½" to 4".
      - 5) 5".
    - o. Engine Generators.
      - 1) Generator set.
      - 2) Generator Control System.
    - p. Distribution Equipment.
      - 1) Panelboards.
      - 2) Surge suppression.
      - 3) Circuit breakers.
    - q. Coordination Drawings.
      - 1) Switchgear Building with Switchgear and other supporting systems.
    - r. Identification: Include the following Project identification on the Detailed Breakdown:
      - 1) Project name and location.
      - 2) Name of Engineer.
      - 3) Engineer's project number.
      - 4) Contractor's name and address.
      - 5) Contractor's trade for which the Contract was awarded.

- 6) Date of submittal.
  - 7) Contract price.
  - s. Table Format: Include the following columns in the Schedule of Values (Detailed Breakdown):
    - 1) Item No. and Description of Item.
    - 2) Number & Kind of Units.
    - 3) Cost per Unit.
    - 4) Division of Unit: Breakout the following into separate columns:
      - (a) Material.
      - (b) Labor.
    - 5) Total Amount.
  - t. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment, progress reports, Change Orders (debit/credit), Work Orders (time and material), etc.
    - 1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
    - 2) Round amounts to nearest whole dollar; total shall equal the Contract Sum.
- C. The Contractor shall submit the Schedule of Values (Detailed Breakdown) for review as a shop drawing at the earliest possible date prior to all other shop drawings and/or product data and before proceeding with any Work.

### **2.3 RECORD DOCUMENTS**

- A. Mark-up Procedure: During construction, maintain a set of blue- or black-line white prints of Contract Drawings and Shop Drawings for Project Record Document purposes.
1. Mark these Drawings to show the actual installation where the installation varies from the installation shown originally. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later. Items required to be marked include, but are not limited to, the following:
    - a. Revisions to details shown on the Drawings.
    - b. Locations and depths of all underground utilities and underslab conduits.
    - c. Locations of interior conduits larger than 2" diameter not installed underslab.
    - d. Locations of all feeder conduits.
    - e. Revisions to Branch and Feeder Circuits: Record circuit numbers and associated panelboard space numbers for all existing, new, or relocated electrical appurtenances, mechanical equipment, owner furnished equipment, etc. that required power or reconnection of existing electrical services. Each circuit number shall be shown with a homerun coming off the equipment it serves. Circuit numbers indicated on the record drawings shall match the new or updated panelboard indexes.
    - f. Actual installed equipment locations.
    - g. Changes made by change order, Engineer's written orders, and Owner requested.
    - h. Mark record sets with red erasable colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
    - i. Mark important additional information that was either shown schematically or omitted from original Drawings.
    - j. Note Construction alternate numbers, change-order numbers, and similar identification.
    - k. Accurately record information in an understandable drawing technique.
    - l. Record data as soon as possible after obtaining it. Record and check the mark-up prior to enclosing concealed installations.
    - m. At time of Substantial Completion, submit record drawings to the Engineer for the Owner's records. Organize into sets and bind and label sets for the Owner's continued use.

- B. Format: Record drawings shall be made complete including all changes and additional information that were recorded. Final record drawings may be provided at time of Substantial Completion in either hard copy format or in electronic media format as follows:
1. Copies
    - a. Hard Copy: Print/copy a minimum of two (2) black-line prints of each record drawing as referenced in the general provisions of the Contract by the "Related Documents" paragraph and as directed by the Engineer. Organize the copies into manageable sets. Bind each set with durable-paper cover sheets. Include appropriate identification, including titles, dates, and other information on the cover sheets.
    - b. Electronic Media: Provide record drawings in electronic format on compact disk(s) in Autodesk's AutoCAD 2008 for Windows reflecting the set of blue- or black-line prints. Label CD and CD case with appropriate identification, including titles, dates, and other information which may appear on the project prints.
  2. Distribution
    - a. Organize and bind original marked-up set of prints that were maintained during the construction period into manageable sets. Bind and date marked-up set. Provide protective covering to prevent moisture, dirt, and other debris from deteriorating marked-up set of prints. Protective covering shall include appropriate identification, including project title and date.
    - b. Submit the original marked-up record set(s) and hard copy sets or electronic media to the Engineer for the Owner's records.

#### **2.4 OPERATION AND MAINTENANCE MANUALS**

- A. Form of Submittal: In addition to these requirements, coordinate organization and submission with the requirements of Division 1. Prepare operation and maintenance manuals in the form of an instructional manual for use by the Owner's operating personnel. Organize into suitable sets of manageable size. Where possible, assemble instructions for similar equipment into a single binder.
1. Binders: For each manual, provide heavy-duty, commercial-quality, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to receive 8-1/2-by-11-inch paper. Provide a clear plastic sleeve on the spine to hold labels describing contents. Provide pockets in the covers to receive folded sheets.
    - a. Where two (2) or more binders are necessary to accommodate data, correlate data in each binder into related groupings according to the Project Manual table of contents. Cross-reference other binders where necessary to provide essential information for proper operation or maintenance of the piece of equipment or system.
    - b. Identify each binder on front and spine, with the printed title "ELECTRICAL OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter covered. Indicate volume number for multiple volume sets of manuals.
  2. Dividers: Provide heavy paper dividers with celluloid-covered tabs for each separate Section. Mark each tab to indicate contents. Provide a typed description of the product and major parts of equipment included in the Section on each divider.
  3. Protective Plastic Jackets: Provide protective, transparent, plastic jackets designed to enclose diagnostic software for computerized electronic equipment.
  4. Text Material: Where maintenance manuals require written material, use the manufacturer's standard printed material. If manufacturer's standard printed material is not available, provide specially prepared data, neatly typewritten, on 8-1/2-by-11-inch, 20-lb/sq. ft. white bond paper.
  5. Drawings: Where maintenance manuals require drawings or diagrams, provide reinforced, punched binder tabs on drawings and bind in with text.
    - a. Where oversize drawings are necessary, fold drawings to the same size as text pages and use as a foldout.

- b. If drawings are too large to be used practically as a foldout, place the drawing, neatly folded, in front or rear pocket of binder. Insert a typewritten page indicating drawing title, description of contents, and drawing location at the appropriate location in the manual.

B. Manual Content

1. In each manual include information specified in the individual Specification Section and the following information for each major component of building equipment and its controls:
  - a. General system or equipment description.
  - b. Design factors and assumptions.
  - c. Copies of all approved Shop Drawings and Product Data including products/systems installed during construction by change order, etc.
  - d. System or equipment identification, including:
    - 1) Name of manufacturer.
    - 2) Model number.
    - 3) Serial number of each component.
  - e. Operating instructions.
  - f. Emergency instructions.
  - g. Wiring diagrams.
  - h. Inspection and test procedures.
  - i. Inspection reports and certificates.
  - j. Maintenance procedures and schedules.
  - k. Precautions against improper use and maintenance.
  - l. Copies of warranties.
  - m. Repair instructions including spare parts listing.
  - n. Sources of required maintenance materials and related services.
  - o. Manual index.
  - p. Training documentation and DVD of training.
2. Organize each manual into separate Sections for each piece of related equipment. As a minimum, each manual shall contain a title page; a table of contents; copies of Product Data, supplemented by Drawings and written text; and copies of each warranty, bond, and service contract issued.
  - a. Title Page: Provide a title page in a transparent, plastic envelope as the first sheet of each manual. Provide the following information:
    - 1) Subject matter covered by the manual.
    - 2) Name and address of the Project.
    - 3) Date of submittal.
    - 4) Name, address, and telephone number of the Contractor.
    - 5) Name and address of the Engineer.
    - 6) Cross-reference to related systems in other operation and maintenance manuals.
  - b. Table of Contents: After title page, include a typewritten table of contents for each volume, arranged systematically according to the Project Manual format. Include a list of each product included, identified by product name or other appropriate identifying symbol and indexed to the content of the volume.
    - 1) Where a system requires more than one volume to accommodate data, provide a comprehensive table of contents for all volumes in each volume of the set.
  - c. General Information: Provide a general information Section immediately following table of contents, listing each product included in the manual, identified by product name. Under each product, list the name, address, and telephone number of the Subcontractor or Manufacturer and the maintenance contractor. Clearly delineate the extent of responsibility of each of these entities. Include a local source for replacement parts and equipment.
  - d. Product Data: Where the manuals include manufacturer's standard printed data, include only sheets that are pertinent to the part or product installed. Mark each sheet to identify

each part or product included in the installation. Where the Project includes more than one item in a tabular format, identify each item, using appropriate references from the Contract Documents. Identify data that is applicable to the installation, and delete references to information that is not applicable.

- e. **Written Text:** Prepare written text to provide necessary information where manufacturer's standard printed data is not available, and the information is necessary for proper operation and maintenance of equipment or systems. Prepare written text where it is necessary to provide additional information or to supplement data included in the manual. Organize text in a consistent format under separate headings for different procedures. Where necessary, provide a logical sequence of instruction for each operation or maintenance procedure.
- f. **Drawings:** Provide specially prepared drawings where necessary to supplement manufacturer's printed data to illustrate the relationship of component parts of equipment or systems or to provide control or flow diagrams. Coordinate these drawings with information contained in project record drawings to assure correct illustration of the completed installation.
  - 1) Do not use original project record documents as part of operation and maintenance manuals.
- g. **Warranties, Bonds, and Service Contracts:** Provide a copy of each warranty, bond, or service contract in the appropriate manual for the information of the Owner's operating personnel. Provide written data outlining procedures to follow in the event of product failure. List circumstances and conditions that would affect validity of warranty or bond.
- h. **Approval letters from the following:**
  - 1) Local authority having jurisdiction.
  - 2) Inspection agency.
  - 3) Field representative for specific systems, i.e. fire alarm, signal/communication, intrusion detection, etc.

C. **Electrical Maintenance Manual**

- 1. **Equipment and Systems:** Provide the following information for each piece of equipment, each building operating system, and each electric or electronic system.
  - a. **Description:** Provide a complete description of each unit and related component parts, including the following:
    - 1) Equipment or system function.
    - 2) Operating characteristics.
    - 3) Limiting conditions.
    - 4) Performance curves.
    - 5) Engineering data and tests.
    - 6) Complete nomenclature and number of replacement parts.
  - b. **Manufacturer's Information:** For each manufacturer of a component part or piece of equipment, provide the following:
    - 1) Printed operation and maintenance instructions.
    - 2) Assembly drawings and diagrams required for maintenance.
    - 3) List of items recommended to be stocked as spare parts.
  - c. **Maintenance Procedures:** Provide information detailing essential maintenance procedures, including the following:
    - 1) Routine operations.
    - 2) Troubleshooting guide.
    - 3) Disassembly, repair, and reassembly.
    - 4) Alignment, adjusting, and checking.
  - d. **Operating Procedures:** Provide information on equipment and system operating procedures, including the following:

- 1) Startup procedures.
  - 2) Equipment or system break-in.
  - 3) Routine and normal operating instructions.
  - 4) Regulation and control procedures.
  - 5) Instructions on stopping.
  - 6) Shutdown and emergency instructions.
  - 7) Summer and winter operating instructions.
  - 8) Required sequences for electric or electronic systems.
  - 9) Special operating instructions.
  - 10) Video training sessions with Owner.
- e. Servicing Schedule: Provide a schedule of routine servicing and lubrication requirements, including a list of required lubricants for equipment with moving parts.
  - f. Controls: Provide a description of the sequence of operation and as-installed control diagrams by the control manufacturer for systems requiring controls.
  - g. Circuit Directories: For electric and electronic systems, provide complete circuit directories of panelboards, including the following:
    - 1) Electric service.
    - 2) Controls.
    - 3) Communication.
- D. The Contractor shall submit to the Engineer copies of the maintenance manual(s) for review and approval. Maintenance manuals shall be corrected as directed by the Engineer and resubmitted until satisfactory.
1. In addition to the number of maintenance manuals referenced in the "Related Documents" paragraph, prepare one (1) additional copy in PDF format to be kept by the Engineer.
- E. Format: Maintenance manuals shall be made complete including all changes and additional information that were recorded. Prepare manuals at time of Substantial Completion as follows:
1. Copies
    - a. Prints/Copies: Print/copy a minimum of two (2) sets of maintenance manuals as referenced in the general provisions by the "Related Documents" paragraph and as directed by the Engineer. Organize the manuals into manageable sets (volumes).
    - b. Electronic Media: Provide maintenance manual(s) in electronic format on compact disk(s) in latest version of Adobe Acrobat reflecting the set of maintenance manuals. Label CD and CD case with appropriate identification, including titles, dates, and other information which may appear on the binder of the maintenance manual and/or the manual's table of contents.
  2. Distribution
    - a. If a set of maintenance manuals includes more than one binder (volume), each set of manuals shall be packaged separately.
    - b. Submit the sets of maintenance manuals and electronic media to the Engineer for review and approval. Maintenance manuals shall be corrected as directed by the Engineer and resubmitted until satisfactory.
    - c. Final sets of maintenance manuals and electronic media shall be turned over to the Engineer for the Owner's records. In addition to the number of maintenance manuals referenced in the "Related Documents" paragraph, prepare one (1) additional copy including the electronic media to be kept by the Engineer.

### **PART 3 EXECUTION**

#### **3.1 GENERAL REQUIREMENTS**

- A. This Contractor shall expedite the work for a specific area, section or part of the Project to make provision for, or protect equipment or to permit the installation of another part of the work.

- B. All materials and equipment supplied by this Contractor shall be new, of the best of their respective kinds, without imperfections and blemishes, and shall be protected from the elements prior to installation.
- C. Protect all equipment during construction. All equipment damaged as a result of not properly protecting said equipment shall be repaired at no cost and to the satisfaction of the Engineer and Owner.
- D. All conduits, wire, cable, wiring devices and equipment shall be installed in such a manner as to preserve access to any existing equipment or to any new equipment installed under this specification or under other specifications or contracts for this Project and with sufficient space provided for proper operation and maintenance.
- E. The drawings are generally indicative of the work to be installed but do not indicate all bends, fittings, boxes, etc., which may be required. The Contractor shall carefully investigate the structural and furnish conditions affecting his work, arrange his Work accordingly, and furnish such fittings as may be required to meet such conditions.
  - 1. The schematic or layout wiring as shown on the drawings shall not be considered as absolute; it shall be subject to changes where necessary to overcome obstacles in construction.
  - 2. Where a major deviation from the plans is indicated by practical consideration, shop drawings shall be submitted showing all deviations in detail to clearly indicate the necessity or desirability for the change.
- F. This Contractor shall coordinate his Work with other trades so that all work may be installed in the most direct manner and so that interference between piping, ducts, equipment, and Architectural or structural features will be avoided. In cases of interference, conflicts, or fouling results, the Engineer shall decide which work is to be relocated, regardless of which was installed first. Such relocation shall be at no additional expense to the Owner.
- G. All materials and equipment installed by the Contractor shall be firmly supported and secured to the building structure/construction as required.
  - 1. Furnish and install all necessary steel angles, beams, channels, hanger rods or other supports for equipment and piping furnished under this Contract requiring support or suspension from building structure, except support steel where otherwise noted on the plans.
- H. Scaffolding with ladders shall be furnished and erected, where required for the proper installation of wiring, equipment and fixtures.

### **3.2 SCHEDULING**

- A. Construction Schedule:
  - 1. Time is of the essence. The Contractor shall immediately procure all long lead equipment items with the associated equipment manufacturer/distributor of the equipment to trigger the submittal process as defined for each equipment item as listed in its respective technical specification. The Contractor is solely responsible for the management of the effort to meet the time requirements of the contract as defined in the Contract Documents and Division 1.
  - 2. The Contractor shall develop and maintain a construction schedule for all major tasks associated with the project. In addition, milestone dates shall be included to document major equipment approvals, release to manufacture, anticipated delivery dates, anticipated mobilization to site, startup and testing of major equipment, substantial completion, close out and demobilization. These key milestone dates are identified in the Contract Provisions of the Project Manual. The Contractor shall provide updates to the construction schedule as requested by Engineer/Owner and prior to scheduled construction progress meetings.

3. The construction schedule shall utilize construction oriented project scheduling software (Suretrak, Primavera, or Equal) and shall utilize the initial construction schedule as submitted and approved with critical path activities within 60 days of notice to proceed. All progress updates shall reflect true reality of the actual progress of construction showing lead and lag time durations and associated with each task. For scheduled items delaying the anticipated critical path of the schedule, the Contractor shall narratively describe in explicit detail remediation of the particular items associated with delaying the critical path to bring the project back into the contract defined duration. The details associated with the task remediation will be discussed in detail with the Engineer and Owner for acceptance of resolving the particular issue. If an issue cannot be resolved or agreed upon with the Owner\Engineer, the Contractor shall submit a detailed contingency plan in conjunction with the discussed task or with 3 days of a meeting with the Owner/Engineer.

### **3.3 TEMPORARY POWER**

- A. The Contractor shall furnish temporary electrical power to maintain the normal operation of the facility as indicated on drawings. The Contractor shall coordinate with Owner for additional temporary electrical power needs.

### **3.4 USE OF OWNER EQUIPMENT**

- A. The existing restroom facilities are designated for City employees. The Contractor shall provide temporary restroom facilities for their workforces and their sub-contractors forces.

### **3.5 ROUGH-IN**

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. All kitchen, lab, shop equipment, and process equipment shall be coordinated with final approved shop drawings before roughing-in any electrical work.
- C. If the required location of equipment, outlets, etc. differs from that indicated on the drawings, the Engineer shall determine the position of the equipment.
- D. The Engineer and/or Owner reserve the right to change the location of any receptacle, outlet, light fixture, panelboard, control equipment, motor, etc. to any point not over 10 feet distance from the location shown on the drawings without cost to the Owner. This Contractor shall verify final locations for the above-indicated equipment with the Owner or the Owner's representative prior to proceeding with any rough-in work.
- E. Refer to equipment specifications in Divisions 2 through 32 and approved product data and shop drawings for rough-in requirements.

### **3.6 ELECTRICAL INSTALLATIONS**

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
  1. Coordinate electrical systems, equipment, and materials installation with other building components.
  2. Verify all dimensions by field measurements.
  3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
  4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.



5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
  6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
  7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
  8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.
  9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces. Firmly support all materials and equipment.
  10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Install access panel or doors where units are concealed behind finished surfaces.
  11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
- B. Performance of Equipment
1. All materials, equipment and appurtenances of any kind, shown on the drawings, hereinafter specified or required for the completion of the Project in accordance with the intent of these specifications, shall be completely satisfactory and acceptable in operation, performance, and capacity. No approval either in written or verbal of any drawings, descriptive data, or samples of such material, equipment and/or appurtenances shall relieve this Contractor of his responsibility to turn over the same to the Owner in perfect working order at the completion of the Project.
  2. Any material, equipment or appurtenances, the operation, capacity or performance of which does not comply with the drawings and/or specification requirements or which is not new or which is damaged prior to acceptance by the Owner will be held to be defective material and shall be removed and replaced with the proper acceptable materials, equipment and/or appurtenances or put in proper acceptable working order, satisfactory to the Engineer with additional expense to the Owner.
  3. All systems specified herein shall be furnished by manufacturers who have been regularly engaged in the manufacture of these products for a period of not less than five (5) years. This Contractor shall deliver to the Engineer, prior to final payment, a statement from the manufacturer or his authorized representative, certifying that the equipment has been inspected by him and found to be properly installed and functioning satisfactorily. Installation, final connections and testing of such systems shall be performed under the direct supervision of competent authorized service engineers who shall be in the employ of the respective equipment manufacturer. Any and all expenses incurred by these equipment manufacturer's representatives shall be borne by the Contractor.
  4. All details of the installation of all equipment shall be electrically and mechanically correct. All equipment shall operate without objectionable noise or vibration should be produced and transmitted to occupied portions of the building by apparatus, conduit or other parts of a system, any corrections to eliminate noise and vibration shall be at no expense to the Owner.
- C. Any materials or workmanship found to be of inferior quality, damaged, improperly installed, or having been exposed to harmful substances or conditions at any time in the construction Work, shall be

immediately replaced upon notification of the Contractor by the Engineer or Owner that such condition has been observed by the Engineer or Owner or his representatives.

- D. The Contractor shall at all times provide protective equipment as may become necessary to protect all parts of the work from damage or exposure to harmful conditions or contaminating substances.

### **3.7 CUTTING AND PATCHING**

- A. General: Perform cutting and patching in accordance with Part 1 paragraph "Related Documents." In addition to the requirements referenced in the "Related Documents" paragraph, the following requirements apply:
1. Quality Control
    - a. Craftsmanship: Workmen shall have a minimum five (5) years experience in working with materials being cut and patched.
  2. Materials
    - a. Unless otherwise indicated, use materials for patching that are identical in quality and texture to existing materials. If identical materials are not available or cannot be used, the use of substitute materials that match existing to the fullest extent possible with regard to visual effect and performance may be installed only where approved by the Engineer.
    - b. Reclaimed face brick and structural tile shall be used where possible.
    - c. Materials used for sealing openings shall have a fire rating equal to or greater than the rating of the floor, ceiling, or partition and shall comply with applicable codes. See Division 07 Section "Firestopping" for additional material and installation requirements.
  3. Perform cutting, fitting, and patching of electrical equipment and materials required to:
    - a. Uncover Work to provide for installation of ill-timed Work.
    - b. Remove and replace defective Work.
    - c. Remove and replace Work not conforming to requirements of the Contract Documents.
    - d. Install equipment and materials in existing structures.
    - e. Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer observation of concealed Work.
  4. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
  5. During cutting and patching operations, protect adjacent installations including, but not limited to, the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
  6. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas. Seal all openings utilized in plenum spaces, floors, ceilings, and/or partitions after the Work has been installed. Openings shall be suitably treated to prevent passage of stray light, air, or sound.
- B. Existing Facility
1. General: Electrical Contractor shall be responsible for all cutting, patching, and finishing of existing construction for the proper installation of all electrical equipment and materials to be installed in the existing facility of this Project except as indicated below. The cutting and patching applies to both installation of new equipment and removal of existing equipment and materials.
    - a. The General Contractor shall provide the cutting and patching at the following areas for all Contracts and shall coordinate the total number of openings required:
      - 1) Openings extending through exterior walls.
      - 2) Openings in the exterior wythes of exterior walls.
    - b. All cutting shall be kept to an absolute minimum consistent with the requirements of the Project.

- c. Core drilling not permitted through motor floor.
  - d. No cutting shall be done which may affect the building structurally or architecturally including building systems without first securing the approval of the Engineer. Cutting shall be accomplished in such a manner as not to cause damage to the building or leave unsightly surfaces that cannot be concealed by plates, escutcheons, or other construction. Where unsightly conditions are caused, the Contractor shall be required, at his own expense, to repair the damaged areas.
    - 1) Cutting of the construction excessively or carelessly done shall be repaired by this Contractor to match the original work and to the satisfaction of the Engineer who will make the final decision with respect to excessive or careless cutting work.
  - e. Where existing equipment is removed and new equipment is installed utilizing the existing opening, the Contractor shall close up the unused portion of the opening.
  - f. Where existing equipment is removed, the Contractor shall patch and repair the existing partitions, floors, and ceilings including any existing openings that are no longer utilized by the removed equipment.
  - g. All patching shall match adjacent undisturbed areas perfectly and to the satisfaction of the Engineer.
  - h. Cutting and patching of the inner wythe of exterior walls where an opening does not extend through the outer wythe shall be by the Electrical Contractor. Where lintels are necessary, the Contractor shall coordinate opening with the Engineer for lintel sizes.
2. Cutting: Cut and remove existing construction only to the extent required by new Work and as indicated. Use methods required to complete Work within limitations of governing regulations and as follows:
- a. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
    - 1) All holes or openings for the passage of conduit to be provided in the existing concrete shall be bored.
  - b. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
  - c. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
  - d. Maintain adequate ventilation when using cutting torches.
  - e. Cut concrete and masonry at junctures with construction to remain, using power-driven masonry saw or hand tools; do not use power-driven impact tools.
3. Patching: All elements of construction and surfaces shall be returned to the same physical condition(s) existing prior to the start of cutting operations.
4. Painting
- a. Painting of the final finished areas will be by the Contractor as needed to restore final finishes to match existing. Paint wall or ceiling in entirety to closest edge or delineation and match existing colors. Coordinate with Engineer and Owner.
  - b. All surfaces to be painted shall receive an undercoat 24 hours before the final coat is applied. Undercoats that show lumps or rough areas shall be smoothed with fine sandpaper or steel wool and dusted off before the final coat is applied. Final coat shall be solid, even color, free of lumps, drops, sags, run brush marks, laps, or other defects, finished to a line where they adjoin other colors or unpainted surfaces.
  - c. Drop cloths shall be used to protect floors and all other work from damage. Any covering temporarily removed from any part of the work or finish shall be promptly replaced and any

damage from neglect to so protect all surfaces shall be made good at the Contractor's expense.

- d. Paint color shall match adjoining surfaces as closely as possible and to the satisfaction of the Engineer.

C. New Construction

1. All openings or chases required for the installation of the Work in the new portion of the building shall be provided by the Electrical Contractor.
2. The Electrical Contractor shall establish sizes and locations and shall coordinate with the General Contractor.
3. The Electrical Contractor shall set all sleeves, hangers, and anchors required for his Work and shall be responsible for their proper and permanent location.

D. Macadam and Concrete Areas

1. Openings in concrete or macadam required for Electrical construction shall be made by taking extreme precautions to prevent excessive damage to existing facilities.
2. Prior to completion, all disturbed areas shall be closed, restored to normal and finished to match surrounding areas.

- E. Clean Up: The Electrical Contractor shall daily remove all waste and debris resulting from his Work and shall immediately remove water present in the area resulting from the Work.

### **3.8 PROTECTION OF WORK, MATERIALS, AND EQUIPMENT**

- A. This Contractor shall effectively protect at his own expense, all existing facilities and such of his new work, materials or equipment as is liable to injury during the construction period. All openings in to any part of the conduit system as well as all associated fixtures, equipment, etc. both before and after being set in place shall be securely covered or otherwise protected to prevent obstruction, damage, or injury due to carelessly or maliciously dropped tools or materials, grit, dirt moisture, water or any foreign matter. This Contractor shall be held responsible for all damage so done, until his work is fully accepted by the Engineer.

1. Conduit ends shall be covered with capped bushings.

- B. All surfaces, either finished or in preparation for finishing or finish material application, shall be protected against damage from painting, welding, cutting, burning, soldering or similar construction functions. The protection shall be accomplished by care in operations, covering and shielding. Special care shall be directed to exposed finished masonry, metal or wood surfaces and painted surfaces. Corrective measures required shall be accomplished by the trade which made the original installation and shall be at the expense of the Contractor causing the damage with no cost to the Owner.

- C. Any damage caused by neglect on the part of this Contractor or his representative, or by the elements due to neglect on the part of this Contractor or his representatives, either to the existing work, or to his work or to the work of any other Contractor, shall be repaired at his expense to the Engineer's satisfaction.

### **3.9 RECYCLING AND DISPOSAL OF HAZARDOUS/CONTAMINATED MATERIAL**

- A. General: All contaminated materials (i.e. ballasts, batteries, lamps, thermometers, transformers, etc.) removed by this Contract shall be properly recycled and/or disposed of pursuant to applicable laws enforced by the appropriate Federal and State governing agencies. All uncontaminated metal components shall be recycled, recovered, or reclaimed. The Contractor shall provide a manifest and a Certificate of Recycling and Disposal (CRD) as required by the governing agencies.

1. Process: Hazardous and/or contaminated components shall be removed, segregated, and shipped for disposal/destruction at an EPA approved facility. Nonhazardous/uncontaminated components (glass, aluminum, copper, steel) shall be reclaimed for recycling.
  2. Material Tracking: All recycled or disposed material shall be tracked to ensure a that permanent record of proper disposal can be made readily available to the required governing agencies.
  3. Liability Coverage: \$5 million in General Liability and \$5 million in Pollution Liability with a fully funded closure fund.
  4. Permits: Contractor shall be EPA approved as a Commercial Holder of PCB waste and for and Alternative Disposal Method for ballast recycling. All lamp and PCB waste processing facilities shall be fully permitted.
- B. Hazardous/Contaminated Material
1. Ballasts: The Contractor shall either test each ballast for PCB concentrations or assume that the ballast contains PCBs. If the ballast contains concentrations greater than 50 ppm, the ballast shall be disposed of at an EPA approved TSCA facility permitted for the Commercial Storage of PCB waste.
    - a. Note: Most ballasts manufactured before 1979 typically contained PCBs but this does not alleviate the Contractor from verifying that post 1979 ballasts do not contain PCBs.
  2. Batteries: The Contractor shall properly recycle and/or dispose of Alkaline, NiCad, Lead Acid and Lithium batteries which contain significant amounts of heavy metals including zinc, mercury, nickel, cadmium, selenium, steel and chrome and at a permitted recycling/disposal facility.
  3. Lamps: The Contractor shall recycle lamps that contain mercury at a permitted recycling facility or manage it as a fully regulated hazardous waste in accordance with EPA's Resource Recovery Act (RCRA) requirements.
    - a. Note: Mercury is currently used as a conductor in all fluorescent and HID lamps.
  4. Thermometers: The Contractor shall recycle all thermometers containing mercury.
  5. Transformers: The Contractor shall either test each transformer for PCB concentrations or assume that the transformer contains PCBs. If the transformer contains concentrations greater than 50 ppm, the transformer shall be disposed of at an EPA approved TSCA facility permitted for the Commercial Storage of PCB waste.
- C. This Contractor shall be responsible for all fees and payments associated with the removal and disposal of hazardous/contaminated electrical equipment.

### **3.10 START-UP AND TESTING**

- A. Provide the services of a manufacturer's representative to start-up, adjust and test each piece of equipment. Refer to equipment specifications and specification section 26 05 10 for additional requirements.
- B. All start-up and testing shall be performed in the presence of the Owner and the Engineer. All start-up data and controls configuration and programming shall be recorded at start-up or training on approved data recording sheets and verified. Completed data sheets shall accompany the operations and maintenance manuals provided for use in training. Scheduling and coordination arrangements are to be made a minimum of two (2) weeks in advance, approved by the Owner.

### **3.11 CLEAN-UP**

- A. Daily, and when directed by the Engineer, the Electrical Contractor shall remove all waste and debris resulting from his Work.
- B. Upon completion of his Work and when directed by the Engineer, the Electrical Contractor shall remove all dirt, foreign materials, stains, fingerprints, etc. from all equipment, light fixtures, panelboards, motor control centers, switchboards, variable frequency drives, cover plates, system equipment, etc., installed

under this Contract. Internal areas of all equipment must be cleaned of all construction dust, debris, etc., prior to pre-final and/or final inspection.

1. Clean paint, varnish spots and stains caused by finishing materials used by this Contractor from all walls, floors, ceilings, trim, glass, hardware, fixtures, masonry or any other surface that is damaged by this Contractor's Work.
  2. Do not use solvents that would remove or damage the finish of the finish hardware or other factory-finished materials. If damage occurs, the affected materials shall be returned to the factory for refinishing at not expense to the Owner.
- C. Repair all finishes damaged by this Contractor in areas that the General Contractor does not have any work and/or the General Contractor is not required to finish the space that was affected by this Contractor's Work and leave all work clean and perfect at completion such that no additional cleaning will be required by the Owner.

### **3.12 PROJECT SAFETY**

- A. General: This Article pertains to any Work that may be performed on electrical equipment (new or existing). Contractor shall follow Owners safety requirements as provided under the attachment to the contract and Division 1.
- B. Contractor shall exert extreme caution in the disconnection and connection of all primary cables and high current carrying buses and cables on the secondaries of all transformers. All work on these facilities shall be done by mechanics skilled in this type of Work and in the necessary safety precautions for blocking out and locking and tagging of all breakers associated with the lines being worked on. All lines shall be tested for potential and grounding facilities that shall be applied on the line or cables being worked on.

### **3.13 INSTRUCTION AND TRAINING FOR THE OWNER'S PERSONNEL**

- A. All statements of days or time periods required for training refer to actual time used to train the specified personnel and are exclusive of any travel, preparatory, delay, or lunch periods. Each day as stated in any requirement shall be considered to be eight (8) hours of actual training time and shall not be combined with start-up, testing, configuration, programming, or remediation activities. See individual Division 26 and other Division Sections including Division 1 and 26 01 80 for time period requirements for each piece of equipment and/or system.
- B. Prior to final inspection, instruct and train the Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Provide instruction and training at mutually agreed upon times.
1. Instruction/training sessions shall be provided for the individual equipment and systems and shall include, but not be limited to, the following:
    - a. Theory of operation.
    - b. Maintenance.
    - c. Start-up.
    - d. Troubleshooting procedures.
    - e. Control and monitoring/metering systems with specific emphasis on use and performance of these systems in concert with the Owner's framework of controls and reporting systems.
  2. All instruction/training shall be performed by qualified and manufacturer certified representatives.
- C. Use operation and maintenance manuals for each piece of equipment or system as the basis of instruction/training. Review contents in detail to explain all aspects of operation and maintenance.
1. Operations and maintenance manuals shall be submitted prior to scheduling of instruction/training. Scheduling and commencement of instruction/training shall be contingent

on the approved status of the O&M manuals. Unless noted otherwise, provide a minimum of three (3) O&M manuals with completed start-up and test data sheets for all equipment-training sessions.

- D. The instruction/training shall be provided for the following equipment and systems:
1. Engine Generator and Transfer Switch.
  2. Surge Protection Devices (SPD).

### 3.14 SUBMITTALS CHART

- A. Submittal List:

<u>DESCRIPTION OF ITEMS TO BE SUBMITTED</u>	<u>DIV</u>	<u>MFR</u>	<u>PROD</u>	<u>SHDR</u>	<u>DEDA</u>	<u>CERT</u>	<u>TEST</u>	<u>WARR</u>
<u>BOXES (INCLUDING JUNCTION, PULL AND OUTLET TYPE)</u>	<u>ALL</u>				<u>X</u>			
<u>CERTIFICATES AND/OR CERTIFICATIONS</u>	<u>ALL</u>					<u>X</u>		
<u>CONDUCTORS AND CABLES - LOW-VOLTAGE POWER AND INSTRUMENTATION</u>	<u>26</u>				<u>X</u>			
<u>CONDUIT (INCLUDING FITTINGS)</u>	<u>26</u>				<u>X</u>			
<u>COORDINATION DRAWING(S)</u>	<u>ALL</u>			<u>X</u>				
<u>FIELD TEST REPORTS</u>	<u>ALL</u>		<u>X</u>			<u>X</u>	<u>X</u>	
<u>GROUNDING</u>	<u>ALL</u>	<u>X</u>			<u>X</u>		<u>X</u>	
<u>HAZARDOUS DISPOSAL &amp; RECYCLING CONTRACTORS</u>	<u>26</u>		<u>X</u>			<u>X</u>		
<u>IDENTIFICATION</u>	<u>ALL</u>	<u>X</u>			<u>X</u>			
<u>INSPECTION AGENCY - INDEPENDENT</u>	<u>ALL</u>		<u>X</u>			<u>X</u>		
<u>INSPECTION REPORT &amp; CERTIFICATES</u>	<u>ALL</u>		<u>X</u>			<u>X</u>		
<u>OPERATION AND MAINTENANCE MANUALS</u>	<u>ALL</u>							<u>X</u>
<u>PANELBOARDS (INCLUDING OVERCURRENT PROTECTIVE DEVICES)</u>	<u>26</u>	<u>X</u>			<u>X</u>			
<u>RACEWAY SUPPORTS (INCLUDING CONDUIT AND CABLE FASTENERS)</u>	<u>ALL</u>	<u>X</u>			<u>X</u>			
<u>RECORD DRAWINGS (DOCUMENTS)</u>	<u>ALL</u>							<u>X</u>
<u>RELAYS AND CONTACTORS</u>	<u>26</u>	<u>X</u>			<u>X</u>			
<u>SAFETY SWITCHES - DISCONNECT SWITCHES</u>	<u>26</u>	<u>X</u>			<u>X</u>			
<u>SCHEDULE OF VALUES (DETAILED BREAKDOWN)</u>	<u>ALL</u>			<u>X</u>				
<u>SURGE PROTECTION DEVICES (SPD)</u>	<u>26</u>	<u>X</u>		<u>X</u>	<u>X</u>			<u>X</u>
<u>WARRANTIES (BOTH PROJECT AND EQUIPMENT)</u>	<u>ALL</u>							<u>X</u>
<u>ENGINE GENERATORS AND TRANSFER SWITCHES</u>	<u>26</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>

- A. Abbreviations for the Submittal Chart
1. DIV - Specification Division
  2. MFR - Manufacturer
  3. PROD - Producer or Supplier
  4. SHDR - Shop Drawings
  5. DEDA - Descriptive Data or Catalog Cutsheets (Product Data)
  6. CERT - Certification
  7. TEST - Test Reports or Studies
  8. WARR - Warranties
- B. The above submittal list is not intended to be all inclusive. Additional submittal items may be required by each Division 26 and Other Division specification section. Therefore, the Contractor shall review the "Submittals" paragraph for each Division Division 26, and Other Division specification sections for specific submission requirements and submit for review the appropriate product data and shop drawings as required by the "Submittals" paragraph including the submission items listed above.

**END OF SECTION 26 01 00**



**SECTION 26 05 01****ELECTRICAL DEMOLITION****PART 1 GENERAL****1.1 SUMMARY**

- A. Section Includes: Selective demolition requirements for the electrical Work.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Division 26 Section "General Electrical Requirements" for additional cutting and patching requirements.

**1.2 DEFINITIONS**

- A. Disconnect: Disconnect electrical service to indicated items. Associated conduit and wire shall be disconnected and removed, complete, back to its source. Where electrical equipment (i.e. generator) is connected to radiator, fuel, and exhaust piping, intake and exhaust ductwork, etc., this Contractor shall disconnect and remove all associated appurtenances, complete, back to their source unless noted otherwise.
- B. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Owner's property as directed.
- C. Salvage (Turn Over to Owner): Items indicated to be salvaged remain the Owner's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to Owner's designated storage area.

**1.3 PROJECT CONDITIONS**

- A. General: Demolition work, as specified herein, is not intended to be performed as a wrecking operation but as Work relative to the performance of the various construction operations of the Project. The Contractor shall perform a site investigation prior to submitting a bid and prior to performing any demolition or new work. Selective demolition shall include, but not be limited to:
  - 1. All labor, materials, and equipment required to perform selective demolition activities required by the Contract Documents.
  - 2. All labor, materials, and equipment to properly dispose of abandoned electrical equipment and apparatus as specified herein and as shown on the drawings.
- B. Protection: Exercise care during demolition work to confine demolition operations to the areas as indicated on the Drawings. The physical means and methods used for protection are at the Contractor's option. However, the Contractor shall be held completely responsible for replacement and restitution Work of whatever nature at no expense to the Owner.

**1.4 SUBMITTALS**

- A. General: Submit in accordance with Section 01 30 00
- B. Inventory of items removed and salvaged by the Contractor for the Owner for inclusion in the Operation and Maintenance Manuals.
- C. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions on drawings at Project closeout according to Division 01.

**1.5 QUALITY ASSURANCE**

- A. Perform all electrical demolition work in accordance with all applicable Codes and Regulatory Agencies and Standards having jurisdiction.

**1.6 COORDINATION**

- A. Coordinate the shut-off and disconnection of electrical service with the Owner and the utility company.
- B. Notify the Owner at least five days prior to commencing demolition operations.
- C. Arrange selective demolition so as not to interfere with Owner's on-site operations.
- D. Perform selective demolition in phases as indicated.

**1.7 SEQUENCING AND SCHEDULING**

- A. Coordinate selective demolition with other trades and schedule electrical appurtenance to be removed and de-energized to permit installation of new work.

**PART 2 PRODUCTS****2.1 MATERIALS AND EQUIPMENT**

- A. Equipment, machinery and apparatus, motorized or otherwise, used to perform the demolition work may be used as chosen at the Contractor's discretion, but which will perform the Work within the limits of the Contract requirements.
- B. Patching Materials: Patching materials must match, as nearly as practical, the existing original structure material for each surface being patched.

**PART 3 EXECUTION****3.1 GENERAL**

- A. Abandoned Electrical Equipment and Apparatus: Existing electrical equipment and apparatus in or on the structures shall become the property of the Contractor. The Contractor shall be responsible for reviewing the materials and equipment being assigned for removal and shall investigate for any contaminants or hazards; including, but not limited to, materials such as PCBs or asbestos. All material assigned to the Contractor shall be removed in a manner suitable to the Owner and may not be disposed of on the site but shall be disposed of off site in a lawful manner.
- B. Abandoned Work: Cut and remove buried raceway and wiring indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- C. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety. In exposed through-structure conduit locations, or where concealed conduits become exposed by penetrating a structural floor, wall or ceiling, the abandoned conduits shall be cut below the finished structural surface in order to perform surface patching.
- D. Cutting and Patching: Comply with requirements of Division 26 "General Electrical Requirements," Part 3 paragraph "Cutting and Patching" for additional patching requirements.
  - 1. Cutting: Perform cutting work of existing structure materials by such methods as will prevent extensive damage beyond the immediate area of cutting.

2. Patching: After demolition and removal Work is performed, patch the existing structure as to match surrounding materials in finish, plane and appearance including the appropriate surface decoration.
- E. Disposal: Any such materials and equipment not desired by the Owner shall become the property of the Contractor and shall be removed promptly from the project site. Disposal shall be in accordance with the regulations of the authorities at the disposal site.
- F. Removed Non-Electrical Equipment: Disconnect and remove abandoned distribution equipment, devices, disconnect switches, motor starters, etc. serving utilization equipment that has been removed by others.
- G. Salvage: The Owner shall have the right to claim as salvage any items and materials removed under the Work of this Section in accordance with the Contract Documents. Should such right of salvage be exercised by the Owner, carefully handle, protect, move and neatly store removed items on the site in a location agreeable to the Owner, in a manner approved by the Architect and/or Construction Manager. All materials not claimed as salvage by the Owner shall become the property of the Contractor, who shall consider the equipment and materials as Abandoned Electrical Equipment and Apparatus.

### **3.2 EXAMINATION**

- A. Verify that field measurements and existing circuiting arrangements are as shown on Drawings.
  1. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
  2. Inventory and record the condition of items to be removed and salvaged.
  3. Survey the condition of the building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during selective demolition.
  4. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- B. Verify that abandoned wiring and electrical equipment serve only abandoned facilities.
- C. Beginning of demolition operations shall mean that the Contractor accepts existing conditions.

### **3.3 PREPARATION**

- A. General: Prior to removal or interception of any raceway or equipment, the Contractor shall positively de-energize, lockout, and safety tag all related safety equipment and energy sources, and verify all systems are safe for human contact and to prevent damage to any system equipment. The Contractor shall review emergency action plans with the Owner immediately before each excavation, removal, or disconnecting work proceeds, to prepare for contingency of encountering unexpected or hazardous conditions.
- B. System De-activation: Prior to performance of demolition and removal work, seek prior approval from the Owner and the Architect. After receiving direct authorization from the Owner, de-activate such existing electrical systems as indicated or as directed by the Architect.
  1. Use such means and methods for permanent disconnection that render the remaining electrical systems and apparatus in conformity with the National Electrical Code.
  2. System deactivation will be performed with direct authorization by the Owner and the Architect and shall be performed as directed or required by code and regulatory agency(s).
- C. Provide temporary wiring and connections to maintain existing systems in service during construction.
  1. Conform temporary wiring to the requirements of NEC Article 590.

2. Provide temporary electrical service work as specified herein as shown on the drawings in order to maintain existing services and systems required for continued operation.
- D. Coordinate electrical power outages with requirements specified in the Contract Documents.

### 3.4 **PERFORMANCE**

- A. General: The means and methods of performing electrical demolition and removal operations are the sole responsibility of the Contractor, except as otherwise specified. However, equipment used, and methods of demolition and removal will be subject to approval of the Architect.
1. Protection
    - a. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
    - b. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality as approved by the Architect.
  2. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
  3. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.
- B. Demolition of existing electrical installation shall be performed to support the construction efforts of this Project. Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed. Refer to drawings for further information.
1. Remove, relocate and extend existing installations to accommodate new construction as indicated and/or as required.
  2. Remove exposed abandoned conduit systems, including abandoned conduit systems above accessible ceiling systems.
  3. Remove wiring in abandoned conduit systems to source of power supply.
  4. Maintain access to existing electrical installations that remain active. Modify installations and provide access panels or plates as appropriate.
  5. Extend existing installations using materials and methods compatible with existing electrical installations, and as specified elsewhere.
- C. Electrical Materials and Equipment
1. Unintentional De-energization of Required Appurtenances: Any circuit and/or equipment indicated to be retained, and that is left de-energized because of the removal of existing equipment and materials, shall have a new homerun of required size extended to nearest panel and connected to a spare circuit breaker of required size therein. Total connected load on any one circuit breaker shall not exceed that required by the NEC.
  2. Boxes - Flush: Where devices (other than flush mounted light fixtures) and wiring are removed from existing flush boxes, a blank, stainless steel plate shall be provided and installed on the box by the Contractor.
  3. Circuits or Subfeeders: All circuits or subfeeders scheduled for removal shall be disconnected and removed to respective panelboards or the next retained outlet. If concealed conduits are encountered, they shall be cut at point of concealment and plugged with watertight and weatherproof caps as directed.
  4. Panelboards: Where existing flush mounted panelboards are indicated to be removed, they shall have their interiors and covers removed. This Contractor shall provide a new blank cover on the backbox.

5. Wiring Devices: Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduits serving them is abandoned and removed. Provide blank covers for abandoned outlets that are not removed.

**END OF SECTION 26 05 01**

**SECTION 26 05 10****ELECTRICAL ACCEPTANCE TESTING****ELECTRICAL ACCEPTANCE TESTING****1.1 TESTING SHALL BE PERFORMED ON ELECTRICAL EQUIPMENT AND SYSTEMS TO ASSURE THAT EQUIPMENT AND SYSTEMS ARE OPERATIONAL AND WITHIN APPLICABLE STANDARDS AND MANUFACTURER'S TOLERANCES. TESTING SHALL VERIFY THAT EQUIPMENT AND SYSTEMS ARE INSTALLED IN ACCORDANCE WITH DESIGN SPECIFICATIONS. ALL TESTING SHALL OCCUR AT THE SITE.**

- A. Testing shall be performed by an independent organization that is professionally independent of the manufacturers, suppliers, and installers of the equipment or systems being evaluated. The name of the proposed testing organization shall be submitted to Engineer for approval.
- B. Qualified technicians who are trained and regularly employed for testing services shall do all testing. Submit technician qualifications.
- C. The testing organization shall conform to the general guidelines of section 5 of the latest NETA Acceptance Testing Specifications, in their entirety. This includes the following:
  - 1. Safety and Precautions
  - 2. Suitability of Test Equipment
  - 3. Test Instrument Calibration
  - 4. Test Report
- D. Provide formal report with findings, recommendations, resolutions and supporting field data in clear and concise format, one (1) electronic PDF copy, and four (4) paper copies of the completed report to Owner and Engineer.
- E. Notify Owner at least seven (7) days in advance of any testing. An Owner representative shall witness the testing, if needed.
- F. Inspection and testing of all applicable electrical equipment listed below shall be done in accordance with the latest version of NETA ATS. This will include all tests marked optional unless waived in writing by Owner. In addition, follow testing requirements of each individual Division 26 Specification Section for each item in the project.
  - 1. Panelboards
  - 2. Cables: Low Voltage - Insulation Resistance / Voltage Drop
  - 3. Low Voltage Circuit Breakers:
    - a. Insulated Case/Molded Case (100 amp frame and larger)
  - 4. Grounding Systems
  - 5. Surge Arresters
    - a. Low Voltage Surge Protection Devices
  - 6. Emergency Systems:
    - a. Engine Generator
    - b. Automatic Transfer Switches

**1.2 SYSTEM FUNCTION TESTS**

- A. Perform system function tests upon completion of equipment tests as defined in 26 05 10.01. It is the purpose of the system function tests to prove the correct interaction of all sensing, process, and action devices.
- B. Verify the correct operation of all safety devices for fail-safe functions in addition to design function.

- C. Verify the correct operation of all sensing devices, alarms, and indicating devices.

### **1.3 THERMOGRAPHIC SURVEY**

- A. Perform a thermographic survey on all current carrying devices. Perform the survey during periods of maximum possible loading and prior to expiration of warranty or bond period.
- B. Imaging equipment shall be capable of detecting a minimum of 1-degree Celsius at 30 degrees Celsius.
- C. Level 2 certified thermographer shall perform the survey.
- D. A report shall be submitted to Owner and Engineer, which includes the following:
  - 1. Description of equipment tested
  - 2. Discrepancies
  - 3. Temperature difference between area of concern and reference area
  - 4. Areas inspected
  - 5. Load conditions at time of inspection
  - 6. Provide photographs and/or thermograms of deficient areas
  - 7. Summary which includes recommendations for corrective actions.

### **1.4 VOLTAGE DROP TESTING**

- A. A voltage test shall be made at the last receptacle of each branch circuit of each Panelboard. Total voltage drop shall not exceed 3% of the initial voltage measured at the end of that branch circuit. The test shall be made using a 12A load attached to the furthest receptacle. Contractor is responsible to correct any installation with a voltage drop of greater than 3%. If a branch circuit fails the test, all other branch circuits on that panel shall be tested. Submit all test results to Owner and Engineer.
- B. Documentation of the results shall be provided to Owner and Engineer.
- C. Any non-conforming branch circuits shall be corrected.

### **1.5 INSULATION RESISTANCE TESTING**

- A. Cable/Conduit fails insulation resistance testing if cable results are below 1.0 Mega ohm readings on 500V DC or 1000V DC test equipment. Submit results to Engineer/Owner for review and interpretation. Advise Engineer on testing equipment used and test voltage. Resistance measurements are affected by temperature (ambient) and humidity.

**END OF SECTION 26 05 10**

**SECTION 26 05 19****LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Single conductor building wire.
- B. Wiring connectors.
- C. Electrical tape.
- D. Heat shrink tubing.
- E. Wire pulling lubricant.
- F. Cable ties.

**1.2 RELATED REQUIREMENTS**

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

**1.3 REFERENCE STANDARDS**

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.
- F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.
- G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- H. NEMA WC 70 - Nonshielded Power Cable 2000 V or Less for the Distribution of Electrical Energy; 2009.
- I. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- L. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- M. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.



- N. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- O. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- P. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

#### **1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
  - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
  - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

#### **1.5 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- B. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.
- C. Field Quality Control Test Reports.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

#### **1.6 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

#### **1.8 FIELD CONDITIONS**

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

**PART 2 PRODUCTS****2.1 CONDUCTOR AND CABLE APPLICATIONS**

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

**2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS**

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.
- H. Conductor Material:
  - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
  - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
  - 3. Tinned Copper Conductors: Comply with ASTM B33.
- I. Minimum Conductor Size:
  - 1. Branch Circuits: 12 AWG.
    - a. Exceptions:
      - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
      - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
  - 2. Control Circuits: 14 AWG for digital circuits; 16 AWG for analog circuits.
- J. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- K. Conductor Color Coding:
  - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
  - 2. Color Coding Method: Integrally colored insulation.
    - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
  - 3. Color Code:
    - a. 240/120 V, 1 Phase, 3 Wire System:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Neutral/Grounded: White.

- b. Equipment Ground, All Systems: Green.
- c. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.

### **2.3 SINGLE CONDUCTOR BUILDING WIRE**

- A. Manufacturers:
  - 1. Copper Building Wire:
    - a. Cerro Wire LLC: [www.cerrowire.com](http://www.cerrowire.com).
    - b. Encore Wire Corporation: [www.encorewire.com](http://www.encorewire.com).
    - c. General Cable Technologies Corporation: [www.generalcable.com](http://www.generalcable.com).
    - d. Southwire Company: [www.southwire.com](http://www.southwire.com).
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
  - 1. Feeders and Branch Circuits:
    - a. Size 10 AWG and Smaller: Solid.
    - b. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
  - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
    - a. Size 4 AWG and Larger: Type XHHW-2.
    - b. Installed Underground: Type XHHW-2.

### **2.4 WIRING CONNECTORS**

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.
- C. Wiring Connectors for Splices and Taps:
  - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
- D. Wiring Connectors for Terminations:
  - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
  - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
  - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
  - 4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
  - 5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
  - 6. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
  - 7. Conductors for Control Circuits: Use crimped terminals for all connections.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
  - 1. Manufacturers:
    - a. 3M: [www.3m.com](http://www.3m.com).
    - b. Ideal Industries, Inc: [www.idealindustries.com](http://www.idealindustries.com).
    - c. NSI Industries LLC: [www.nsiindustries.com](http://www.nsiindustries.com).
- H. Mechanical Connectors: Provide bolted type or set-screw type.
  - 1. Manufacturers:
    - a. Burndy LLC: [www.burndy.com](http://www.burndy.com).
    - b. IlSCO: [www.ilSCO.com](http://www.ilSCO.com).
    - c. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
  - 1. Manufacturers:
    - a. Burndy LLC: [www.burndy.com](http://www.burndy.com).
    - b. IlSCO: [www.ilSCO.com](http://www.ilSCO.com).
    - c. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
- J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
  - 1. Manufacturers:
    - a. Burndy LLC: [www.burndy.com](http://www.burndy.com).
    - b. IlSCO: [www.ilSCO.com](http://www.ilSCO.com).
    - c. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
- K. Low Voltage Motor Termination/Insulation Kit: Utilize lug connectors, insulated by means of Raychem, RVC Series (RAYVOLVE Insulating Splice Cover) pre-manufactured "roll-on" type insulation kits or equal products by Thomas and Betts. Voltage rating as required by the installation.

## **2.5 ACCESSORIES**

- A. Electrical Tape:
  - 1. Manufacturers:
    - a. 3M: [www.3m.com](http://www.3m.com).
    - b. Plymouth Rubber Europa: [www.plymouthrubber.com](http://www.plymouthrubber.com).
  - 2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
  - 3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
  - 4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
  - 5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.

6. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
  7. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
1. Manufacturers:
    - a. 3M: [www.3m.com](http://www.3m.com).
    - b. Burndy LLC: [www.burndy.com](http://www.burndy.com).
    - c. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
- C. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
1. Manufacturers:
    - a. 3M: [www.3m.com](http://www.3m.com).
    - b. American Polywater Corporation: [www.polywater.com](http://www.polywater.com).
    - c. Ideal Industries, Inc: [www.idealindustries.com](http://www.idealindustries.com).
- D. Cable Ties: Material and tensile strength rating suitable for application.

### **PART 3 EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

#### **3.2 PREPARATION**

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

#### **3.3 INSTALLATION**

- A. Circuiting Requirements:
1. Unless dimensioned, circuit routing indicated is diagrammatic.
  2. When circuit destination is indicated without specific routing, determine exact routing required.
  3. Arrange circuiting to minimize splices.
  4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
  5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
  6. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
    - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.

- b. Increase size of conductors as required to account for ampacity derating.
  - c. Size raceways, boxes, etc. to accommodate conductors.
  - 7. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Installation in Raceway:
- 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
  - 2. Pull all conductors and cables together into raceway at same time.
  - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
  - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- G. Install conductors with a minimum of 12 inches of slack at each outlet.
- H. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- I. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- J. Make wiring connections using specified wiring connectors.
- 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
  - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
  - 3. Do not remove conductor strands to facilitate insertion into connector.
  - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
  - 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
  - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- K. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
- 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
    - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
    - b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.

2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
    - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
    - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
  3. Wet Locations: Use heat shrink tubing.
- L. Insulate ends of spare conductors using vinyl insulating electrical tape.
- M. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- N. Identify conductors and cables in accordance with Section 26 05 53.
- O. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

### **3.4 FIELD QUALITY CONTROL**

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
  1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- C. Perform thermographic survey.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

**END OF SECTION 26 05 19**

**SECTION 26 05 26****GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground rod electrodes.
- E. Ground access wells.

**1.2 RELATED REQUIREMENTS**

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

**1.3 REFERENCE STANDARDS**

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.
- C. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

**1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Verify exact locations of underground metal water service pipe entrances to building.
  - 2. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
  - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

**1.5 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C. Field quality control test reports.



- D. Project Record Documents: Record actual locations of grounding electrode system components and connections.

## 1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

## PART 2 PRODUCTS

### 2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding Electrode System:
  - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
    - a. Provide continuous grounding electrode conductors without splice or joint.
    - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
  - 2. Metal Underground Water Pipe(s):
    - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
    - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
    - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
  - 3. Ground Rod Electrode(s):
    - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
    - b. Space electrodes not less than 10 feet from each other and any other ground electrode.
    - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.

- F. Service-Supplied System Grounding:
1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
  2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
- G. Separately Derived System Grounding:
1. Separately derived systems include, but are not limited to:
    - a. Generators, when neutral is switched in the transfer switch.
  2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
  3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
  4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
  5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
  6. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.
- H. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
  2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
  3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
  4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
  5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
  6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
  7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
    - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
  8. Provide bonding for metal building frame.

## 2.2 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
  - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
  - 2. Provide products listed and labeled as complying with UL 467 where applicable.
  
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
  - 1. Use insulated copper conductors unless otherwise indicated.
    - a. Exceptions:
      - 1) Use bare copper conductors where installed underground in direct contact with earth.
      - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
  
- C. Connectors for Grounding and Bonding:
  - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
  - 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
    - a. Exceptions:
      - 1) Use mechanical connectors for connections to electrodes at ground access wells.
  - 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
    - a. Exceptions:
      - 1) Use exothermic welded connections for connections to metal building frame.
  - 4. Manufacturers - Mechanical and Compression Connectors:
    - a. Advanced Lightning Technology (ALT): [www.altfab.com](http://www.altfab.com).
    - b. Burndy LLC: [www.burndy.com](http://www.burndy.com).
    - c. Harger Lightning & Grounding: [www.harger.com](http://www.harger.com).
    - d. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
  - 5. Manufacturers - Exothermic Welded Connections:
    - a. Burndy LLC: [www.burndy.com](http://www.burndy.com).
    - b. Cadweld, a brand of Erico International Corporation: [www.erico.com](http://www.erico.com).
    - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: [www.thermoweld.com](http://www.thermoweld.com).
  
- D. Ground Rod Electrodes:
  - 1. Comply with NEMA GR 1.
  - 2. Material: Copper-bonded (copper-clad) steel.
  - 3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
  - 4. Manufacturers:
    - a. Advanced Lightning Technology (ALT): [www.altfab.com](http://www.altfab.com).
    - b. Erico International Corporation: [www.erico.com](http://www.erico.com).
    - c. Galvan Industries, Inc: [www.galvanelectrical.com](http://www.galvanelectrical.com).
    - d. Harger Lightning & Grounding: [www.harger.com](http://www.harger.com).
  
- E. Ground Access Wells:
  - 1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
  - 2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
    - a. Round Wells: Not less than 8 inches in diameter.
    - b. Rectangular Wells: Not less than 12 by 12 inches.

3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
4. Cover: Factory-identified by permanent means with word "GROUND".
5. Manufacturers:
  - a. Advanced Lightning Technology (ALT): [www.altfab.com](http://www.altfab.com).
  - b. Erico International Corporation: [www.erico.com](http://www.erico.com).
  - c. Harger Lightning & Grounding: [www.harger.com](http://www.harger.com).
  - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: [www.thermoweld.com](http://www.thermoweld.com).

### **PART 3 EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

#### **3.2 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
  1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
- D. Make grounding and bonding connections using specified connectors.
  1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
  2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
  3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
  4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
  5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 26 05 53.

#### **3.3 FIELD QUALITY CONTROL**

- A. Inspect and test in accordance with NETA ATS except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.13.
- C. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

- D. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
- E. Submit detailed reports indicating inspection and testing results and corrective actions taken.

**END OF SECTION 26 05 26**

**SECTION 26 05 29****HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

**1.2 RELATED REQUIREMENTS**

- A. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- B. Section 26 05 33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.

**1.3 REFERENCE STANDARDS**

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

**1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
  - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
  - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
  - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
  - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

**1.5 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for post-installed concrete and masonry anchors.

- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

#### **1.6 QUALITY ASSURANCE**

- A. Comply with NFPA 70.
- B. Comply with applicable building code.
- C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

### **PART 2 PRODUCTS**

#### **2.1 SUPPORT AND ATTACHMENT COMPONENTS**

- A. General Requirements:
  - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
  - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
  - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
  - 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
  - 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
  - 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
    - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
    - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
  - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
  - 2. Conduit Clamps: Bolted type unless otherwise indicated.
  - 3. Manufacturers:
    - a. Cooper Crouse-Hinds, a division of Eaton Corporation: [www.cooperindustries.com](http://www.cooperindustries.com).
    - b. Erico International Corporation: [www.erico.com](http://www.erico.com).

- c. HoldRite, a brand of Reliance Worldwide Corporation: [www.holdrite.com](http://www.holdrite.com).
  - d. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com](http://www.emerson.com).
  - e. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
- 1. Manufacturers:
    - a. Cooper Crouse-Hinds, a division of Eaton Corporation: [www.cooperindustries.com](http://www.cooperindustries.com).
    - b. Erico International Corporation: [www.erico.com](http://www.erico.com).
    - c. HoldRite, a brand of Reliance Worldwide Corporation: [www.holdrite.com](http://www.holdrite.com).
    - d. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com](http://www.emerson.com).
    - e. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
- 1. Comply with MFMA-4.
  - 2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
  - 3. Channel Material:
    - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
    - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
  - 4. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
  - 5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
  - 6. Manufacturers:
    - a. Cooper B-Line, a division of Eaton Corporation: [www.cooperindustries.com](http://www.cooperindustries.com).
    - b. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
    - c. Unistrut, a brand of Atkore International Inc: [www.unistrut.com](http://www.unistrut.com).
    - d. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
- 1. Minimum Size, Unless Otherwise Indicated or Required:
    - a. Equipment Supports: 1/2 inch diameter.
    - b. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch diameter.
    - c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter.
    - d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
- F. Anchors and Fasteners:
- 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
  - 2. Concrete: Use expansion anchors or screw anchors.
  - 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
  - 4. Hollow Masonry: Use toggle bolts.
  - 5. Powder-actuated fasteners are not permitted.
  - 6. Hammer-driven anchors and fasteners are not permitted.
  - 7. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
  - 8. Manufacturers - Mechanical Anchors:
    - a. Hilti, Inc: [www.us.hilti.com](http://www.us.hilti.com).
    - b. ITW Red Head, a division of Illinois Tool Works, Inc: [www.itwredhead.com](http://www.itwredhead.com).
    - c. Powers Fasteners, Inc: [www.powers.com](http://www.powers.com).
    - d. Simpson Strong-Tie Company Inc: [www.strongtie.com](http://www.strongtie.com).



**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

**3.2 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Equipment Support and Attachment:
  - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
  - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
  - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
  - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- I. Conduit Support and Attachment: Also comply with Section 26 05 33.13.
- J. Box Support and Attachment: Also comply with Section 26 05 33.16.
- K. Secure fasteners according to manufacturer's recommended torque settings.
- L. Remove temporary supports.

**3.3 FIELD QUALITY CONTROL**

- A. Inspect support and attachment components for damage and defects.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Correct deficiencies and replace damaged or defective support and attachment components.

**END OF SECTION 26 05 29**



**SECTION 26 05 33.13****CONDUIT FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Galvanized steel rigid metal conduit (RMC).
- B. PVC-coated galvanized steel rigid metal conduit (RMC).
- C. Flexible metal conduit (FMC).
- D. Liquidtight flexible metal conduit (LFMC).
- E. Electrical metallic tubing (EMT).
- F. Rigid polyvinyl chloride (PVC) conduit.
- G. Conduit fittings.
- H. Accessories.

**1.2 RELATED REQUIREMENTS**

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 31 23 17 - Trenching, Backfilling, and Compacting.

**1.3 REFERENCE STANDARDS**

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
- B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.
- E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.
- F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
- G. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005.
- H. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.
- I. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2015.
- J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

- L. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- M. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
- N. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- O. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- P. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

#### **1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
  - 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
  - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
  - 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
  - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
  - 1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

#### **1.5 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- B. Shop Drawings:
  - 1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
  - 2. Include proposed locations of roof penetrations and proposed methods for sealing.
- C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

#### **1.6 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

**PART 2 PRODUCTS****2.1 CONDUIT APPLICATIONS**

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
  - 1. Under Slab on Grade: Use PVC-coated galvanized steel rigid metal conduit or rigid PVC conduit.
  - 2. Exterior, Direct-Buried: Use PVC-coated galvanized steel rigid metal conduit or rigid PVC conduit.
  - 3. Where rigid polyvinyl (PVC) conduit is provided, transition to PVC-coated galvanized steel rigid metal conduit where emerging from underground.
  - 4. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use PVC-coated galvanized steel rigid metal conduit elbows for bends.
- D. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- E. Exposed, Interior: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- F. Exposed, Exterior: Use PVC-coated galvanized steel rigid metal conduit.
- G. Connections to Vibrating Equipment:
  - 1. Dry Locations: Use flexible metal conduit.
  - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
  - 3. Maximum Length: 6 feet unless otherwise indicated.
  - 4. Vibrating equipment includes, but is not limited to:
    - a. Motors.

**2.2 CONDUIT REQUIREMENTS**

- A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.
- B. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Minimum Conduit Size, Unless Otherwise Indicated:
  - 1. Branch Circuits: 3/4 inch (21 mm) trade size.
  - 2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
  - 3. Underground, Exterior: 1 inch (27 mm) trade size.
- E. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

**2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)**

- A. Manufacturers:
  - 1. Allied Tube & Conduit: [www.alliedeg.com](http://www.alliedeg.com).

2. Republic Conduit: [www.republic-conduit.com](http://www.republic-conduit.com).
  3. Wheatland Tube, a Division of Zekelman Industries: [www.wheatland.com](http://www.wheatland.com).
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
1. Manufacturers:
    - a. Bridgeport Fittings Inc: [www.bptfittings.com](http://www.bptfittings.com).
    - b. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com](http://www.emerson.com).
    - c. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
  2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  3. Material: Use steel or malleable iron.
    - a. Do not use die cast zinc fittings.
  4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

#### **2.4 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)**

- A. Manufacturers:
1. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
  2. Robroy Industries: [www.robroy.com](http://www.robroy.com).
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.
- D. Interior Coating: Urethane, minimum thickness of 2 mil.
- E. PVC-Coated Fittings:
1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
  2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
  3. Material: Use steel or malleable iron.
  4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.
  5. Interior Coating: Urethane, minimum thickness of 2 mil.
- F. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

#### **2.5 FLEXIBLE METAL CONDUIT (FMC)**

- A. Manufacturers:
1. AFC Cable Systems, Inc: [www.afcweb.com](http://www.afcweb.com).
  2. Electri-Flex Company: [www.electriflex.com](http://www.electriflex.com).
  3. International Metal Hose: [www.metalhose.com](http://www.metalhose.com).
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- C. Fittings:
1. Manufacturers:
    - a. Bridgeport Fittings Inc: [www.bptfittings.com](http://www.bptfittings.com).
    - b. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com](http://www.emerson.com).

- c. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
- 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
- 3. Material: Use steel or malleable iron.
  - a. Do not use die cast zinc fittings.

## **2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)**

- A. Manufacturers:
  - 1. AFC Cable Systems, Inc: [www.afcweb.com](http://www.afcweb.com).
  - 2. Electri-Flex Company: [www.electriflex.com](http://www.electriflex.com).
  - 3. International Metal Hose: [www.metalhose.com](http://www.metalhose.com).
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
  - 1. Manufacturers:
    - a. Bridgeport Fittings Inc: [www.bptfittings.com](http://www.bptfittings.com).
    - b. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com](http://www.emerson.com).
    - c. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
  - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 3. Material: Use steel or malleable iron.
    - a. Do not use die cast zinc fittings.

## **2.7 ELECTRICAL METALLIC TUBING (EMT)**

- A. Manufacturers:
  - 1. Allied Tube & Conduit: [www.alliedeg.com](http://www.alliedeg.com).
  - 2. Republic Conduit: [www.republic-conduit.com](http://www.republic-conduit.com).
  - 3. Wheatland Tube, a Division of Zekelman Industries: [www.wheatland.com](http://www.wheatland.com).
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
  - 1. Manufacturers:
    - a. Bridgeport Fittings Inc: [www.bptfittings.com](http://www.bptfittings.com).
    - b. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com](http://www.emerson.com).
    - c. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
  - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 3. Material: Use steel or malleable iron.
    - a. Do not use die cast zinc fittings.
  - 4. Connectors and Couplings: Use compression (gland) type.
    - a. Do not use indenter type connectors and couplings.
    - b. Do not use set-screw type connectors and couplings.

## **2.8 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT**

- A. Manufacturers:
  - 1. Cantex Inc: [www.cantexinc.com](http://www.cantexinc.com).
  - 2. Carlon, a brand of Thomas & Betts Corporation: [www.carlon.com](http://www.carlon.com).

3. JM Eagle: [www.jmeagle.com](http://www.jmeagle.com).
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- C. Fittings:
  1. Manufacturer: Same as manufacturer of conduit to be connected.
  2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

## **2.9 ACCESSORIES**

- A. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- C. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- D. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
- E. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.
- F. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for the conduit/duct arrangement to be installed.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

### **3.2 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
- E. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- F. Conduit Routing:
  1. Unless dimensioned, conduit routing indicated is diagrammatic.
  2. When conduit destination is indicated without specific routing, determine exact routing required.
  3. Conceal all conduits unless specifically indicated to be exposed.
  4. Conduits in the following areas may be exposed, unless otherwise indicated:
    - a. Electrical rooms.



- b. Mechanical equipment rooms.
  5. Unless otherwise approved, do not route conduits exposed:
    - a. Across floors.
    - b. Across roofs.
    - c. Across top of parapet walls.
    - d. Across building exterior surfaces.
  6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
  7. Arrange conduit to maintain adequate headroom, clearances, and access.
  8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
  9. Arrange conduit to provide no more than 150 feet between pull points.
  10. Route conduits above water and drain piping where possible.
  11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
  12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
  13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
    - a. Heaters.
    - b. Hot water piping.
    - c. Flues.
  14. Group parallel conduits in the same area together on a common rack.
- G. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
  2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
  3. Use conduit strap to support single surface-mounted conduit.
    - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
  4. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
  5. Use conduit clamp to support single conduit from beam clamp or threaded rod.
  6. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
  7. Use of spring steel conduit clips for support of conduits is permitted only as follows:
    - a. Support of electrical metallic tubing (EMT) up to 1 inch (27 mm) trade size concealed above accessible ceilings and within hollow stud walls.
  8. Use of wire for support of conduits is not permitted.
  9. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.
- H. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
  2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
  3. Use suitable adapters where required to transition from one type of conduit to another.

4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
  5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
  6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
  7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
- I. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
  2. Make penetrations perpendicular to surfaces unless otherwise indicated.
  3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
  4. Conceal bends for conduit risers emerging above ground.
  5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
  6. Provide suitable modular seal where conduits penetrate exterior wall below grade.
  7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
  8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
- J. Underground Installation:
1. Provide trenching and backfilling in accordance with Section 31 23 17.
  2. Minimum Cover, Unless Otherwise Indicated or Required:
    - a. Underground, Exterior: 24 inches.
    - b. Under Slab on Grade: 12 inches to bottom of slab.
- K. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
  2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
  3. Where conduits are subject to earth movement by settlement or frost.
- L. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
  2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- M. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- N. Provide grounding and bonding in accordance with Section 26 05 26.
- O. Identify conduits in accordance with Section 26 05 53.

**3.3 FIELD QUALITY CONTROL**

- A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- B. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- C. Correct deficiencies and replace damaged or defective conduits.

**3.4 CLEANING**

- A. Clean interior of conduits to remove moisture and foreign matter.

**3.5 PROTECTION**

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

**END OF SECTION 26 05 33.13**

**SECTION 26 05 33.16****BOXES FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

**1.2 RELATED REQUIREMENTS**

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 26 05 33.13 - Conduit for Electrical Systems:
  - 1. Conduit bodies and other fittings.
  - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

**1.3 REFERENCE STANDARDS**

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

**1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
  - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

### **1.5 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for outlet and device boxes, junction and pull boxes, and cabinets and enclosures.
- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C. Project Record Documents: Record actual locations for junction boxes, pull boxes, and cabinets and enclosures.
- D. Maintenance Materials: Furnish the following for City of Reading Department of Public Works's use in maintenance of project.
  1. See Section 01 60 00 - Product Requirements, for additional provisions.
  2. Keys for Lockable Enclosures: Two of each different key.

### **1.6 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

### **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

## **PART 2 PRODUCTS**

### **2.1 BOXES**

- A. General Requirements:
  1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
  2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
  3. Provide products listed, classified, and labeled as suitable for the purpose intended.
  4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
  5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
  2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
  3. Use suitable concrete type boxes where flush-mounted in concrete.
  4. Use suitable masonry type boxes where flush-mounted in masonry walls.
  5. Use raised covers suitable for the type of wall construction and device configuration where required.
  6. Use shallow boxes where required by the type of wall construction.
  7. Do not use "through-wall" boxes designed for access from both sides of wall.
  8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
  9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
  10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
  11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
  12. Minimum Box Size, Unless Otherwise Indicated:
    - a. Wiring Devices: 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
  13. Manufacturers:
    - a. Cooper Crouse-Hinds, a division of Eaton Corporation: [www.cooperindustries.com](http://www.cooperindustries.com).
    - b. Hubbell Incorporated; Bell Products: [www.hubbell-rtb.com](http://www.hubbell-rtb.com).
    - c. Hubbell Incorporated; RACO Products: [www.hubbell-rtb.com](http://www.hubbell-rtb.com).
    - d. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com](http://www.emerson.com).
    - e. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
  2. NEMA 250 Environment Type, Unless Otherwise Indicated:
    - a. Indoor Clean, Dry Locations: Type 1, painted steel.
    - b. Outdoor Locations: Type 3R, painted steel.
  3. Junction and Pull Boxes Larger Than 100 cubic inches:
    - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
    - b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
  4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
    - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
    - b. Back Panels: Painted steel, removable.
    - c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
  5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
  6. Manufacturers:
    - a. Cooper B-Line, a division of Eaton Corporation: [www.cooperindustries.com](http://www.cooperindustries.com).
    - b. Hoffman, a brand of Pentair Technical Products: [www.hoffmanonline.com](http://www.hoffmanonline.com).
    - c. Hubbell Incorporated; Wiegmann Products: [www.hubbell-wiegmann.com](http://www.hubbell-wiegmann.com).

**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

**3.2 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- G. Box Locations:
  - 1. Unless dimensioned, box locations indicated are approximate.
  - 2. Locate boxes as required for devices installed under other sections or by others.
  - 3. Locate boxes so that wall plates do not span different building finishes.
  - 4. Locate boxes so that wall plates do not cross masonry joints.
  - 5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
  - 6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
  - 7. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.
  - 8. Locate junction and pull boxes in the following areas, unless otherwise indicated:
    - a. Electrical rooms.
    - b. Mechanical equipment rooms.
- H. Box Supports:
  - 1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
  - 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
- I. Install boxes plumb and level.
- J. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
  2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
  3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- K. Install boxes as required to preserve insulation integrity.
- L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- M. Close unused box openings.
- N. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- O. Provide grounding and bonding in accordance with Section 26 05 26.
- P. Identify boxes in accordance with Section 26 05 53.

### **3.3 CLEANING**

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

### **3.4 PROTECTION**

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

**END OF SECTION 26 05 33.16**



**SECTION 26 05 53****IDENTIFICATION FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Underground warning tape.
- F. Warning signs and labels.

**1.2 RELATED REQUIREMENTS**

- A. Section 09 91 13 - Exterior Painting.
- B. Section 09 91 23 - Interior Painting.
- C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

**1.3 REFERENCE STANDARDS**

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

**1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
  - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
  - 2. Do not install identification products until final surface finishes and painting are complete.

**1.5 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- B. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

## 1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

## 1.7 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

## PART 2 PRODUCTS

### 2.1 IDENTIFICATION REQUIREMENTS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. Identification for Equipment:
  - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
    - a. Panelboards:
      - 1) Identify ampere rating.
      - 2) Identify voltage and phase.
      - 3) Identify power source and circuit number. Include location when not within sight of equipment.
      - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
      - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
      - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
    - b. Enclosed switches, circuit breakers, and motor controllers:
      - 1) Identify voltage and phase.
      - 2) Identify power source and circuit number. Include location when not within sight of equipment.
      - 3) Identify load(s) served. Include location when not within sight of equipment.
    - c. Transfer Switches:
      - 1) Identify voltage and phase.
      - 2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
      - 3) Identify load(s) served. Include location when not within sight of equipment.
      - 4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
  - 2. Service Equipment:
    - a. Use identification nameplate to identify each service disconnecting means.
  - 3. Emergency System Equipment:
    - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.

- b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
  - c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.
  4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
  5. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
  6. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
  7. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following. Consult Engineer for values and label for the main enclosed circuit breaker.
    - a. Service equipment.
  8. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.
- C. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
  2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
  3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
    - a. At each source and load connection.
    - b. Within boxes when more than one circuit is present.
    - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
  4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
- D. Identification for Raceways:
1. Use underground warning tape to identify underground raceways.
- E. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.
  2. Use voltage markers to identify systems other than normal power system.
    - a. Color-Coded Boxes: Field-painted in accordance with Section 09 91 23 and 09 91 13 per the following color code:
      - 1) Emergency Power System: Red.

## 2.2 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
1. Manufacturers:
    - a. Brimar Industries, Inc: [www.brimar.com](http://www.brimar.com).
    - b. Kolbi Pipe Marker Co: [www.kolbipipemarkers.com](http://www.kolbipipemarkers.com).
    - c. Seton Identification Products: [www.seton.com](http://www.seton.com).
  2. Materials:

- a. Indoor Clean, Dry Locations: Use plastic nameplates.
  - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
  3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
  4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
  5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
  6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
1. Manufacturers:
    - a. Brady Corporation: [www.bradyid.com](http://www.bradyid.com).
    - b. Brother International Corporation: [www.brother-usa.com](http://www.brother-usa.com).
    - c. Panduit Corp: [www.panduit.com](http://www.panduit.com).
  2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
  3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
1. Minimum Size: 1 inch by 2.5 inches.
  2. Legend:
    - a. System designation where applicable:
      - 1) Emergency Power System: Identify with text "EMERGENCY".
    - b. Equipment designation or other approved description.
  3. Text: All capitalized unless otherwise indicated.
  4. Minimum Text Height:
    - a. System Designation: 1 inch.
    - b. Equipment Designation: 1/2 inch.
  5. Color:
    - a. Normal Power System: White text on black background.
    - b. Emergency Power System: White text on red background.
- D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch by 2.5 inches.
  2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
  3. Text: All capitalized unless otherwise indicated.
  4. Minimum Text Height: 1/4 inch.
  5. Color: Black text on white background unless otherwise indicated.
    - a. Exceptions:
      - 1) Provide white text on red background for general information or operational instructions for emergency systems.
- E. Format for Caution and Warning Messages:
1. Minimum Size: 2 inches by 4 inches.
  2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
  3. Text: All capitalized unless otherwise indicated.
  4. Minimum Text Height: 1/2 inch.
  5. Color: Black text on yellow background unless otherwise indicated.

**2.3 WIRE AND CABLE MARKERS**

- A. Manufacturers:
  - 1. Brady Corporation: [www.bradyid.com](http://www.bradyid.com).
  - 2. HellermannTyton: [www.hellermanntyton.com](http://www.hellermanntyton.com).
  - 3. Panduit Corp: [www.panduit.com](http://www.panduit.com).
- B. Markers for Conductors and Cables: Use heat-shrink sleeve or plastic clip-on type markers suitable for the conductor or cable to be identified.
  - 1. Do not use self-adhesive type markers.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
  - 1. Do not use handwritten text.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.

**2.4 VOLTAGE MARKERS**

- A. Manufacturers:
  - 1. Brady Corporation: [www.bradyid.com](http://www.bradyid.com).
  - 2. Brimar Industries, Inc: [www.brimar.com](http://www.brimar.com).
  - 3. Seton Identification Products: [www.seton.com](http://www.seton.com).
- B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- C. Minimum Size:
  - 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
  - 2. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
  - 3. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- D. Legend:
  - 1. Markers for Voltage Identification: Highest voltage present.
  - 2. Markers for System Identification:
    - a. Emergency Power System: Text "EMERGENCY".
- E. Color: Black text on orange background unless otherwise indicated.

**2.5 UNDERGROUND WARNING TAPE**

- A. Manufacturers:
  - 1. Brady Corporation: [www.bradyid.com](http://www.bradyid.com).
  - 2. Brimar Industries, Inc: [www.brimar.com](http://www.brimar.com).
  - 3. Seton Identification Products: [www.seton.com](http://www.seton.com).
- B. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

- C. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.
- D. Legend: Type of service, continuously repeated over full length of tape.
- E. Color:
  - 1. Tape for Buried Power Lines: Black text on red background.

## **2.6 WARNING SIGNS AND LABELS**

- A. Manufacturers:
  - 1. Brimar Industries, Inc: [www.brimar.com](http://www.brimar.com).
  - 2. Clarion Safety Systems, LLC: [www.clarionsafety.com](http://www.clarionsafety.com).
  - 3. Seton Identification Products: [www.seton.com](http://www.seton.com).
- B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- C. Warning Signs:
  - 1. Materials:
    - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
    - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
  - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
  - 3. Minimum Size: 7 by 10 inches unless otherwise indicated.
- D. Warning Labels:
  - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
    - a. Do not use labels designed to be completed using handwritten text.
  - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
  - 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

## **PART 3 EXECUTION**

### **3.1 PREPARATION**

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

### **3.2 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
  - 1. Surface-Mounted Equipment: Enclosure front.
  - 2. Flush-Mounted Equipment: Inside of equipment door.
  - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
  - 4. Elevated Equipment: Legible from the floor or working platform.
  - 5. Branch Devices: Adjacent to device.
  - 6. Interior Components: Legible from the point of access.
  - 7. Conduits: Legible from the floor.
  - 8. Boxes: Outside face of cover.
  - 9. Conductors and Cables: Legible from the point of access.

- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
  - 1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
- G. Secure rigid signs using stainless steel screws.
- H. Mark all handwritten text, where permitted, to be neat and legible.

### **3.3 FIELD QUALITY CONTROL**

- A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

**END OF SECTION 26 05 53**

**SECTION 26 24 16****PANELBOARDS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

**1.2 RELATED REQUIREMENTS**

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

**1.3 REFERENCE STANDARDS**

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2009.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- E. NEMA PB 1 - Panelboards; 2011.
- F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.
- G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 67 - Panelboards; Current Edition, Including All Revisions.
- L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

**1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:



1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

### **1.5 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
  1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
  1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
  2. Include wiring diagrams showing all factory and field connections.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- F. Maintenance Materials: Furnish the following for City of Reading Department of Public Works's use in maintenance of project.
  1. Panelboard Keys: Two of each different key.

### **1.6 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

### **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

### **1.8 FIELD CONDITIONS**

- A. Maintain ambient temperature within the following limits during and after installation of panelboards:
  - 1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Eaton Corporation: [www.eaton.com](http://www.eaton.com).
- B. Schneider Electric; Square D Products: [www.schneider-electric.us](http://www.schneider-electric.us).
- C. Siemens Industry, Inc: [www.usa.siemens.com](http://www.usa.siemens.com).
- D. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

### **2.2 PANELBOARDS - GENERAL REQUIREMENTS**

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
  - 1. Altitude: Less than 6,600 feet.
  - 2. Ambient Temperature:
    - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
  - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
  - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
  - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
  - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
    - a. Indoor Clean, Dry Locations: Type 1.
  - 2. Boxes: Galvanized steel unless otherwise indicated.

- a. Provide wiring gutters sized to accommodate the conductors to be installed.
- b. Provide removable end walls for NEMA Type 1 enclosures.
3. Fronts:
  - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
  - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
  - c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- J. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- K. Load centers are not acceptable.

### **2.3 POWER DISTRIBUTION PANELBOARDS**

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
  1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
  2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
  1. Phase and Neutral Bus Material: Copper.
  2. Ground Bus Material: Copper.
- D. Circuit Breakers:
  1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
  2. Provide thermal magnetic circuit breakers unless otherwise indicated.
  3. Provide electronic trip circuit breakers where indicated.
- E. Enclosures:
  1. Provide surface-mounted enclosures unless otherwise indicated.
  2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
  3. Provide clear plastic circuit directory holder mounted on inside of door.

### **2.4 LIGHTING AND APPLIANCE PANELBOARDS**

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
  1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
  2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
  1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
  2. Phase and Neutral Bus Material: Copper.
  3. Ground Bus Material: Copper.

- D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- E. Enclosures:
  - 1. Provide surface-mounted or flush-mounted enclosures as indicated.
  - 2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
  - 3. Provide clear plastic circuit directory holder mounted on inside of door.

## **2.5 OVERCURRENT PROTECTIVE DEVICES**

- A. Molded Case Circuit Breakers:
  - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
  - 2. Interrupting Capacity:
    - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
    - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
  - 3. Conductor Terminations:
    - a. Provide mechanical lugs unless otherwise indicated.
    - b. Provide compression lugs where indicated.
    - c. Lug Material: Copper, suitable for terminating copper conductors only.
  - 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
    - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
  - 5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units. Furnish as required to meet features identified on drawings and panel schedules.
    - a. Provide the following field-adjustable trip response settings:
      - 1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
      - 2) Long time delay.
      - 3) Short time pickup and delay.
      - 4) Instantaneous pickup.
    - b. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
  - 6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
  - 7. Do not use tandem circuit breakers.
  - 8. Do not use handle ties in lieu of multi-pole circuit breakers.
  - 9. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

## **2.6 SOURCE QUALITY CONTROL**

- A. Factory test panelboards according to NEMA PB 1.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.

- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

### **3.2 INSTALLATION**

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 26 05 29.
- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- I. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- J. Provide grounding and bonding in accordance with Section 26 05 26.
- K. Install all field-installed branch devices, components, and accessories.
- L. Set field-adjustable circuit breaker tripping function settings as indicated.
- M. Provide filler plates to cover unused spaces in panelboards.
- N. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
  - 1. Emergency and night lighting circuits.
  - 2. Fire detection and alarm circuits.
- O. Identify panelboards in accordance with Section 26 05 53.
- P. Provide sheet metal fillers where panels are installed within or adjacent to existing panelboard back boxes designated for replacement as indicated on the Drawings.

### **3.3 FIELD QUALITY CONTROL**

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 100 amperes. Tests listed as optional are not required.
- C. Correct deficiencies and replace damaged or defective panelboards or associated components.

**3.4 ADJUSTING**

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

**3.5 CLEANING**

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

**END OF SECTION 26 24 16**

**SECTION 26 28 16.13****ENCLOSED CIRCUIT BREAKERS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Enclosed circuit breakers.

**1.2 RELATED REQUIREMENTS**

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

**1.3 REFERENCE STANDARDS**

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- I. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

**1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
  - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
  - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
  - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

**1.5 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
  - 1. Include characteristic trip curves for each type and rating of circuit breaker upon request.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
  - 1. Include dimensioned plan and elevation views of enclosed circuit breakers and adjacent equipment with all required clearances indicated.
  - 2. Include wiring diagrams showing all factory and field connections.
- D. Field Quality Control Test Reports.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- F. Project Record Documents: Record actual installed locations of enclosed circuit breakers.
- G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

**1.6 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

**1.8 FIELD CONDITIONS**

- A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

**PART 2 PRODUCTS****2.1 MANUFACTURERS**

- A. Eaton Corporation: [www.eaton.com](http://www.eaton.com).
- B. Schneider Electric; Square D Products: [www.schneider-electric.us](http://www.schneider-electric.us).



- C. Siemens Industry, Inc: [www.usa.siemens.com](http://www.usa.siemens.com).
- D. Source Limitations: Furnish enclosed circuit breakers and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

## **2.2 ENCLOSED CIRCUIT BREAKERS**

- A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
  - 1. Altitude: Less than 6,600 feet.
  - 2. Ambient Temperature: Between 23 degrees F and 104 degrees F.
- D. Short Circuit Current Rating:
  - 1. Provide enclosed circuit breakers with listed short circuit current rating as indicated on the drawings.
- E. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- F. Conductor Terminations: Suitable for use with the conductors to be installed.
- G. Provide thermal magnetic circuit breakers unless otherwise indicated.
- H. Provide electronic trip circuit breakers where indicated or required to provide features on drawings or schedules.
- I. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- J. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
- K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
  - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
    - a. Indoor Clean, Dry Locations: Type 1.
  - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
  - 3. Provide surface-mounted enclosures unless otherwise indicated.
- L. Provide externally operable handle with means for locking in the OFF position.
- M. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

## **2.3 MOLDED CASE CIRCUIT BREAKERS**

- A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

- B. Interrupting Capacity:
  - 1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
    - a. 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
  - 2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
- C. Conductor Terminations:
  - 1. Provide mechanical lugs unless otherwise indicated.
  - 2. Provide compression lugs where indicated.
  - 3. Lug Material: Copper, suitable for terminating copper conductors only.
- D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
  - 1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
  - 2. Provide interchangeable trip units where indicated.
- E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
  - 1. Provide the following field-adjustable trip response settings:
    - a. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
    - b. Long time delay.
    - c. Short time pickup and delay.
    - d. Instantaneous pickup.
  - 2. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
- F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

### **PART 3 EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

#### **3.2 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install enclosed circuit breakers plumb.

- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 05 26.
- H. Set field-adjustable circuit breaker tripping function settings as indicated.
- I. Identify enclosed circuit breakers in accordance with Section 26 05 53.

### **3.3 FIELD QUALITY CONTROL**

- A. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers used for service entrance and for circuit breakers larger than 100 amperes. Tests listed as optional are not required.
- C. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

### **3.4 ADJUSTING**

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

### **3.5 CLEANING**

- A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

**END OF SECTION 26 28 16.13**

**SECTION 26 32 13****ENGINE GENERATORS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Packaged engine generator system and associated components and accessories:
  - 1. Engine and engine accessory equipment.
  - 2. Alternator (generator).
  - 3. Generator set control system.
  - 4. Generator set enclosure.

**1.2 RELATED REQUIREMENTS**

- A. Section 03 30 53 - Concrete for Utility Construction
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 36 00 - Transfer Switches.

**1.3 REFERENCE STANDARDS**

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.
- C. NEMA MG 1 - Motors and Generators; 2014.
- D. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2015.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 99 - Health Care Facilities Code; 2015.
- G. NFPA 110 - Standard for Emergency and Standby Power Systems; 2013.
- H. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.
- I. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

**1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
    - a. Transfer Switches: See Section 26 36 00.
  - 2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.

3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
  4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
  5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

### 1.5 **SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
1. Include generator set sound level test data.
  2. Include characteristic trip curves for overcurrent protective devices upon request.
  3. Include alternator thermal damage curve upon request.
- B. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
- C. Derating Calculations: Indicate ratings adjusted for applicable service conditions.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- E. Manufacturer's factory emissions certification.
- F. Manufacturer's certification that products meet or exceed specified requirements.
- G. Source quality control test reports.
- H. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:
1. Certified prototype tests.
  2. Torsional vibration compatibility certification.
  3. NFPA 110 compliance certification.
  4. Certified rated load test at rated power factor.
- I. Manufacturer's detailed field testing procedures.
- J. Field quality control test reports.
- K. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
- L. Executed Warranty: Submit documentation of final executed warranty completed in City of Reading Department of Public Works's name and registered with manufacturer.
- M. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

- N. Maintenance Materials: Furnish the following for City of Reading Department of Public Works's use in maintenance of project.
1. Extra Filter Elements: One of each type, including fuel, oil and air.

#### **1.6 QUALITY ASSURANCE**

- A. Comply with the following:
1. NFPA 70 (National Electrical Code).
  2. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
1. Authorized service facilities located within 200 miles of project site.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

#### **1.8 FIELD CONDITIONS**

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

#### **1.9 WARRANTY**

- A. Provide minimum two year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

### **PART 2 PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Packaged Engine Generator Set - Basis of Design: Kohler KG45.
- B. Packaged Engine Generator Set - Other Acceptable Manufacturers:
1. Caterpillar Inc: [www.cat.com](http://www.cat.com).
  2. Cummins Power Generation Inc: [www.cumminspower.com](http://www.cumminspower.com).
  3. MTU Onsite Energy, a Brand of Rolls-Royce Power Systems: [www.mtuonsiteenergy.com](http://www.mtuonsiteenergy.com).
- C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

- D. Source Limitations: Furnish engine generator sets and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

## 2.2 PACKAGED ENGINE GENERATOR SYSTEM

- A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. System Description:
1. Application: Emergency/standby.
  2. Configuration: Single packaged engine generator set operated independently (not in parallel).
- D. Packaged Engine Generator Set:
1. Type: Gaseous (spark ignition).
  2. Basis of Design: Kohler KG45.
  3. Power Rating: As indicated on drawings, standby.
  4. Voltage: As indicated on drawings.
  5. Main Line Circuit Breaker:
    - a. Type: Electronic trip with long time and short time delay and instantaneous pickup.
    - b. Trip Rating: As indicated on drawings.
- E. Generator Set General Requirements:
1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
  2. Factory-assembled, with components mounted on suitable base.
  3. List and label engine generator assembly as complying with UL 2200.
  4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
  5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
  6. Main Line Circuit Breakers: Provide factory-installed line side connections with suitable lugs for load side connections.
- F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.
- G. Starting and Load Acceptance Requirements:
1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
  2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
  3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
  4. Maximum Load Step: Supports 100 percent of rated load in one step.
- H. Exhaust Emissions Requirements:
1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
  2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

- I. Sound Level Requirements:
  1. Comply with applicable noise level regulations.

### **2.3 ENGINE AND ENGINE ACCESSORY EQUIPMENT**

- A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.
- B. Engine Fuel System - Gaseous (Spark Ignition):
  1. Fuel Source: Natural gas.
  2. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
  3. Provide components/features indicated and as necessary for operation and/or required by applicable codes, including but not limited to:
    - a. Carburetor.
    - b. Gas pressure regulators.
    - c. Fuel shutoff control valves.
    - d. Low gas pressure switches.
- C. Engine Starting System:
  1. System Type: Electric, with DC solenoid-activated starting motor(s).
  2. Battery(s):
    - a. Battery Type: Lead-acid.
    - b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
    - c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
  3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
  4. Battery Charger:
    - a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
    - b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
    - c. Recognized as complying with UL 1236.
    - d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
    - e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
    - f. Provide alarm output contacts as necessary for alarm indications.
  5. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.
- D. Engine Speed Control System (Governor):
  1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
  2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.
- E. Engine Lubrication System:



1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
  2. Oil Heater: Provide thermostatically controlled oil heater to improve starting under cold ambient conditions.
- F. Engine Cooling System:
1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
  2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
  3. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.
- G. Engine Air Intake and Exhaust System:
1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
  2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.

## **2.4 ALTERNATOR (GENERATOR)**

- A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.
- B. Exciter:
1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
  2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
  3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.
- C. Temperature Rise: Comply with UL 2200.
- D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.
- E. Enclosure: NEMA MG 1, drip-proof.
- F. Total Harmonic Distortion: Not greater than five percent.
- G. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

## **2.5 GENERATOR SET CONTROL SYSTEM**

- A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.
- B. Control Panel:
1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
  2. Generator Set Control Functions:
    - a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
    - b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.

- c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
  - d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
  - e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
  - f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
  - g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
  - h. Alternator Overload Shunt Relay Accessory or Communication Link: Generator controller shall monitor alternator loading and shunt standby load to allow emergency loads to continue being served. Relay/communication shall shunt standby ATS with hard wired control or communication between genset controller and remote ATS.
3. Generator Set Status Indications:
- a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
  - b. Current (Amps): For each phase.
  - c. Frequency (Hz).
  - d. Real power (W/kW).
  - e. Reactive power (VAR/kVAR).
  - f. Apparent power (VA/kVA).
  - g. Power factor.
  - h. Duty Level: Actual load as percentage of rated power.
  - i. Engine speed (RPM).
  - j. Battery voltage (Volts DC).
  - k. Engine oil pressure.
  - l. Engine coolant temperature.
  - m. Engine run time.
  - n. Generator powering load (position signal from transfer switch).
4. Generator Set Protection and Warning/Shutdown Indications:
- a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
    - 1) Overcrank (shutdown).
    - 2) Low coolant temperature (warning).
    - 3) High coolant temperature (warning).
    - 4) High coolant temperature (shutdown).
    - 5) Low oil pressure (shutdown).
    - 6) Overspeed (shutdown).
    - 7) Low fuel level (warning).
    - 8) Low coolant level (warning/shutdown).
    - 9) Generator control not in automatic mode (warning).
    - 10) High battery voltage (warning).
    - 11) Low cranking voltage (warning).
    - 12) Low battery voltage (warning).
    - 13) Battery charger failure (warning).
  - b. In addition to NFPA 110 requirements, provide the following protections/indications:
    - 1) High AC voltage (shutdown).
    - 2) Low AC voltage (shutdown).
    - 3) High frequency (shutdown).
    - 4) Low frequency (shutdown).
    - 5) Overcurrent (shutdown).
  - c. Provide contacts for local and remote common alarm.
  - d. Provide lamp test function that illuminates all indicator lamps.
5. Other Control Panel Features:

- a. Event log.
- C. Remote Annunciator:
- 1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
  - 2. Generator Set Status Indications:
    - a. Generator powering load (via position signal from transfer switch).
    - b. Communication functional.
  - 3. Generator Set Warning/Shutdown Indications:
    - a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following indications:
      - 1) Overcrank (shutdown).
      - 2) Low coolant temperature (warning).
      - 3) High coolant temperature (warning).
      - 4) High coolant temperature (shutdown).
      - 5) Low oil pressure (shutdown).
      - 6) Overspeed (shutdown).
      - 7) Low fuel level (warning).
      - 8) Low coolant level (warning/shutdown).
      - 9) Generator control not in automatic mode (warning).
      - 10) High battery voltage (warning).
      - 11) Low cranking voltage (warning).
      - 12) Low battery voltage (warning).
      - 13) Battery charger failure (warning).
    - b. Provide audible alarm with silence function.
    - c. Provide lamp test function that illuminates all indicator lamps.
- D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button at unit or at located required by authorities having jurisdiction. Provide tamper-proof, weather-proof cover to avoid accidental activation or tampering.

## 2.6 GENERATOR SET ENCLOSURE

- A. Enclosure Type: Sound attenuating, weather protective.
- B. Enclosure Material: Steel or aluminum.
- C. Hardware Material: Stainless steel.
- D. Color: Manufacturer's standard.
- E. Access Doors: Lockable, with all locks keyed alike.
- F. Openings: Designed to prevent bird/rodent entry.
- G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.
- H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.
- I. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.

**2.7 SOURCE QUALITY CONTROL**

- A. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.
- B. Generator Set production testing to include, at a minimum:
  - 1. Operation at rated load and rated power factor.
  - 2. Single step load pick-up.
  - 3. Transient and steady state voltage and frequency performance.
  - 4. Operation of safety shutdowns.

**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.
- C. Verify that rough-ins for field connections are in the proper locations.
- D. Verify that mounting surfaces are ready to receive equipment.
- E. Verify that conditions are satisfactory for installation prior to starting work.

**3.2 INSTALLATION**

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.
- D. Arrange equipment to provide minimum clearances and required maintenance access.
- E. Unless otherwise indicated, mount generator set on properly sized, minimum 6 inch high concrete pad constructed in accordance with Section 03 30 53.
- F. Provide required support and attachment in accordance with Section 26 05 29.
- G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.
- H. Provide grounding and bonding in accordance with Section 26 05 26.
- I. Identify system wiring and components in accordance with Section 26 05 53.

**3.3 FIELD QUALITY CONTROL**

- A. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
- B. Notify City of Reading Department of Public Works and Architect at least two weeks prior to scheduled inspections and tests.
- C. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

- D. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.
- E. Preliminary inspection and testing to include, at a minimum:
  - 1. Inspect each system component for damage and defects.
  - 2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
  - 3. Check for proper oil and coolant levels.
- F. Prepare and start system in accordance with manufacturer's instructions.
- G. Perform acceptance test in accordance with NFPA 110.
- H. Inspection and testing to include, at a minimum:
  - 1. Verify compliance with starting and load acceptance requirements.
  - 2. Verify voltage and frequency; make required adjustments as necessary.
  - 3. Verify phase sequence.
  - 4. Verify control system operation, including safety shutdowns.
  - 5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
  - 6. Perform load tests in accordance with NFPA 110 (1.5 hour building load test followed by 2 hour full load test).
- I. Provide field emissions testing where necessary for certification.
- J. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- K. Submit detailed reports indicating inspection and testing results and corrective actions taken.

### **3.4 CLEANING**

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

### **3.5 CLOSEOUT ACTIVITIES**

- A. Demonstration: Demonstrate proper operation of system to City of Reading Department of Public Works, and correct deficiencies or make adjustments as directed.
- B. Training: Train City of Reading Department of Public Works's personnel on operation, adjustment, and maintenance of system.
  - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
  - 2. Provide minimum of four hours of training.
  - 3. Instructor: Manufacturer's authorized representative.
  - 4. Location: At project site.
- C. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters.

### **3.6 PROTECTION**

- A. Protect installed engine generator system from subsequent construction operations.

**END OF SECTION 26 32 13**



**SECTION 26 36 00****TRANSFER SWITCHES****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
  - 1. Automatic transfer switches.

**1.2 RELATED REQUIREMENTS**

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 32 13 - Engine Generators: For interface with transfer switches.
  - 1. Includes additional testing requirements.
  - 2. Includes related demonstration and training requirements.

**1.3 REFERENCE STANDARDS**

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- C. NEMA ICS 10 Part 1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment; 2005.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 110 - Standard for Emergency and Standby Power Systems; 2013.
- G. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

**1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.
    - a. Engine Generators: See Section 26 32 13.
  - 2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
  - 3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
  - 4. Coordinate the work with placement of supports, anchors, etc. required for mounting.
  - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

- B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.
- C. Where work of this section involves interruption of existing electrical service, arrange service interruption with City of Reading Department of Public Works.

### 1.5 **SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.
- B. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
- C. Specimen Warranty: Submit sample of manufacturer's warranty.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- E. Manufacturer's certification that products meet or exceed specified requirements.
- F. Source quality control test reports.
- G. Manufacturer's detailed field testing procedures.
- H. Field quality control test reports.
- I. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
- J. Executed Warranty: Submit documentation of final executed warranty completed in City of Reading Department of Public Works's name and registered with manufacturer.
- K. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

### 1.6 **QUALITY ASSURANCE**

- A. Comply with the following:
  - 1. NFPA 70 (National Electrical Code).
  - 2. NFPA 110 (Standard for Emergency and Standby Power Systems).
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
  - 1. Authorized service facilities located within 200 miles of project site.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.



**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

**1.8 FIELD CONDITIONS**

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

**1.9 WARRANTY**

- A. Provide minimum two year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

**PART 2 PRODUCTS****2.1 MANUFACTURERS**

- A. Transfer Switches:
  - 1. Same as manufacturer of engine generator(s) used for this project.
- B. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
- C. Source Limitations: Furnish transfer switches and accessories produced by a single manufacturer and obtained from a single supplier.

**2.2 TRANSFER SWITCHES**

- A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Applications:
  - 1. Utilize open transition transfer unless otherwise indicated or required.
  - 2. Neutral Switching (Single Phase, Three Wire and Three Phase, Four Wire Systems):
    - a. Unless otherwise indicated or required, provide solid (unswitched) neutral.
- D. Construction Type: Only "contactor type" (open contact) transfer switches are acceptable. Do not use "breaker type" (enclosed contact) transfer switches.
- E. Automatic Transfer Switch:
  - 1. Transfer Switch Type: Automatic transfer switch.
  - 2. Transition Configuration: Open-transition (no neutral position).
  - 3. Voltage: As indicated on the drawings.
  - 4. Ampere Rating: As indicated on the drawings.
  - 5. Neutral Configuration: Solid neutral (unswitched), except as indicated.

6. Load Served: As indicated on the drawings.
  7. Primary Source: As indicated on the drawings.
  8. Alternate Source: As indicated on the drawings.
- F. Comply with NEMA ICS 10 Part 1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).
- G. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.
- H. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.
- I. Switching Methods:
1. Open Transition:
    - a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
  2. Obtain control power for transfer operation from line side of source to which the load is to be transferred.
- J. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.
- K. Enclosures:
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
    - a. Indoor Clean, Dry Locations: Type 1 or Type 12.
  2. Finish: Manufacturer's standard unless otherwise indicated.
- L. Short Circuit Current Rating:
1. Withstand and Closing Rating: Provide transfer switches, when protected by the supply side overcurrent protective devices to be installed, with listed withstand and closing rating not less than the available fault current at the installed location as indicated on the drawings.
- M. Automatic Transfer Switches:
1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.
  2. Control Functions:
    - a. Automatic mode.
    - b. Test Mode: Simulates failure of primary/normal source.
    - c. Voltage and Frequency Sensing:
      - 1) Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.
      - 2) Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.
      - 3) Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.
    - d. Outputs:
      - 1) Contacts for engine start/shutdown (except where direct generator communication interface is provided).
      - 2) Auxiliary contacts; one set(s) for each switch position.
    - e. Adjustable Time Delays:

- 1) Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.
  - 2) Transfer to alternate/emergency source time delay.
  - 3) Retransfer to primary/normal source time delay.
  - 4) Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.
  - f. In-Phase Monitor (Open Transition Transfer Switches): Monitors phase angle difference between sources for initiating in-phase transfer.
  - g. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.
  - h. Shunt from Emergency Position in the Event of Alternator Overload: The ATS shall have means to receive communication directly from the Generator Control Panel or relay contact from generator control panel to shed load for non-emergency loads (standby loads) as connected to ATS load position to neutral or normal source position.
3. Status Indications:
    - a. Connected to alternate/emergency source.
    - b. Connected to primary/normal source.
    - c. Alternate/emergency source available.
  4. Other Features:
    - a. Event log.
  5. Automatic Sequence of Operations:
    - a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator where applicable.
    - b. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.
    - c. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.
    - d. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.
- N. Interface with Other Work:
1. Interface with engine generators as specified in Section 26 32 13.

## **2.3 SOURCE QUALITY CONTROL**

- A. Perform production tests on transfer switches at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.
- C. Verify that rough-ins for field connections are in the proper locations.
- D. Verify that mounting surfaces are ready to receive transfer switches.
- E. Verify that conditions are satisfactory for installation prior to starting work.

**3.2 INSTALLATION**

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Arrange equipment to provide minimum clearances and required maintenance access.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install transfer switches plumb and level.
- F. Provide grounding and bonding in accordance with Section 26 05 26.
- G. Identify transfer switches and associated system wiring in accordance with Section 26 05 53.

**3.3 FIELD QUALITY CONTROL**

- A. Prepare and start system in accordance with manufacturer's instructions.
- B. Automatic Transfer Switches:
  - 1. Inspect and test in accordance with NETA ATS, except Section 4.
  - 2. Perform inspections and tests listed in NETA ATS, Section 7.22.3. The insulation-resistance tests listed as optional are not required.
- C. Provide additional inspection and testing as required for completion of associated engine generator testing as specified in Section 26 32 13.
- D. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- E. Submit detailed reports indicating inspection and testing results and corrective actions taken.

**3.4 CLEANING**

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

**3.5 CLOSEOUT ACTIVITIES**

- A. Demonstration: Demonstrate proper operation of transfer switches to City of Reading Department of Public Works, and correct deficiencies or make adjustments as directed.
- B. Training: Train City of Reading Department of Public Works's personnel on operation, adjustment, and maintenance of transfer switches.
  - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
  - 2. Provide minimum of four hours of training.
  - 3. Instructor: Manufacturer's authorized representative.
  - 4. Location: At project site.
- C. Coordinate with related generator demonstration and training as specified in Section 26 32 13.

**3.6 PROTECTION**

- A. Protect installed transfer switches from subsequent construction operations.

**END OF SECTION 26 36 00**

**SECTION 26 43 00****SURGE PROTECTIVE DEVICES****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Surge protective devices for branch panelboard locations.

**1.2 RELATED REQUIREMENTS**

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

**1.3 ABBREVIATIONS AND ACRONYMS**

- A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.
- B. SPD: Surge Protective Device.

**1.4 REFERENCE STANDARDS**

- A. MIL-STD-220 - Method of Insertion Loss Measurement; Revision C, 2009.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.
- G. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

**1.5 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

**1.6 SUBMITTALS**

- A. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
- B. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
  - 1. UL 1449.
  - 2. UL 1283 (for Type 2 SPDs).
- C. Field Quality Control Test Reports.

- D. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.
- F. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in City of Reading Department of Public Works's name and registered with manufacturer.
- G. Project Record Documents: Record actual connections and locations of surge protective devices.

### **1.7 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

### **1.8 DELIVERY, STORAGE, AND PROTECTION**

- A. Store in a clean, dry space in accordance with manufacturer's written instructions.

### **1.9 FIELD CONDITIONS**

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

### **1.10 WARRANTY**

- A. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.
- B. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Field-installed, Externally Mounted Surge Protective Devices:
  - 1. Advanced Protection Technologies, Inc (APT): [www.aptsurge.com](http://www.aptsurge.com).
  - 2. Current Technology; a brand of Thomas & Betts Power Solutions: [www.tnbpowersolutions.com](http://www.tnbpowersolutions.com).
  - 3. Schneider Electric; Square D Brand Surgellogic Products: [www.surgellogic.com](http://www.surgellogic.com).
- B. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
- C. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

**2.2 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS**

- A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.
- B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mounted SPDs.
- C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.
- D. Protected Modes:
  - 1. Delta Systems: L-G, L-L.
- E. UL 1449 Voltage Protection Ratings (VPRs):
  - 1. 240/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
- F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.
- G. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
  - 1. Indoor clean, dry locations: Type 1.
- H. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
  - 1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.

**2.3 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS**

- A. Surge Protective Device:
  - 1. Protection Circuits: Field-replaceable modular.
  - 2. Surge Current Rating: Not less than 60 kA per mode/120 kA per phase.
  - 3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
  - 4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
  - 5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
    - a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
  - 6. Diagnostics:
    - a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
    - b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
    - c. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.



**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.
- C. Verify system grounding and bonding is in accordance with Section 26 05 26, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.
- D. Verify that conditions are satisfactory for installation prior to starting work.

**3.2 INSTALLATION**

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.
- E. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.
- F. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 05 26 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.
- G. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

**3.3 FIELD QUALITY CONTROL**

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS Section 7.19.1.

**3.4 CLEANING**

- A. Repair scratched or marred exterior surfaces to match original factory finish.

**END OF SECTION 26 43 00**

**SECTION 31 23 17****TRENCHING, BACKFILLING, AND COMPACTING****PART 1 GENERAL****1.1 DESCRIPTION**

- A. The Work of This Section Includes, but is not limited to:
  - 1. Trench excavation, backfill and compaction
  - 2. Support of excavation
  - 3. Pipe and electrical conduit/ductbank bedding requirements
  - 4. Control of excavated material
  - 5. Restoration of unpaved surfaces
- B. Related Work Specified Elsewhere:
  - 1. Section 32 92 00 - Finish Grading and Seeding

**1.2 QUALITY ASSURANCE**

- A. Testing Agency: Density testing shall be performed by an independent soils testing laboratory engaged and paid for by the Contractor and approved by the Architect.
- B. Referenced Standards:
  - 1. Pennsylvania Department of Transportation (PADOT):
    - a. Publication 408 Specifications
    - b. Publication 213 Work Zone Traffic Control
  - 2. American Society for Testing and Materials (ASTM):
    - a. D698 - Test for Laboratory Compaction Characteristics of Soil Using Standard Effort
    - b. D1556 - Test for Density and Unit Weight of Soil in Place by the Sand Cone Method
    - c. D2922 - Test for Density of Soil and Soil Aggregate in Place by Nuclear Methods
- C. Density Testing:
  - 1. Conduct a minimum of two tests per pipeline or conduit/ductbank. Conduct one test in the lower half of the trench and one test in the upper half of the trench at locations as directed by the Architect during backfilling operations. If any test fails, the Contractor shall take remedial steps to correct the compaction and rerun the test until compliance with the density requirements are shown. A density test that fails does not count toward the number of tests to be taken. The cost of the initial test and any required retesting is the responsibility of the Contractor.
  - 2. Determine density by ASTM D1556 or ASTM D2922.

**1.3 SUBMITTALS**

- A. Certificates:
  - 1. Submit, prior to delivery of the material to the job site, a Statement of Compliance from the materials supplier, together with supporting data, attesting that the composition analysis of pipe or conduit/ductbank bedding and select material stone backfill materials meets specification requirements. Should a change in source of materials be made during construction, submit a new Statement of Compliance from the new source for approval before the material is delivered to the job site.
  - 2. Submit certified density testing results from the soils testing laboratory.
- B. Compaction Equipment List: Submit a list of all equipment to be utilized for compacting, including the equipment manufacturer's lift thickness limitations.

- C. Agreements with Property Owners: Prior to storing or disposing of excavated materials on private property, submit a copy of the written agreement with the property owner.

#### **1.4 JOB CONDITIONS**

- A. Classification of Excavation: All excavation, trenching, boring, jacking and tunneling work under this Contract shall be UNCLASSIFIED, and includes excavation and removal of all soil, rock, boulders, fill, and other materials encountered of whatever nature.
- B. Control of Traffic: Employ traffic control measures in accordance with Pennsylvania Department of Transportation Publication 213, "Work Zone Traffic Control".
- C. Protection of Existing Utilities and Structures:
1. Take all precautions and utilize all facilities required to protect existing utilities and structures. In compliance with Act 121 of the General Assembly of Pennsylvania, PA One Call System and Common Grounds Alliance Best practices Manual, advise in advance of intent to excavate, do demolition work or use explosives and give the location of the job site. Request cooperative steps of the Utility and suggestions for procedures to avoid damage to its lines.
  2. Advise each person in physical control of powered equipment or explosives used in excavation or demolition work of the type and location of utility lines at the job site, the Utility assistance to expect, and procedures to follow to prevent damage.
  3. Immediately report to the Utility and the Architect any break, leak or other damage to the lines or protective coatings made or discovered during the work and immediately alert the occupants of premises of any emergency created or discovered.
  4. Allow free access to Utility personnel at all times for purposes of maintenance, repair and inspection.
- D. Department of Environmental Protection Bureau of Land Recycling and Waste Management - Clean Fill Policy:
1. See Department of Environmental Protection Bureau of Land Recycling and Waste Management Document No. 258-2182-773, included at the end of this specification.
  2. Imported Fill: The Contractor will perform environmental due diligence to determine whether imported fill is clean or regulated as specified in DEP Clean Fill Policy. The Contractor will manage the fill following the guidelines of the policy including the furnishing of any certifications, testing or permits that may be required. Testing that may be required shall be included in the Contractor's Base Bid.
  3. Exported Fill: The Contractor will perform environmental due diligence and testing to determine that the excavated material scheduled to be spoiled off site qualifies as clean fill under DEP Clean Fill Policy. Should materials be uncovered that are suspected of being other than clean fill, the Contractor will immediately notify the City of Reading Department of Public Works. Testing requirements shall be included in the Contractor's Base Bid. If evidence of release of regulated substance is found, material shall be disposed of as regulated fill and will be paid for by Change Order.

## **PART 2 PRODUCTS**

### **2.1 PIPE OR CONDUIT/DUCTBANK BEDDING MATERIAL**

- A. Type IV Pipe Bedding Material: Crushed stone or gravel aggregate conforming to AASHTO No. 8 as specified in Section 703.2, Publication 408 Specifications.
- B. Type IV Direct Buried Conduit Bedding Material: Screenings.

**2.2 BACKFILL MATERIAL**

- A. Coarse Aggregate Backfill: Crushed stone or gravel aggregate conforming to Subbase (2A), Section 703.2, Publication 408 Specifications.
- B. Suitable Backfill Material: or (Non-Paved Areas):
  - 1. From top of pipe or conduit/ductbank bedding material to 24 inches over top of pipe or conduit/ductbank:
    - a. Material excavated from the trench if free of stones larger than 2 inches in size and free of wet, frozen, or organic materials.
  - 2. From 24 inches above pipe or conduit/ductbank to subgrade elevation:
    - a. Material excavated from the trench if free of stones larger than 8 inches in size and free of wet, frozen, or organic materials.
- C. Unsuitable Backfill Material: Where the Architect deems backfill material to be unsuitable and rejects all or part thereof due to conditions prevailing at the time of construction, remove the unsuitable material and replace with select material stone backfill as specified in paragraph 2.2.A or suitable foreign backfill material.

**2.3 DETECTABLE UNDERGROUND UTILITY MARKING TAPE**

- A. Tape shall consist of a minimum 5-mil (0.005 inch) overall thickness, with no less than a 35 gauge (0.00035 inch) solid aluminum foil core. The foil must be visible from BOTH sides. The layers shall be laminated together with the extrusion lamination process, not adhesives. Further, there shall be NO inks or printing extending to the edges of the tape. The adhesive will NOT contain any dilutants, pigments or contaminants and is specially formulated to resist degradation by elements normally encountered in the soil. All printing shall be encased to avoid ink rub-off.
- B. Test Data:

<u>Property</u>	<u>Method</u>	<u>Value</u>
Thickness	ASTM D2103	5 mils
Tensile Strength	ASTM D882	25 pounds per inch (5,500 psi)
Elongation	ASTM D882	Less than 50 percent at break
Printability	ASTM D2578	Greater than 50 dynes/cm <sup>2</sup>
Flexibility	ASTM D671	Pliable hand
Inks	Manufacturer Specifications	Heat set Mylex
Message Repeat	Manufacturer Specifications	Every 20 inches
Foil	Manufacturer Specifications	Dead soft/annealed
Top Layer	Manufacturer Specifications	Virgin PET
Bottom Layer	Manufacturer Specifications	Virgin LDPE
Adhesives	Manufacturer Specifications	Less than 30 percent, solid 1.5#/R
Bond Strength	Boiling Water at 100 Degrees Centigrade	5 hours without peel
Colors	APWA Code	See below

- C. Color Code shall be as follows:
  - 1. Safety Red: Electric power, distribution and transmission and municipal electric systems.
  - 2. High Visibility Safety Yellow: Gas and oil distribution and transmission, dangerous materials, product and steam.

3. Safety Alert Orange: Telephone and telegraph systems, police and fire communications, and cable television.
4. Safety Precaution Blue: Water systems and slurry pipelines.
5. Safety Green: Sanitary and storm sewer systems.
6. Safety Brown: Force mains, reclaimed water lines and effluent reuse lines.
7. Alert Purple: Reclaimed non-potable water lines.

### **PART 3 EXECUTION**

#### **3.1 MAINTENANCE AND PROTECTION OF TRAFFIC**

- A. Coordinate the work to ensure the least inconvenience to traffic and maintain traffic in one or more unobstructed lanes unless closing the street is authorized.
- B. Maintain access to all streets and private drives.
- C. Provide and maintain signs, flashing warning lights, barricades, markers, and other protective devices as required to conform with construction operations and to keep traffic flowing with minimum restrictions.
- D. Comply with State and local codes, permits and regulations.

#### **3.2 CUTTING PAVED SURFACES**

- A. Where excavation includes breaking a paved surface, make cuts in a neat uniform fashion forming straight lines parallel with the centerline of the trench. Cut offsets at right angles to the centerline of the trench. Saw cut concrete surfaces; saw cut other hard surfaces or make straight cuts with jackhammer. No paving shall be broken except that which has been previously cut.
- B. Protect edges of cut pavement during excavation to prevent raveling or breaking; square edges prior to pavement replacement.

#### **3.3 TRENCH EXCAVATION**

- A. Topsoil Stripping and Stockpiling: Strip topsoil encountered during trench excavation to its full depth and stockpile for reuse.
- B. Depth of Excavation:
  1. Pressure Pipelines:
    - a. Excavate trenches to the minimum depth necessary to place required pipe bedding material and to provide 4' from the top of the pipe to the finish ground elevation, except where specific depths are otherwise indicated on the Contract Drawings.
    - b. Where unsuitable bearing material is encountered in the trench bottom, continue excavation until the unsuitable material is removed, solid bearing is obtained or can be established, or concrete cradle can be placed. If no concrete cradle is to be installed, refill the trench to required pipeline grade with pipe bedding material.
    - c. Where the Contractor, by error or intent, excavates beyond the minimum required depth, backfill the trench to the required pipeline grade with pipe bedding material.
  2. Electrical Conduits/Ductbanks:
    - a. Excavate trenches to the depth required for the direct buried conduit being installed plus the excavation necessary for the placement of the bedding material.
    - b. Where unsuitable bearing material is encountered in the trench bottom, continue excavation until the unsuitable material is removed, solid bearing is obtained or can be established, or concrete cradle can be placed. If no concrete cradle is to be installed, refill the trench to required grade with bedding material. This work will be handled by Change Order.

- c. Where the Contractor, by error or intent, excavates beyond the minimum required depth, backfill the trench to the required grade with bedding material at no cost to the City of Reading Department of Public Works.
  - d. No bedding is required for reinforced concrete encasement duct banks in areas of undisturbed soil or recompacted soil in accordance with these specifications.
- C. Width of Excavation:
- 1. Excavate trenches to a width necessary for placing and jointing the pipe or conduit/ductbank and for placing and compacting bedding and backfill around the pipe or conduit/ductbank.
  - 2. Shape trench walls completely vertical from trench bottom to at least 24 inches above the top of the pipe or conduit/ductbank.
  - 3. For pressure pipeline fittings, excavate trenches to a width that will permit placement of concrete thrust blocks. Provide earth surfaces for thrust blocks that are perpendicular to the direction of thrust and are free of loose or soft material.
  - 4. Where rock is encountered in the sides of the trench, remove the rock to provide a minimum clearance between the pipe or conduit/ductbank and rock of 6 inches.

### **3.4 SUPPORT OF EXCAVATION**

- A. Support excavations with sheeting, shoring, and bracing or a "trench box" as required to comply with Federal and State laws and codes. Install adequate excavation supports to prevent ground movement or settlement to adjacent structures, pipelines or utilities. Damage due to settlement because of failure to provide support or through negligence or fault of the Contractor in any other manner shall be repaired at the Contractor's expense.
- B. Withdraw shoring, bracing, and sheeting as backfilling proceeds unless otherwise directed by the Architect.

### **3.5 CONTROL OF EXCAVATED MATERIAL**

- A. Keep the ground surface within a minimum of 2 feet of both sides of the excavation free of excavated material.
- B. In areas where pipelines parallel or cross streams, ensure that no material slides, is washed, or dumped into the stream course. Remove cofferdams immediately upon completion of pipeline construction.
- C. Maintain accessibility to all fire hydrants, valve pit covers, valve boxes, curb boxes, fire and police call boxes, and other utility controls at all times. Keep gutters clear or provide other satisfactory facilities for street drainage. Do not obstruct natural watercourses. Where necessary, provide temporary channels to allow the flow of water either along or across the site of the work.
- D. Provide temporary barricades to prevent excavated material from encroaching on private property, walks, gutters, and storm drains.
- E. Do not place or store excavated material on private property without a written agreement signed by the property owner.

### **3.6 DEWATERING**

- A. Keep excavations dry and free of water. Dispose of precipitation and subsurface water clear of the work.
- B. Maintain pipe or conduit/ductbank trenches dry until pipe or conduit/ductbank has been jointed, inspected, and backfilled, and concrete work has been completed. Prevent trench water from entering pipelines under construction.

- C. Intercept and divert surface drainage away from excavations. Maintain storm drainage facilities, gutters, and natural surface watercourses open and in operation. Provide and install temporary facilities to maintain excavations free of water as required. Design surface drainage systems so that they do not cause erosion on or off the site, or cause unwanted flow of water. When mechanical equipment is utilized to control water conditions, provide and maintain sufficient standby units onsite.
- D. Comply with Federal, State and Local requirements for dewatering to any watercourse, prevention of stream degradation, and erosion and sediment control. Comply with the Sedimentation and Erosion Control Plan.

### **3.7 PIPE OR CONDUIT/DUCTBANK BEDDING REQUIREMENTS**

- A. Type IV Bedding:
  - 1. Depth of bedding material aggregate as shown on the Contract Drawings.
  - 2. Provide Type IV bedding when using ABS, PE, and PVC pipe and direct buried conduit.
- B. Shape recesses for the joints or bell of the pipe by hand. Assure that the pipe is supported on the lower quadrant for the entire length of the barrel.

### **3.8 PIPE OR CONDUIT/DUCTBANK LAYING**

- A. Lay pipe or conduit/ductbank as specified in the appropriate Section of these Specifications for pipeline and conduit/ductbank construction.

### **3.9 BACKFILLING TRENCHES**

- A. After pipe or conduit/ductbank installation and inspection, backfill trenches from trench bottom or from the top of pipe or conduit/ductbank bedding material, whichever is greater, to 12 inches above the crown of the pipe or conduit/ductbank with specified backfill material hand placed and carefully compacted with hand-operated mechanical tampers in layers of suitable thickness to provide specified density around and under the haunches of the pipe or conduit/ductbank. Backfill and compact the remainder of the trench with specified backfill material.
- B. Exposed Joints for Testing:
  - 1. The Contractor has the option to test the pipe prior to backfilling the trench. If this option is selected, install reaction blocks where required and place 2 feet of thoroughly compacted backfill over the pipe leaving pipe joints partially exposed.
  - 2. If the Contractor elects to completely backfill the trench prior to testing, he shall be responsible for locating and uncovering leaks which may cause the test to fail.
- C. Lift Thickness Limitations:
  - 1. In no case shall maximum lift thickness placed exceed the maximum limits specified by the manufacturer's recommendations. However, if the equipment manufacturer's lift thickness recommendation is followed and the specified density is not obtained, the Contractor shall, at his own expense, remove, replace, and retest as many times as is required to obtain the specified density.
  - 2. Compact each layer of backfill to 95 percent of the standard proctor maximum dry density as determined by ASTM D698 in load bearing areas and 90 percent in non-load bearing areas.
  - 3. Lift thickness limitations specified for state highways, shoulders, or embankments govern over the compaction equipment manufacturer's recommendations.
  - 4. Notwithstanding the specified requirements for trench backfill compaction, trenches that settle below the surrounding grade prior to final completion shall be filled to surrounding grade level with appropriate materials.

**3.10 UTILITY MARKING TAPE**

- A. Install detectable utility marking tape as specified, 12 to 18 inches below final grade.

**3.11 DISPOSAL OF EXCAVATED MATERIAL**

- A. Excavated material remaining after completion of backfilling shall remain the property of the Contractor, removed from the construction area and legally disposed.

**3.12 RESTORATION OF UNPAVED SURFACES**

- A. Restore unpaved surfaces disturbed by construction to equal the surface condition prior to construction.
- B. Restore grassed areas in accordance with Section 32 92 00, Finish Grading and Seeding.

**END OF SECTION 31 23 17**



**SECTION 32 92 00****FINISH GRADING AND SEEDING****PART 1 GENERAL****1.1 DESCRIPTION**

- A. The Work of this section includes, but is not limited to:
  - 1. Placing topsoil
  - 2. Soil conditioning
  - 3. Finish grading
  - 4. Seeding
  - 5. Maintenance
- B. The "Seeding Restoration Table" at the end of this section lists specific seeding restoration requirements.
- C. Related Work specified elsewhere:
  - 1. Section 31 23 17 - Trenching, Backfilling, and Compacting

**1.2 QUALITY ASSURANCE**

- A. Soil and soil supplement testing shall be performed by a Soils Testing Laboratory engaged and paid for by the Contractor and approved by the Architect.
- B. Collect soil samples under the direction of the Architect.
- C. Reference Standards:
  - 1. Pennsylvania Department of Transportation (PADOT); Publication 408 Specifications.
  - 2. Pennsylvania Seed Act of 1965, Act 187, as Amended.
  - 3. Pennsylvania Soil Conditioner and Plant Growth Substance Law, Act of December 1, 1977, P.L. 258, No. 86(3P.S.68.2), as Amended.
  - 4. Pennsylvania Agricultural Liming Materials Act of 1978, P.L. 15, No. 9(3P.S.132-1), as Amended.
  - 5. Rules for Testing Seeds of the Association of Official Seed Analysts.

**1.3 SUBMITTALS**

- A. Certificates:
  - 1. Prior to use or placement of material, submit a Statement of Compliance, from the materials suppliers, together with supporting data, attesting that the composition of the following products meets specification requirements.
    - a. Fertilizer - Analysis content and percent of each.
    - b. Lime - Analysis content and percent of each.
    - c. Seed mixture(s) - State percentage of mixtures, purity, germination and maximum weed seed content of each grass mixture.
  - 2. Submit certified soil sample analyses, including laboratory's recommended soil supplement formulation, topsoil analysis - State pH, texture, organic content, and macro nutrients.

**1.4 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Seed:
  - 1. Deliver seed fully tagged and in separate packages according to species or seed mix.
  - 2. Seed which has become wet, moldy, or otherwise damaged in transit or storage will not be accepted.

**PART 2 PRODUCTS**

**2.1 TOPSOIL**

- A. All topsoil stripped from the site and stockpiled may be reused provided the following requirements are met:
  - 1. Have a pH of between 6.0 and 7.0; contain not less than 2 percent nor more than 10 percent organic matter as determined by AASHTO T194.
  - 2. Fertile friable loam, sand loam, or clay loam which will hold a ball when squeezed with the hand, but which will crumble shortly after being released.
  - 3. Free of clods, grass, roots, or other debris harmful to plant growth. Free of pests, pest larvae, and matter toxic to plants.

**2.2 SEED**

- A. Fresh, clean, dated material from the last available crop and within the date period specified, with a date of test not more than 9 months prior to the date of sowing.
- B. Percentage of pure seed present shall represent freedom from inert matter and from other seeds distinguishable by their appearance.
- C. All seeds will be subject to analysis and testing.
- D. Seed mix in accordance with Seeding Restoration Table.
- E. Individual species comprising 20 percent or less of the total seeding mixture may be of one variety. All varieties utilized shall have a mean quality rating of 7.0 or higher as listed in Table 1, for the Pennsylvania, University Park, high maintenance test plot, the USDA National Turfgrass Evaluation Program.

TABLE 1 - GRASS AND AGRICULTURAL SEEDS

<u>Individual Species</u>	<u>Minimum Guaranteed Purity (Percent)</u>	<u>Maximum Weed Seed (Percent)</u>	<u>Minimum Guaranteed Germination (Percent)</u>
Kentucky Bluegrass ( <i>Poa pratensis</i> ) min. 21 lb. per bushel	98	0.20	80
Perennial Ryegrass ( <i>Lolium perenne</i> )	98	0.15	90
Tall Fescue ( <i>Festuca arundinacea</i> )	98	0.15	85
Crownvetch ( <i>Coronilla varia</i> )	99	0.10	70
Red Fescue ( <i>Festuca rubra</i> )	98	0.15	85
Annual Ryegrass ( <i>Lolium multiflorum</i> )	98	0.15	90
Timothy ( <i>Phleum pratense</i> )	98	0.25	95

Birdsfoot Trefoil Mixture (Lotus corniculatus) A mixture of 1/2 Viking & 1/2 of either Empire, Nocen, or Leo	98	0.10	80
Redtop (Agrostis alba)	92	0.15	80

**2.3 FERTILIZER**

- A. Liquid formulations may be used in lieu of dry formulations, provided the rate of application is adjusted to apply the same quantities of nitrogen, phosphorus and potassium per unit area as specified for dry formulations.
- B. Basic Dry Formulation Fertilizer: Analysis 0-20-20 and as defined by the Pennsylvania Fertilizer Law.
- C. Starter Fertilizer: Analysis 10-5-5 or 12-6-6 and 12-18-10 or 18-24-10 as defined by the Pennsylvania Fertilizer Law.
- D. Contractor must submit soils samples to an approved laboratory for fertilizing recommendations. Recommendations shall be submitted to Owner for his review and decision relating to modifying the application rate as shown on the Seeding Restoration Table.

**2.4 LIME**

- A. Pulverized agricultural limestone conforming to Section 804.2(a), Publication 408 Specifications.
- B. Provide all lime in accordance with application rates shown in the Seeding Restoration Table, or as recommended by the soil test laboratory.

**2.5 INOCULANT**

- A. Inoculate leguminous seed before seeding with nitrogen fixing bacteria culture prepared specifically for the species.
- B. Do not use inoculant later than the date indicated by the manufacturer.
- C. Protect inoculated seed from prolonged exposure to sunlight prior to sowing.
- D. Reinoculate seed not sown within 24 hours following initial inoculation.

**2.6 EROSION CONTROL FABRIC**

- A. Shall be a knitted construction of yarn with uniform openings interwoven with strips of biodegradable paper, furnished in rolls with 4-mil opaque polyethylene base as protection for outdoor storage.
- B. Fabric 0.2 pound per square yard.

**2.7 JUTE MATTING**

- A. Shall be heavy weight, minimum 0.9 pound per square yard, jute mesh with 1 inch opening.

**2.8 FABRIC/MATTING ANCHORS**

- A. Staples for fastening fabric to ground shall be minimum 11 gauge wire, "U" shaped, with a 1 inch crown and 6 inch legs.

**2.9 MULCHING MATERIALS**

- A. Mulches for seeded areas shall be one, or a combination, of the following:

1. Wheat or oat straw; thoroughly threshed.
    - a. Cured to less than 20 percent moisture content by weight.
    - b. Containing no stems of tobacco, soybeans, or other coarse or woody material, free of mature seed bearing stalks or roots of prohibited or noxious weeds.
  2. Wood Cellulose:
    - a. Containing no growth or germination-inhibiting substances.
    - b. Green-dyed and air-dried.
    - c. Packages not exceeding 100 pounds.
    - d. Moisture Content: 12 percent  $\pm$  3 percent
    - e. Organic Matter (Dry oven basis): 98.6 percent  $\pm$  0.2 percent
    - f. Ash Content: 1.4 percent  $\pm$  0.2 percent
    - g. Minimum Water-Holding Capacity: 100 percent
- B. Mulch Binders:
1. Emulsified Asphalt AASHTO M140, Grade SS-1
  2. Cut Back Asphalt AASHTO M81, RC 250
  3. Nonasphaltic Emulsion - Natural Vegetable Gum Blended with Gelling and Hardening Agents
  4. Polyvinyl Acetate Emulsion Resin, Containing 60 percent (+ 1 percent) Total Solids by Weight

### **PART 3 EXECUTION**

#### **3.1 TIME OF OPERATIONS**

- A. Conduct seeding operations during the times specified in the Seeding Restoration Table.

#### **3.2 PREPARATION OF SUBGRADE**

- A. "Hard pan" or heavy shale:
1. Plow to a minimum depth of 6 inches.
  2. Loosen and grade by harrowing, discing, or dragging.
  3. Remove surface stones over 3 inches in any dimension and other debris.
- B. Loose loam, sandy loam, or light clay:
1. Loosen and grade by harrowing, discing, or dragging.
  2. Remove surface rocks over 3 inches in any dimension and other debris.

#### **3.3 PLACING TOPSOIL**

- A. Place topsoil and spread over the prepared subgrade to obtain the required depth and grade elevation. Final compacted thickness of topsoil not less than 4 inches.
- B. Roller weighing over 120 pounds per foot of width shall not be used for compaction.
- C. Remove all materials unsuitable or harmful to plant growth, and legally dispose off site.
- D. Do not place topsoil when the subgrade is frozen, excessively wet, or extremely dry; do not handle topsoil when frozen or excessively wet.
- E. Finish surface of topsoil shall be smooth, even and true to lines and grades with no ponding areas.

#### **3.4 TILLAGE**

- A. After seed bed areas have been brought to proper compacted elevation, thoroughly loosen to a minimum depth of 5 inches by discing, harrowing, or other approved methods.
- B. Do not work topsoiled areas when frozen or excessively wet.

- C. Liming:
  - 1. Distribute limestone uniformly at the rate indicated by the soil test.
  - 2. Thoroughly incorporate into the topsoil to a minimum depth of 4 inches as a part of the tillage operation.
- D. Basic Fertilizer:
  - 1. Distribute basic fertilizer uniformly at the rate indicated by the soil test.
  - 2. Incorporate into soil to depth of 4 inches by approved methods as part of tillage operation.

### 3.5 **FINISH GRADING**

- A. Remove unsuitable material larger than 1 inch in any dimension.
- B. Uniformly grade surface to the required contours without the formation of water pockets.
- C. Distribute starter fertilizer at the rates indicated on the Seeding Restoration Table, or as recommended by the soil test laboratory.
- D. Incorporate starter fertilizer into the upper 1 inch of soil.

### 3.6 **SEEDING**

- A. Uniformly sow specified seed mix by use of approved hydraulic seeder, power-drawn drill, power-operated seeder or hand-operated seeder.
- B. Do not seed when winds are over 15 miles per hour.
- C. Upon completion of seed covering, roll the area with a roller, exerting a maximum force of 65 pounds per foot width of roller.

### 3.7 **MULCHING**

- A. Mulch within 48 hours of seeding.
- B. Place straw mulch in a continuous blanket at a minimum rate of 1,200 pounds per 1,000 square yards.
- C. Anchor straw mulch by use of twine, stakes, wire staples, plastic nets, or asphalt or chemical mulch binder. Apply binders by the manufacturer's method and rate.
- D. Apply wood cellulose fiber hydraulically at a rate of 320 pounds per 1,000 square yards; incorporate as an integral part of the slurry after seed and soil supplements have been thoroughly mixed.
- E. Protect structures, pavements, curbs, and walls to prevent asphalt staining.
- F. Do not spray asphalt and chemical mulch binders onto any area within 100 feet of a stream or other body of water.

### 3.8 **MAINTENANCE**

- A. Contractor shall be responsible for maintenance of seeded work.
- B. Maintenance includes watering, weeding, two initial mowings, cleanup, edging, and repair of washouts or gullies.
- C. Keep seeded areas moist to a depth of 3 inches for a period of 14 days following seeding.
- D. Those areas which do not show a prompt catch of grass within 24 days of seeding shall be reseeded until complete grass catch occurs.

- E. When the grass reaches an average height of three inches, cut to a height of two inches; irregularities or depressions which show up at this time shall be leveled and reseeded.
- F. Contractor's maintenance shall continue until all areas are grassed and free from bare spots or off-color areas, and turf areas are accepted.

**SEE ATTACHED SEEDING RESTORATION TABLE**

**SEEDING RESTORATION TABLE**

<u>Restoration Condition</u>	<u>Topsoil</u>	<u>Lime*</u>	<u>Basic Fertilizer</u>	<u>Starter Fertilizer</u>	<u>Seed Mix &amp; Sowing Rate (% by Weight)</u>
Temporary Cover**	N/A	N/A	N/A	N/A	100% Annual Ryegrass, Sow 9 lb. per 1,000 sq. yd. Mar thru May/Aug thru Sept
Roadside, Non-Mowed	Yes	100 lb. per 1,000 sq. ft.	No	10-5-5 at 50 lb. per 1,000 sq. ft. <u>or</u> 12-6-6 at 33 lb. per 1,000 sq. ft.	80% Kentucky 31 Fescue 20% Pennlawn Red Fescue Sow 21 lb. per 1,000 sq. yd. Mar thru May/Aug thru Sept
Roadside, Mowed	Yes	100 lb. per 1,000 sq. ft.	No	10-5-5 at 50 lb. per 1,000 sq. ft. <u>or</u> 12-6-6 at 33 lb. per 1,000 sq. ft.	50% Kentucky Bluegrass 30% Pennlawn Red Fescue 20% Perennial Ryegrass Sow 21 lb. per 1,000 sq. yd. Mar thru May/Aug thru Sept
Bank Areas, Steeper than 3:1 Slopes	Yes	100 lb. per 1,000 sq. ft.	No	12-18-10 at 18 lb. per 5,000 sq. ft. <u>or</u> 18-24-10 at 20 lb. per 5,000 sq. ft.	45% Crownvetch 55% Annual Ryegrass Sow 9 lb. per 1,000 sq. yd. Any time except Sept-Oct
Lawns	Yes	100 lb. per 1,000 sq. ft.	0-20-0 50 lb. per 1,000 sq. ft.	12-18-10 at 18 lb. per 5,000 sq. ft. <u>or</u> 18-24-10 at 20 lb. per 5,000 sq. ft.	50% Kentucky Bluegrass 30% Pennlawn Red Fescue 20% Perennial Ryegrass Sow 21 lb. per 1,000 sq. yd. Mar thru May/Aug thru Sept
Fields and pasture, Non-Cultivated	No	No	No	10-5-5 at 50 lb. per 1,000 sq. ft. <u>or</u> 12-6-6 at 33 lb. per 1,000 sq. ft.	100% Timothy Sow 9 lb. per 1,000 sq. yd. Mar thru May/Aug thru Sept
Fields, Cultivated	No	No	No	10-5-5 at 50 lb. per 1,000 sq. ft. <u>or</u> 12-6-6 at 33 lb. per 1,000 sq. ft.	100% Annual Ryegrass Sow 9 lb. per 1,000 sq. yd. Mar thru May/Aug thru Sept
Woods, Sparse	No	No	No	10-5-5 at 50 lb. per 1,000 sq. ft. <u>or</u> 12-6-6 at 33 lb. per 1,000 sq. ft.	100% Red Fescue Sow 36 lb. per 1,000 sq. yd. Mar thru May/Aug thru Sept
Woods, Dense	No	No	No	No	Stabilize soil with biodegradable netting and paper fabric material

\*Unless lesser rate indicated by soils tests

**END OF SECTION 32 92 00**







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