ELECTRICAL RELIABILITY UPGRADE

169 - Bioengineering Building
818 W. Hancock Avenue, Detroit, Michigan 48202
WSU Project No. 169-235557

603 - College of Pharmacy
259 Mack Avenue, Detroit, Michigan 48202
WSU Project No. 603-243264

005 - Science Hall
5055 Cass Avenue, Detroit, Michigan 48202
WSU Project No. 005-219056

Issued for Bids
August 26, 2014

Bioengineering Building
PBA Project No. 2013.0288.00

College of Pharmacy
PBA Project No. 2014.0097.00

Science Hall
PBA Project No. 2014.0175.00
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WAYNE STATE UNIVERSITY
Electrical Reliability Upgrade
169 - Bioengineering Building
603 - College of Pharmacy
005 - Science Hall

PETER BASSO ASSOCIATES, INC.
Issued for Bids
PBA Project No. 2013.0288.00
PBA Project No. 2014.0097.00
PBA Project No. 2014.0175.00
August 26, 2014

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SECTION 011000 - SPECIAL CONDITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and Division-1 Specification sections, apply to work of this section.

B. These specifications are of abbreviated short form, or streamlined type, and include incomplete sentences. Omissions of words or phrases such as "the contractor shall," "in conformity therewith," "shall be," "shall furnish (and/or install)," "as noted on the drawings," "according to the plans," "a," "an," "the," "is," "are," and "all" are intentional. Omitted words and phrases shall be supplied by inference in the same manner as they are when a note occurs on the drawings.

C. The words "shall," or "shall be" shall be supplied by inference where a colon (:) is used within a sentence. In general, phrases and clauses which follow a semi-colon (;) within a sentence shall refer to the subject of the preceding colon within the sentence.

D. Titles to divisions, sections of these specifications are introduced merely for convenience and are not necessarily correct segregation of labor or materials. Such separations shall not operate to make Engineer an arbiter to establish limits between contractor and subcontractors.

E. Contractor: clarify, allocate furnishing of materials, performance of work to various trades in accordance with local customs, jurisdictional awards, regulations, decisions insofar as they are applicable.

1.2 MANUFACTURERS SPECIFICATIONS

A. Latest edition of manufacturers recommendations, instructions, specifications for products, materials employed in work apply, unless specified otherwise herein.

1.3 STANDARDS, REFERENCES

A. Latest editions of specifications, instructions, recommendations of following organizations govern where applicable to work specified herein:
1. AAMA - Architectural Aluminum Mfrs. Associations
2. ACI - American Concrete Institute
3. AGA - American Gas Association
4. AIA - American Institute of Architects
5. AISC - American Institute of Steel Construction
6. AISI - American Iron and Steel Institute
7. AITC - American Institute of Timber Construction
8. AMA - Acoustical Manufacturers Association
9. APA - American Plywood Association
10. ASA - American Standards Association
11. ASHRAE - American Society of Heating, Refrigerating & Air Conditioning Engineers
12. ASTM - American Society for Testing Materials
13. AWS - American Welding Society
14. BRI - Building Research Institute
15. CRSI - Concrete Reinforcing Steel Institute
16. CSI - Construction Specifications Institute
17. DFPA - Douglas Fir Plywood Association (Now APA)
18. FPL - Forest Products Laboratory
19. FS - Federal Specification
20. NAAMM - National Association of Architectural Metal Mfrs.
21. NBHA - National Builders Hardware Association
22. NBS - National Bureau of Standards
23. NCMA - National Concrete Masonry Association
24. NEC - National Electrical Code
25. NFPA - National Fire Protection Association
26. NHLA - National Hardwood Lumber Association
27. NLMA - National Lumber Manufacturers Association
28. NPVLA - National Paint Varnish & Lacquer Association
29. PCA - Portland Cement Association
30. PDCA - Painting & Decorating Contractors of America
32. SDI - Steel Door Institute
33. SMACNA - Sheet Metal & Air Cond. Contractors Nat'l. Assoc.
34. SPR - Simplified Practice Recommendation
35. UL - Underwriters Laboratory
36. USDC - U. S. Department of Commerce
37. WRI - Wire Reinforcement Institute

1.4 COOPERATION AND CO-RESPONSIBILITY

A. Each Subcontractor: cooperate with General Contractor and/or subcontractor for other trades in performance of their work and with men employed by Owner for purposes of installing equipment, furnishings, and like.

B. When material furnished by one Subcontractor, to be set by another, arrange mutually for time and place of its delivery. Subcontractor for setting: responsible for condition of material, after its acceptance, and replace without charge any such items lost, stolen, or damaged before completion of his work even though installed.

C. Each Subcontractor: make reasonable provision for protection of work; if damage occurs, restoration done only by installing subcontractor with costs borne by party causing damage.

1.5 CONTRACT LIMITS, OPERATIONAL REQUIREMENTS

A. Work at project: confined to areas within contract limits as indicated, unless otherwise defined.

B. Construction operations, delivery, storage of materials, movements of equipment: governed by applicable local building codes, by-laws, traffic regulations, safety, fire regulations of the municipality and Owner's requirements.
1.6 EXISTING PIPING, DRAINS, UTILITY LINES, ETC.
   
   A. Piping, drains, utility lines, etc., shown on drawings or not encountered in excavating or other construction work, unless ordered removed: supported, braced, protected from damage. Notify Engineer if utility lines are encountered. Do not disturb any such work unless so directed. Any existing piping, drain, utility lines, etc., damaged during excavating or by other work under this contract: repaired and any damage related to same made good.

1.7 JOB SAFETY
   
   A. Maintain proper standards of safety in accordance with federal, state, local rules, regulations for the construction industry.

1.8 PROTECTION OF WORK, PROPERTY
   
   A. Contractor: Provide against damage from elements, undermining or displacement due to conditions of the site, methods of construction.
   
   B. Work: carried on in manner which will cause as little inconvenience as possible to Owner in his use of property, existing facilities, structures. Contractor: provide, maintain adequate protective coverings, barricades about work which might be injured during construction; keep same in repair throughout entire work; responsible for injury, damage resulting from his operations.
   
   C. Protect existing sidewalks, pavements, curbs, lawns, adjacent property during construction. Restore to conditions existing prior to construction, any damaged parts, areas.
   
   D. No explosives will be permitted on the Owner's premises.
   
   E. No smoking will be allowed on the Owner's premises.
   

1.9 BARRICADES
   
   A. Contractor: provide, maintain barricades, enclosures, protection as necessary for safety of public and workmen; erect, maintain appropriate, required warning signs, lamps, flares, etc. All protective devices, etc.: constructed of non-combustible materials.

1.10 SITE MAINTENANCE AND CLEAN-UP
   
   A. Provide all labor and equipment necessary to remove debris and scrap materials from the building on a daily basis.
   
   B. Take all measures during construction to enforce the requirements outlined in the various sections of the specifications for protection of adjacent surfaces during application of finishes, etc.
   
   C. Contractor: clean-up the site at the end of the day.
   
   D. Leave premises in condition to allow Owner to use all entrances, walks and drives.
1.11 PARKING
   A. Refer to the Wayne State University special conditions for parking requirements.

1.12 VANDALISM
   A. Contractor: pay for, satisfactorily repair all damage done to site, equipment, and/or stored material of work
      under his contract due to acts of vandalism during construction and until final acceptance by Owner. See
      General Conditions for reimbursement.
   B. Contractor may elect to hire a watchman and/or secure additional insurance coverage at his own expense.
      This option is not a demand to contract.

1.13 RETAINED PERCENTAGE
   A. There shall be retained ten (10) percent of the estimated amounts until the final completion and acceptance of
      all work covered by the Contract.
   B. The balance of the retained percentage shall be paid thirty (30) days after Owner's acceptance of project,
      provided that all requirements of the Contract are met.

1.14 GUARANTEE
   A. Contractors: furnish, unless otherwise indicated in trade sections, written one year guarantee on form included
      under the Contract Conditions in accordance with the terms of the General Conditions and Supplementary
      General Conditions.

1.15 JOB RECORDS, AS-BUILT DRAWINGS
   A. Contractor: keep available in field office accurate, up to date record of actual construction, whether or not
      covered by official revisions, drawings, specifications.
   B. On completion of project, Contractor: furnish marked-up set of sepias of contract drawings showing changes,
      variations from contract documents, accurately dimensioned with sizes, depths, elevations properly noted.

1.16 CRITICAL PHASING AND CRITICAL STAGES OF CONSTRUCTION
   A. Due to the necessity for certain areas and services to remain in operation up to a certain date or through the
      life of the project, critical phasing and critical stages of construction have been established herein for the
      project. It is extremely important that the "Critical Phasing and Critical Stages of Construction" requirements
      be understood and complied with. The Contractor shall coordinate detailed critical phasing and construction
      sequencing and scheduling with the Owner. The Contractor shall expedite the submittal of shop drawings,
      ordering and delivering of materials and equipment, etc., to meet these critical phasing and staging
      requirements and the established completion date for the project.
   B. The requirements set forth by the "Time of Completion" section of the Proposal Form shall be strictly adhered
      to.
   C. Include proposed sequencing and phasing of work and shutdowns in the "Schedule of Operations" which is
      required.
D. Submit a separate detailed schedule to the Owner and the Engineer prior to initiating critical phasing work. Include information such as: dates, times, shutdowns, interruptions, duration of same, connections, etc.

E. All costs for the critical phasing work shall be included in the Bid Proposal, including cost for any necessary overtime work.

F. Submit shop drawings immediately on equipment items required for the critical stages of construction.

G. Coordinate new work and modifications to existing work to hold the number of shutdowns to a minimum. Schedule all shutdowns in advance with the Owner's Representative.

H. Schedule and plan delivery, storage and erection of materials to avoid disruption of Owner's operations. Coordinate unavoidable disruptions with the Owner's Representative.

I. Perform work so as to maintain access to emergency exits at all times.

END OF SECTION 011000
SECTION 011010 - SUMMARY OF WORK

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division-1 Specification Sections, apply to work of this Section.

1.2 PROJECT DESCRIPTION
A. The Work includes, but is not limited to:

1.3 CONTRACTOR USE OF PREMISES
A. General: Limit use of the premises to construction activities in areas indicated; allow for Owner occupancy and use by the public. Take care not to contaminate indoor air systems with smoke, fumes, or exhaust from construction activities.
B. Confine operations to areas within Contract limits indicated. Portions of the site beyond areas in which construction operations are indicated are not to be disturbed.
C. Keep driveways and entrances serving the premises clear and available to the Owner and the Owner’s employees at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on site.
D. Maintain the existing building in a weathertight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.

1.4 OWNER OCCUPANCY
A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire construction period. Cooperate with the Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with the Owner’s operations.
B. The Time of Completion requirements set forth in the Form of Proposal shall be complied with by the Contractor with regards to shutdown of the Owner’s operation.

END OF SECTION 011010
SECTION 011019 - CONTRACT CONSIDERATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

A. Schedule of Values.
B. Application for Payment.
C. Change Procedures.

1.3 RELATED SECTIONS

A. Section 01300 - Submittals: Schedule of Values.
B. Section 01600 - Material and Equipment: Product substitutions.

1.4 SCHEDULE OF VALUES

A. Submit typed schedule on AIA Form G703 - Application and Certificate for Payment Continuation Sheet. Contractor's standard form or electronic media printout will be considered.
B. Submit Schedule of Values in duplicate within 15 days after date of Owner-Contractor Agreement.
C. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the major specification Section. Identify site mobilization, bonds and insurance, breakdown by major category of work, or as directed by Engineer.
D. Revise schedule to list approved Change Orders, with each Application For Payment.

1.5 APPLICATIONS FOR PAYMENT

A. Submit three copies of each application on AIA Form G702 - Application and Certificate for Payment.
B. Content and Format: Utilize Schedule of Values for listing items in Application for Payment.
C. Payment Period: Refer to Agreement.

D. Waivers of LIEN shall accompany each application for payment.

1.6 CHANGE PROCEDURES

A. The Engineer will advise of minor changes in the Work not involving an adjustment to Contract Sum/Price or Contract Time as authorized by AIA A201, 1987 Edition, Article 7.4 by issuing supplemental instructions.

B. The Engineer may issue a Notice of Change, which includes a detailed description of a proposed change with supplementary or revised Drawings and specifications. Contractor will prepare and submit an estimate within ten (10) days.

C. Execution of Change Orders: Engineer will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.

END OF SECTION 011019
COORDINATION AND MEETINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

A. Coordination.
B. Alteration project procedures.
C. Cutting and patching.
D. Preconstruction conference.
E. Progress meetings.

1.3 COORDINATION

A. Coordinate scheduling submittals, and Work of the various Sections of specifications to assure efficient and orderly sequence of installation of interdependent construction elements.
B. Verify that utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
C. Coordinate space requirements and installation of mechanical and electrical work, which are indicated diagrammatically on Drawings. Follow routing shown for conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
D. In finished areas, conceal conduit and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
E. Coordinate completion and clean up of Work of separate Sections in preparation for Substantial Completion and for portions of Work designated for Owners occupancy.
F. Coordinate work to minimize disruption of Owner's activities.
1.4 ALTERATION PROJECT PROCEDURES

A. Materials: As specified in product Sections; match existing products and work for patching and extending work, unless specified or indicated otherwise.

B. Remove, cut, and patch work in a manner to minimize damage and to provide a means of restoring products and finishes to original condition.

C. Refinish visible existing surfaces to remain in renovated rooms and spaces, to specified condition for each material, with a neat transition to adjacent finishes.

D. Where new work abuts or aligns with existing, perform a smooth and even transition. Patched work to match existing adjacent work in texture and appearance.

E. When finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Engineer.

F. Finish surfaces as specified in individual product Sections.

1.5 CUTTING AND PATCHING

A. Employ skilled and experienced installer to perform cutting and patching.

B. Submit written request in advance of cutting or altering elements which affects:

1. Structural integrity of element.
2. Integrity of weather exposed or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.

C. Execute cutting, fitting, and patching, including excavation and fill, to complete Work, and to:

1. Fit the several parts together, to integrate with other Work.
2. Uncover Work to install or correct ill-timed Work.
3. Remove and replace defective and non-conforming Work.
4. Remove samples of installed Work for testing.
5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.

D. Execute work by methods, which will avoid damage to other Work, and provide proper surfaces to receive patching and finishing.

E. Cut rigid materials using masonry saw or core drill.

F. Restore Work with new products in accordance with requirements of Contract Documents.

G. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.

H. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.

I. Identify any hazardous substance or condition exposed during the Work to the Engineer for decision or remedy.
1.6 PRECONSTRUCTION CONFERENCE

A. Owner will schedule a conference after Notice of Award.

B. Attendance Required: Owner, Engineer and Contractor.

C. Agenda:
   1. Submission of executed bonds and insurance certificates.
   3. Submission of list of Subcontractors, list of products, Schedule of Values, and progress schedule.
   4. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders and Contract closeout procedures.
   5. Use of premises by Owner and Contractor.
   6. Owner's requirements and occupancy.
   7. Construction facilities and controls provided by Owner.
   8. Temporary utilities provided by Owner.
  10. Schedules.
  11. Downtime of systems.
  12. Requirements for start-up of equipment.
  13. Record documents.
  15. Owner training.

1.7 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the Work at monthly intervals and prior to critical phases.

B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record minutes, and distribute copies within two days to Engineer, Owner, participants, and those affected by decisions made.

C. Attendance Required: Job superintendent, major Subcontractors and suppliers, Owner, Engineer, as appropriate to agenda topics for each meeting.

   1. Review minutes of previous meetings.
   2. Review of Work progress.
   3. Field observations, problems, and decisions.
   4. Identification of problems which impede planned progress.
   5. Review of submittals schedule and status of submittals.
   6. Review of off-site fabrication and delivery schedules.
   7. Maintenance of progress schedule.
   8. Corrective measures to regain projected schedules.
   9. Planned progress during succeeding work period.
  10. Coordination of projected progress.
  11. Maintenance of quality and work standards.
  12. Effect of proposed changes on progress schedule and coordination.
  13. Other business relating to Work.

END OF SECTION 011039
SECTION 011300 - SUBMITTALS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUBMITTAL PROCEDURES

A. Transmit each submittal with Engineer accepted form.

B. Identify Project, Contractor or supplier; pertinent Drawing sheet and detail number(s), and Specification Section number, as appropriate.

C. Apply Contractor's stamp, signed or initialed certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.

D. Schedule submittals to expedite the Project, and deliver to Engineer at business address. Coordinate submission of related items.

E. Identify variations from Contract Documents and Product or system limitations, which may be detrimental to successful performance of the completed Work.

F. Provide space for Contractor and Engineer review stamps. Allow ten (10) working days for review by the Engineer.

G. Revise and resubmit submittals as required, identify all changes made since previous submittal.

H. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

1.3 CONSTRUCTION PROGRESS SCHEDULES

A. Submit initial progress schedule in duplicate within ten (10) days after date Notice to Proceed for Engineer review.

B. Revise and resubmit as required.

C. Submit revised schedules with each Application for Payment, identifying changes since previous version.
D. Submit a computer generated or horizontal bar chart with separate line for each major section of work or operation, identifying first work day of each week.

E. Indicate estimated percentage of completion for each item of Work at each submission.

F. Indicate submittal dates required for shop drawings, product data, samples, and product delivery dates.

1.4 PROPOSED PRODUCTS LIST

A. Within ten (10) days after date of Notice to Proceed, submit complete list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.5 SHOP DRAWINGS

A. Submit in the form of one (1) reproducible transparency and three (3) copies. After review, the Engineer will retain all three (3) copies of the shop drawings, and will return the reviewed and noted transparency to the Contractor. Any required re-submittal shall follow the same procedure.

1.6 PRODUCT DATA

A. Submit six (6) copies.

B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers standard data to provide information unique to this Project.

1.7 MANUFACTURER’S INSTRUCTIONS

A. When specified in individual specification Sections, submit manufacturers’ printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, in quantities specified for Product Data.

B. Identify conflicts between manufacturers’ instructions and Contract Documents.

1.8 MANUFACTURER’S CERTIFICATES

A. When specified in individual specification Sections, submit manufacturers’ certificate to Engineer for review, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceed specified requirements. Submit supporting reference date, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product, but must be acceptable to Engineer.

END OF SECTION 011300
SECTION 011630 - PRODUCT SUBSTITUTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and Division - 1 Specification Sections, apply to work of this Section.

1.2 SECTION INCLUDES
A. Furnish and install Products specified, under options and conditions for substitutions stated in this section.

1.3 RELATED SECTIONS
A. Section 01300 - Submittals.

1.4 BIDDER’S OPTIONS
A. For products that are specified only by reference standard, select Product that is standard by any manufacturer.

B. For Products specified by naming several Products or manufacturers, select any one of products and manufacturers named which complies with Specifications.

C. For Products specified by naming several Products or manufacturers submit a request as for substitutions, for any Product or manufacturer that is not specifically named for review and approval by the Engineer.

D. For Products specified by naming only one Product and manufacturer, there is no option and no substitution will be allowed.

1.5 SUBSTITUTIONS
A. Base Bid shall be in accordance with the Contract Documents.

1. Engineer will consider requests from the Bidder for substitution of products in place of those specified as set forth in this section. Upon receiving a substitution request substantiating product ten (10) days prior to Bid Date.

2. Those submitted the specified calendar days prior to Bid Date will be included in an addendum if acceptable.

3. After the end of the bidding period, requests will be considered only in case of Product unavailability or other conditions beyond the control of Contractor.
4. Bids shall not be based on assumed acceptance of any item that has not been approved by addendum.

B. Submit separate request for each substitution. Support each request with:

1. Complete data substantiating compliance of proposed substitution with requirements stated in Contract Documents.
   a. Product identification, including manufacturer's name and address.
   b. Manufacturer's literature; identifying:
      1) Product description.
      2) Reference standards.
      3) Performance and test data.
   c. Samples, as applicable.
   d. Name and address of similar projects on which product has been used, and date of each installation.

2. Itemized comparison of the proposed substitution with product specified; list significant variations.
3. Data relating to changes in delivery or construction schedule.
4. All effects of substitution on separate contracts.
5. Accurate cost data comparing proposed substitution with product specified.
   a. Amount of any net change to Contract Sum.

6. Designation of required license fees or royalties.
7. Designation of availability of maintenance services, sources of replacement materials.

C. Substitutions will not be considered for acceptance when:

1. They are indicated or implied on shop drawings or product data submittals without a formal request from Bidder.
2. Acceptance will require substantial revision of Contract Documents.
3. In judgment of Engineer, do not include adequate information necessary for a complete evaluation.
4. Requested after Contract Award directly by a subcontractor or supplier.

D. Substitute products shall not be ordered or installed without written acceptance of Engineer.

E. Engineer will determine acceptability of proposed substitution.

1.6 BIDDER'S REPRESENTATION

A. In making formal request for substitution the Bidder represents that:

1. They have investigated proposed product and determined it is equivalent to or superior in all respects to that specified.
2. They will provide same warranties or bonds for substitution as for product specified.
3. They will coordinate installation of accepted substitution into the Work, and will make such changes as may be required for the Work to be complete in all respects.
4. They waive claims for additional costs caused by substitution that may subsequently become apparent.
5. Cost data is complete and includes related costs under their Contract, but not:
   a. Costs under separate contracts.
   b. Engineer's costs for redesign or revision of Contract Documents.
B. Any modifications necessary as a result of the use of an approved substitute shall be paid by the Contractor proposing the substitution.

C. Any additional engineering costs required to be performed by the Engineer to approve, implement or coordinate the substitution above reasonable review services, shall be paid by the Contractor proposing the substitution.

D. Under no circumstances will the Engineer be required to prove that a product proposed for substitution is or is not equal to the quality of the product specified.

1.7 ENGINEERS DUTIES

A. Review requests for substitutions with reasonable promptness.

B. Coordinate review/approval of "Engineer Approved" substitutions with the Owner.

C. Issue a written instruction of decision to accept the substitution.

D. Substitution requests that are not approved will be returned to the party submitting the request with an explanation for the rejection.

END OF SECTION 011630
SECTION 011650 - STARTING OF SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

A. Starting systems.
B. Demonstration and instructions.

1.3 RELATED SECTIONS

A. Section 01300 - Submittals.
B. Section 01700 - Contract Closeout: System operation and maintenance data and extra materials.

1.4 STARTING SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.
B. Notify Engineer seven (7) days prior to start-up of each item.
C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions that may cause damage.
D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
E. Verify wiring and support components for equipment are complete and tested.
F. Execute start-up under supervision of responsible Contractors' personnel in accordance with manufacturers' instructions.

1.5 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of Products to Owner's personnel two (2) weeks prior to date of Substantial Completion and as described within the individual specification sections.
B. Provide Owner training as described within the individual specification sections.

END OF SECTION 011650
SECTION 011700 - CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and Division-1 Specification Sections, apply to work of this Section.

1.2 SECTION INCLUDES
   A. Closeout procedures.
   B. Final cleaning.
   C. Adjusting.
   D. Project record documents.
   E. Operation and maintenance data.
   F. Warranties.
   G. Spare parts and maintenance materials.

1.3 RELATED SECTIONS
   A. Section 01650 - Starting of Systems: System start-up.
   B. Section 260999 - Testing, Adjusting, and Balancing.

1.4 CLOSEOUT PROCEDURES
   A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's inspection.
   B. Provide submittals to Owner that are required by governing or other authorities.
C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

D. Owner will occupy all portions of the building as specified in Section 01010.

E. Submit appropriate permits.

1.5 FINAL CLEANING

A. Execute final cleaning prior to final inspection.

B. Clean interior and exterior surfaces exposed to view for new work or existing surfaces affected by the new work.

C. Clean equipment and fixtures to a sanitary condition.

D. Clean site.

E. Remove waste and surplus materials, rubbish, and construction facilities from the site.

1.6 ADJUSTING

A. Adjust operating Products and equipment to ensure smooth and unhindered operation.

1.7 PROJECT RECORD DOCUMENTS

A. Maintain on site, one (1) set of the following record documents; record actual revisions to the Work:

2. Specifications.
3. Addenda.
4. Change Orders and other Modifications to the Contract.
5. Reviewed shop drawings, product data, and samples.

B. Store Record Documents separate from documents used for construction.

C. Record information concurrent with construction progress.

D. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:

1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
2. Field changes of dimension and detail.

E. Submit documents to Engineer with claim for final Application for Payment.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit three (3) sets prior to final inspection, bound in 8-1/2 x 11 inch or 11 x 17 inch text pages, three ring binders with durable plastic covers, as described below and as supplemented in the individual specification sections.
B. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS" and title of project.

C. Contents: Prepare a Table of Contents with each Product or system description identified.

D. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers.

E. Part 2: Operation and maintenance instructions.

F. Part 3: Project documents and certificates, including the following:
   1. Shop drawings and product data.
   2. Balance reports.
   3. Certificates.
   4. Photocopies of warranties.

1.9 WARRANTIES

A. Submit warranties required in the General Conditions of the Contract and in the individual specification Sections.

1.10 SPARE PARTS AND MAINTENANCE MATERIALS

A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification Sections.

B. Deliver to Project site and place in location as directed. Obtain receipt prior to final payment.

END OF SECTION 011700
SECTION 012100 - ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SELECTION AND PURCHASE
   A. At the earliest practical date after award of the Contract, advise Architect of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.

1.3 COORDINATION
   A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALLOWANCES
   A. See Bid Form for allowances for all projects.

END OF SECTION 012100
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END OF TABLE OF CONTENTS
SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

PART 2 - PRODUCTS

2.1 FORM FACING MATERIALS

2.2 STEEL REINFORCEMENT

2.3 CONCRETE MATERIALS

2.4 ADMIXTURES

2.5 FIBER REINFORCEMENTS

2.6 WATER STOPS

2.7 VAPOR RETARDERS

2.8 CURING MATERIALS

2.9 RELATED MATERIALS

2.10 CONCRETE MIXTURES

2.11 FABRICATING REINFORCEMENT

2.12 CONCRETE MIXING

PART 3 - EXECUTION

3.1 FORMWORK

3.2 EMBEDDED ITEMS

3.3 VAPOR RETARDERS

3.4 STEEL REINFORCEMENT

3.5 JOINTS

3.6 CONCRETE PLACEMENT

3.7 FINISHING FORMED SURFACES

3.9 CONCRETE PROTECTING AND CURING

3.10 CONCRETE SURFACE REPAIRS

3.11 FIELD QUALITY CONTROL

CAST-IN-PLACE CONCRETE

03 30 00 - 1
1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Design Mixtures: For each concrete mixture.
C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement.
D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1.4 INFORMATIONAL SUBMITTALS
A. Material certificates.
B. Material test reports.
C. Floor surface flatness and levelness measurements.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
B. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
C. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
   1. ACI 301, "Specifications for Structural Concrete,"
   2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
E. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS
A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.


D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's “Manual of Standard Practice.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
   1. Portland Cement: ASTM C 150, Type I Type II, option to supplement with the following:
      a. Fly Ash: ASTM C 618, Class F or C.
      b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, graded.
   1. Maximum Coarse-Aggregate Size: 1 inch (25 mm) nominal.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M.

2.4 ADMIXTURES


B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Retarding Admixture: ASTM C 494/C 494M, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   4. High-range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 FIBER REINFORCEMENT

A. Synthetic Micro-Fiber: Fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1 to 2-1/4 inches long.

B. Synthetic Macro-Fiber: Polyolefin macro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1 3/4 to 2-1/4 inches long.
2.6 WATERSTOPS
   A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch (19 by 25 mm).
   B. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch (10 by 19 mm).

2.7 VAPOR RETARDERS
   A. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick.

2.8 CURING MATERIALS
   A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
   B. Absorbent Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
   C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
   D. Water: Potable.
   E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
   F. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
      1. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   G. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
      1. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.9 RELATED MATERIALS

2.10 CONCRETE MIXTURES
   A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

C. Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing admixture in concrete, as required, for placement and workability.
   2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
   3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

D. Proportion normal-weight concrete mixture as follows:
   1. Minimum Compressive Strength: 3500 psi (24.1 MPa) at 28 days.
   2. Maximum Water-Cementitious Materials Ratio: 0.50
   3. Slump Limit: 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).
   4. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent. Provide 6% plus or minus 1% for any exterior or concrete exposed to weather.

2.11 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
   1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Chamfer exterior corners and edges of permanently exposed concrete.
3.2 EMBEDDED ITEMS
A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 VAPOR RETARDERS
A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
   1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.

3.4 STEEL REINFORCEMENT
A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
   1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.5 JOINTS
A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
   1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
   2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
E. Waterstops: Install in construction joints and at other joints indicated according to manufacturer's written instructions.

3.6 CONCRETE PLACEMENT
A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

C. Cold-Weather Placement: Comply with ACI 306.1.

D. Hot-Weather Placement: Comply with ACI 301.

3.7 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to be covered with a coating or covering material applied directly to concrete.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer’s written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer’s written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless
manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer’s written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.9 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect’s approval.

3.10 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

END OF SECTION 03 30 00
# Division 07 - Thermal and Moisture Protection

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## SECTION 078413 - PENETRATION FIRESTOPPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.

#### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.

1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

B. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

C. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
   a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
   b. Classification markings on penetration firestopping correspond to designations listed by the following:
      1) UL in its "Fire Resistance Directory."
      2) Intertek ETL SEMKO in its "Directory of Listed Building Products."
      3) FM Global in its "Building Materials Approval Guide."

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2. Grace Construction Products.
3. Hilti, Inc.
6. NUCO Inc.
8. RectorSeal Corporation.
9. Specified Technologies Inc.
10. 3M Fire Protection Products.
12. USG Corporation.

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. Fire-resistance-rated walls include fire-barrier walls, smoke-barrier walls and fire partitions.
2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.

D. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.

E. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

F. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.
Low-Emitting Materials: Penetration firestopping sealants and sealant primers shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

H. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:
   a. Slag-wool-fiber or rock-wool-fiber insulation.
   b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
   c. Fire-rated form board.
   d. Fillers for sealants.

2. Temporary forming materials.
5. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.
3.7 PENETRATION FIRESTOPPING SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL’s "Fire Resistance Directory" under product Category XHEZ.

B. Where Intertek ETL SEMKO-listed systems are indicated, they refer to design numbers in Intertek ETL SEMKO’s "Directory of Listed Building Products" under "Firestop Systems."

C. Firestopping for Metallic Pipes, Conduit, or Tubing

1. UL-Classified Systems: Match existing
2. F-Rating: 2 hours
3. T-Rating: 2 hours
4. W-Rating: No leakage of water at completion of water leakage testing.
5. Type of Fill Materials: As required to achieve rating

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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.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 20 Section "Mechanical General Requirements."
3. Division 20 Section "Mechanical Vibration Controls" for vibration isolation devices.
4. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. MFMA: Metal Framing Manufacturers Association.

1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS
A. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Metal framing systems. Include Product Data for components.
   2. Equipment supports.
B. Welding certificates.

1.5 QUALITY ASSURANCE
A. MSS Standards: Pipe hangers, supports, and accessories shall comply with the following:
   1. MSS SP-58, Pipe Hangers and Supports – Materials, Design and Manufacture.
   2. MSS SP-69, Pipe Hangers and Supports – Selection and Application.
   3. MSS SP-89, Pipe Hangers and Supports – Fabrication and Installation Practices.
B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
   5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 HANGER ROD MATERIAL
A. Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575.
   1. Rod continuously threaded.
   2. Use of rod couplings is prohibited.

2.3 METAL FRAMING SYSTEMS
A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
B. Manufacturers:

2. B-Line by Eaton.
4. Unistrut Corp.; Tyco International, Ltd.
5. Hilti USA.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

E. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.4 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

   b. Empire Industries, Inc.
   c. Hilti, Inc.
   d. ITW Ramset/Red Head.
   e. MKT Fastening, LLC.
   f. Powers Fasteners.

B. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application. Exception: Do not use chemical fasteners to support hanger systems for fire protection piping.

1. Manufacturers:

   a. Hilti, Inc.
   b. ITW Ramset/Red Head.
   c. MKT Fastening, LLC.
   d. Powers Fasteners.

2. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.


C. Threaded Inserts: Galvanized malleable iron or galvanized steel for 3/4 inch bolts.

1. Manufacturers:

   a. Superior Concrete Accessories; Threaded Insert.
   b. Dayton Sure-Grip and Shore Co.
   c. Richmond Screw Anchor Co.
D. Slotted Inserts: Continuous galvanized steel with temporary slot fillers and complete with nuts, studs, washers and the like, for 3/4 inch bolts.

1. Manufacturers:
   a. B-Line by Eaton; B22-I Continuous Concrete Insert.
   b. Unistrut Corp.; P-3200 Continuous Insert.
   c. Hohman and Barnard, Inc.
   d. Richmond Screw Anchor Co.
   e. Hilti, Inc.; CIS13812/PG.

2.5 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Refer to application schedules on the Drawings.

B. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

C. Use padded hangers for piping that is subject to scratching.

D. Concrete Structure Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Anchor Devices, Concrete and Masonry: in accordance with Group I, Group II, Type 2, Class 2, Style 1 and Style 2, Group III and Group VIII or FS FF-S-325A. Furnish cast-in floor type equipment anchor devices with adjustable positions. Furnish built in anchor devices for masonry, unless otherwise approved by the Architect. Powder actuated anchoring devices shall not be used to support any mechanical systems components.

2. Inserts, Concrete: TYPE 18 or 19. When applied to loads equivalent to piping in sizes NPS 2 and larger, and where otherwise required by imposed loads, a one foot length of 1/2 inch NPS 4 reinforcing rod shall be inserted and wired through wing slots. Proprietary type continuous inserts may be proposed and shall be submitted for approval.

3. Use mechanical-expansion anchors where required in concrete construction.

4. Use chemical fasteners where required in concrete construction.
E. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Use spring supports and sway braces TYPES 48, 49, 50, 51, 52, 53, 54, 55 or 56. For specific points:
   a. Provide spring supports at point of support where vertical movement will occur.
   b. For light loads and vertical movement less than 1/4 inch, TYPES 48 or 49 spring cushion supports.
   c. For vertical movements in excess of 1/4 inch but less than 1/2 inch, TYPES 51, 52 or 53 variable spring supports shall be used, loaded to not more than 75 percent of published load rating.
   d. For vertical movements of 1/2 inch and more, TYPES 54, 55 and 56 constant support spring hangers.
   e. Sway braces; TYPE 50.
   f. Variable spring hangers in accordance with referenced MSS Standards with "medium" allowable load change.

F. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

3.2 HANGER AND SUPPORT INSTALLATION

A. Provide necessary piping and equipment supporting elements including: building structure attachments, supplementary steel, hanger rods, stanchions and fixtures, vertical pipe attachments, horizontal pipe attachments, anchors, guides, spring supports in accordance with the referenced codes, standards, and requirements specified. Support piping and equipment from building structure, not from roof deck, floor slab, other pipe, duct or equipment.

B. At connections between piping systems, hangers and equipment of dissimilar metals, insulate, using dielectric insulating material, nonferrous piping against direct contact with the building steel by insulating the contact point of the hanger and pipe or the hanger and building steel. Test each point of dielectric insulation with an ohm meter to ensure proper isolation of dissimilar materials. Test shall be observed by the Owner's Representative and/or Architect.

C. Spring supports, within specified limitations: Constant support type, where necessary to avoid transfer of load from support to support or onto connected equipment; otherwise, variable support type located at points subject to vertical movement.

D. Attach supporting elements connected to structural steel columns to preclude vertical slippage and cascading failure.

E. Limit the location of supporting elements for piping and equipment, when supported from roof, to panel points of the bar joists.

F. Building structure shall not be reinforced except as approved by the Architect in writing.

G. Support piping and equipment from concrete building frame, not from roof or floor slabs unless otherwise indicated.

H. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

I. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.


L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
B. Equipment Supports: Painting is specified in Division 09 painting Sections.

C. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

END OF SECTION 20 0529
MECHANICAL VIBRATION CONTROLS

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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUBMITTALS
A. Product Data: Include load deflection curves for each vibration isolation device.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:
   1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

C. Welding certificates.

1.3 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code—Steel.”

1.4 COORDINATION
A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03.
B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Installation of these items is specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION HANGERS

A. Type 8a Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type 30N or a comparable product by one of the following:
   a. Amber/Booth; a VMC Group Company.
   b. Korfund Dynamics; a VMC Group Company.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

B. Type 8b Spring Hangers with Vertical-Limit Stop: Precompressed combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type PC30N or a comparable product by one of the following:
   a. Amber/Booth; a VMC Group Company.
   b. Korfund Dynamics; a VMC Group Company.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

2.2 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance.
B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONNECTIONS
A. Provide flexible electrical connections in the form of large radius, 360 degree loop of flexible conduit for all vibrating isolated equipment. Any cooling water lines, compressed air, or other piping services (except inlet and outlet water connections for pumps, chillers or cooling tower) shall be made with 360 degree loops of reinforced neoprene hose, which are attached using nipples of appropriate gender. All service connections made with neoprene hose shall have shut-off valves between the hose and the supply service.
B. Vibration isolate piping connected to vibration isolated equipment using Type 8a or 8b spring hangers, and with distance to be isolated as scheduled on the Drawings. Maximum spacing between isolators same as maximum distance between pipe hangers and supports.
C. Vibration isolate ductwork connected to air handling units, return air fans, and vibration isolated equipment using Type 8a or 8b spring hangers, and in accordance with isolation distances scheduled on the Drawings.

3.3 FIELD QUALITY CONTROL
A. Testing: Perform the following field quality-control testing:
   1. Isolator deflection.
   2. Snubber minimum clearances.

3.4 ADJUSTING
A. Adjust active height of spring isolators.
B. Adjust snubbers according to manufacturer's written recommendations.

3.5 CLEANING
A. After completing equipment installation, inspect vibration isolation devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION 20 0547
MECHANICAL IDENTIFICATION

20 0553 - 1

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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

1.3 QUALITY ASSURANCE


1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:

1. Seton.
2. Brady.
3. EMED.
5. Brimar Industries, Inc.

2.2 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:
   a. Manufacturer, product name, model number, and serial number.
   b. Capacity, operating and power characteristics, and essential data.
   c. Labels of tested compliances.

2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

2.3 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Vinyl, 2-inch minimum character height, with permanent pressure sensitive adhesive. Include direction and quantity of airflow, air handling unit or fan number, and duct service (such as supply, return, and exhaust).

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 20, 21, 22, and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer’s option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fans, blowers, primary balancing dampers, and mixing boxes.
B. Area Served: Equipment serving different areas of a building other than where the equipment is installed shall be permanently marked in a manner that, in addition to identifying the equipment as specified in this Section, also identifies the area it serves.

3.3 DUCT IDENTIFICATION

A. Identify ductwork with vinyl markers and flow direction arrows.

B. Locate markers at air handling units, each side of floor and wall penetrations, near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.4 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.5 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 20 0553
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SECTION 23 0500 - COMMON WORK RESULTS FOR HVAC

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.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 23 Section “Testing, Adjusting, and Balancing.”

1.2 SUMMARY
A. This Section includes common requirements for fans and air moving equipment.

1.3 SUBMITTALS
A. Product Data: For the following:
   1. Fan bearings.
   2. Direct drive couplings.

1.4 QUALITY ASSURANCE
A. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

C. Sound Power Level Ratings:
   1. Ducted Fans - Rated per AMCA 301, when tested per AMCA 300.
   2. Nonducted Fans - Rated in Zones at 5 feet from acoustic center of fan rated per AMCA 301, tested per AMCA 300 and converted per AMCA 302.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not operate equipment for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 FAN SHAFTS

A. Fan Shafts: Ground from solid cold rolled steel, and proportioned to run at least 25 percent below the first critical speed.

2.3 FLEXIBLE COUPLINGS (DIRECT DRIVE)

A. Fan shaft shall be connected to the motor shaft through a flexible coupling. The flexible member shall be a tire shape, in shear, or a solid mass serrated edge disc shape, made of chloroprene materials and retained by fixed flanges. Flexible coupling shall act as a dielectric connector and shall not transmit sound, vibration or end thrust.

B. Manufacturer:
   1. Falk Corporation (The).

2.4 MOTOR REQUIREMENTS

A. Furnish motors in accordance with Division 20 Section “Motors.”

2.5 FAN BEARINGS

A. Bearings: Anti-friction ball or roller type with provision for self-alignment and thrust load. Made in U.S.A. with ABMA L10 minimum life of 200,000 hours. Use cast iron housings and dust-tight seals suitable for lubricant pressures.
1. Lubrication Provisions - Use surface ball check type supply fittings. Provide extension tubes to allow safe maintenance while equipment is operating. Provide manual or automatic pressure relief fittings to prevent overheating or seal blow-out due to excess lubricant or pressure. Arrange relief fittings opposite supply but visible for normal maintenance observation.

2. Bearings on Equipment with less than 1/2 horsepower rating or on shafts smaller than 1-3/4 inch in diameter: Permanently sealed, pre-lubricated anti-friction bearings per specified materials and ABMA L10 life requirements.

2.6 IDENTIFICATION

A. Nameplate: Affix metallic, corrosion-resistant data plate for each fan in a conspicuous location. Include selection point capacity conditions.

2.7 ACCESSORIES

A. Bird Screens: Of material to match adjacent contact construction, 1/2 inch mesh or equal expanded metal. Use on inlet or outlet of each nonducted fan.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Field Rigging: Do not negate balancing. Do not bend shaft. Use lifting eyes.

B. Refer to individual Division 23 HVAC equipment Sections for additional requirements.

END OF SECTION 23 0500
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.

B. Related Sections include the following:

1. Division 20 Section "Mechanical General Requirements."
2. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 SUMMARY

A. This Section includes metal ducts for supply, return, outside, relief air, and exhaust air-distribution systems in pressure classes from minus 12- to plus 12-inch wg.

1.3 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

B. Low Pressure: Up to 2 inch WG and velocities less than 1,500 fpm. Construct for 2 inch WG positive or negative static pressure.
1.4 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.5 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Application Schedule" Article.

1.6 SUBMITTALS

A. Shop Drawings: CAD-generated and drawn to 1/4 inch equals 1 foot scale. Show fabrication and installation details for metal ducts. Shop drawings shall be reviewed and approved by the Architect prior to any fabrication.

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Duct accessories, including access doors and panels.
10. Hangers and supports, including methods for duct and building attachment, vibration isolation.

B. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

C. Welding certificates.

D. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:


B. NFPA Compliance:
1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."


1.8 COORDINATION

A. Sheet metal trades shall cooperate fully with the Test and Balance Contractor and provide all miscellaneous caps and any other materials required for structural integrity and leakage testing of the complete duct system in whole or in part. Refer to Division 23 Section "Testing, Adjusting and Balancing."

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

2.3 SEALANTS AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Elastomeric Sealant Tape: 3 inches wide; modified butyl adhesive backed.

1. Manufacturers:
   a. Hardcast; Foil-Grip 1402 and Foil-Grip 1402-181BFX.

C. Water-Based Joint and Seam Sealant:

1. Manufacturers:
METAL DUCTS

a. Hardcast; Flex-Grip 550 and Versa-Grip 181.

b. Polymer Adhesives; No. 11.

c. United McGill.


5. Water resistant.

6. Mold and mildew resistant.

7. VOC: Maximum 75 g/L (less water).

8. Maximum Static-Pressure Class: 10-inch wg, positive and negative.


10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.


2. Type: S.

3. Grade: NS.


5. Use: O.

E. Gaskets: Chloroprene elastomer, 40 durometer, 1/8 inch thick, full face, one piece vulcanized or dovetailed at joints.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.

2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.4 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.


2. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

3. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

4. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Attachments for stainless steel and PVC-coated duct shall be stainless steel.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

E. Load Rated Cable Suspension System for Noncorrosive Environments: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.

1. Cable: Aircraft quality 7 x 7 and 7 x 19 wire rope.
2. Fastener: One-piece, die-cast zinc housing with Type 302 S26 stainless steel hardened and tempered springs, and oil impregnated, sintered, hardened and tempered steel locking wedges.
3. End Fixings: Loop, stud or toggle; or plain end suitable for wire rope beam clamp.
4. Manufacturers:
   b. Duro Dyne Corp.; Dyna-Tite System.

2.5 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
3. Internal Tie Rod: Ducts having a side dimension of 48 inches or greater only.

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's and SMACNA guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Nexus Inc.
   c. Ward Industries, Inc.

2.6 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

B. Round and Flat-Oval, Spiral Lock-Seam Ducts:

1. Manufacturers:
   a. RW LaPine Metal Products.
C. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" or SMACNA “Industrial Duct Construction Standards” as required based on pressure class.

1. Round fittings shall be factory fabricated welded design. Use of field fabricated fittings (welded design) shall only be permitted when factory fabricated fittings are unavailable.

D. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
2. Bolts and fasteners for galvanized steel duct shall be carbon steel, zinc coated per ASTM A153. Bolts and fasteners for stainless steel and polyvinyl chloride coated steel duct shall be stainless steel.
3. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.

a. Manufacturers:

1) AccuDuct Mfg. Inc.
2) Ductmate Industries, Inc.
3) Eastern Sheet Metal (ESM).
4) Lindab Inc.
5) Universal Spiral Air.

E. Low Pressure Ductwork (plus or minus 2 inches W.G. Static Pressure Class)

1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible provide single thickness turning vanes.
2. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

F. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
2. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.

PART 3 - EXECUTION (NOT APPLICABLE)

3.1 DUCTWORK APPLICATION SCHEDULE

A. Ductwork materials and performance requirements are scheduled on the Drawing.
3.2 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.

C. Install ducts with fewest possible joints.

D. Install fabricated fittings for changes in directions, size, and shape and for connections.

E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

J. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

K. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.


1. Intermediate level.

3.3 DUCT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated. Ducts must be properly cleaned and sealed in strict accordance with sealant manufacturer’s instructions.

1. Seal Class: Refer to Application Schedule on the Drawings.
2. Seal ducts before external insulation is applied.
3. After pressure testing, remake leaking joints until leakage is equal to or less than maximum allowable. Refer to Application Schedule on the Drawings for allowable leakage rates.
3.4 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Support ductwork from building structure, not from roof deck, floor slab, pipe, other ducts, or equipment.

D. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

E. Use load rated cable suspension system for round duct in exposed locations.

3.5 FIELD QUALITY CONTROL

A. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.

B. Duct system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 233113
SECTION 23 3300 - DUCT ACCESSORIES

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.

B. Related Sections include the following:
   1. Division 20 Section "Mechanical General Requirements."
   2. Division 23 Section "Testing, Adjusting, and Balancing" for duct test holes.
   3. Division 23 Section "Temperature Controls" for motorized control dampers.
   4. Division 28 Section "Fire Alarm" for duct-mounting fire and smoke detectors.

1.2 DEFINITIONS
A. NVLAP: National Voluntary Laboratory Accreditation Program.

B. Low Pressure: Up to 2 inch WG and velocities less than 1,500 fpm. Construct for 2 inch WG positive or negative static pressure.

C. Medium Pressure: Greater than 2 inch WG to 6 inch WG and velocities greater than 1,500 fpm and less than 2,500 fpm. Construct for 6 inch WG positive or negative static pressure.

D. High Pressure: Greater than 6 inch WG to 12 inch WG and velocities greater than 2,500 fpm. Construct for 12 inch WG positive or negative static pressure.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
1. For turning vanes, include data for pressure loss generated sound power levels.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

C. Source quality-control reports.

D. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE


B. Comply with AMCA 500-D testing for damper rating.

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed for each temperature rating.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
C. Bird Screens: No. 2 mesh, 0.063 inch diameter galvanized wire screen with open area of not less than 72 percent. Conceal sharp edges by adding metal edging consisting of rod, flat or angle iron, or 16 gage galvanized sheet steel turned over at least 3/4 inch on both sides.

2.3 PRESSURE RELIEF DOORS (STAINLESS STEEL)

A. Manufacturers:
   1. Kees Incorporated.
   2. Pottorff; a division of PCI Industries.
   3. Ruskin Company.

B. Description: Designed to open automatically to prevent exploding or imploding ductwork in the event dampers close while fan is still operating. Doors open outward for positive pressure relief, or inward for negative pressure relief.

C. Frame: 12 gage stainless steel.

D. Door: 12 gage stainless steel.

E. Seal: Polyurethane foam around door perimeter.

F. Pressure Relief Setting: Factory set, field adjustable, minimum 1.0 inch wg (250 Pa) above normal system pressure.

G. Springs: Negator springs for door closure upon pressure relief and system shutdown.

H. Temperature Limits: Minus 40 deg F minimum, and 120 deg F maximum.

2.4 FIRE DAMPERS (CURTAIN STYLE)

A. Manufacturers:
   1. Air Balance, Inc.
   2. Greenheck.
   3. NCA Manufacturing, Inc.
   4. Nailor Industries Inc.
   5. Ruskin Company.

B. Dynamic fire dampers with curtain style blades, and labeled according to UL 555, maximum velocity 2000 fpm, maximum static pressure 4 inches w.g.

C. Fire Rating:
   1. 1-1/2 hours for 2 hour rated walls.
   2. 3 hours for 4 hour rated walls.

D. Frame: Type B or Type C Curtain type with blades outside airstream; fabricated with roll-formed, galvanized steel in gages required by manufacturer’s UL listing; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.
2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

H. Fusible Links: Replaceable, 165 deg F rated.

2.5 FLEXIBLE CONNECTORS

A. Manufacturers:

1. ADSCO Manufacturing LLC.
2. Duro Dyne Corp.
3. Senior Flexonics Pathway.
4. Ventfabrics, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.


1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards-Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts and PVC coated ducts; and aluminum accessories in aluminum ducts.

C. Install fire dampers according to UL listing.

D. Label access doors according to Division 20 Section "Mechanical Identification."

E. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.

3.3 ADJUSTING

A. Adjust fire and smoke dampers for proper action.

END OF SECTION 23 3300
SECTION 23 3423 - POWER VENTILATORS

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.

B. Related Sections include the following:
1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Motors.”
3. Division 23 Section “Common Work Results for HVAC” for common mechanical drive requirements for fans and air moving equipment.

1.2 PERFORMANCE REQUIREMENTS
A. Classify according to AMCA 99.

1.3 SUBMITTALS
A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For power ventilators to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.6 COORDINATION

A. Coordinate size and location of structural-steel support members.

PART 2 - PRODUCTS

2.1 UTILITY SET FANS

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

1. Greenheck.
2. Loren Cook Company.
3. PennBarry; a unit of Tomkins PLC.
4. Trane.
B. Description: Direct centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

C. Housing: Fabricated of steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
   1. Housing Discharge Arrangement: Adjustable to eight standard positions.

D. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
   2. Blade Type: Airfoil, backward inclined, or forward curved, depending on manufacturer's standard selection practice based on wheel size and anticipated fan performance.

E. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

F. Motor: Electronically commutated motor (ECM)

G. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings. Refer to Division 20 Section "Mechanical General Requirements" for additional requirements.

H. Accessories:
   1. Access Door: Gasketed door in scroll with latch-type handles.
   2. Speed Controller: Potentiometer dial mounted on motor.
   3. Disconnect switch

I. Capacities and Characteristics: Refer to schedule(s) on Drawings.

J. Vibration Isolators: Refer to Division 20 Section "Mechanical Vibration Controls."

2.2 MOTORS

A. Comply with requirements in Division 20 Section "Motors."

2.3 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.
B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

C. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 20 Section "Mechanical Vibration Controls."

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Division 20 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Verify lubrication for bearings and other moving parts.
6. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
7. Shut unit down and reconnect automatic temperature-control operators.
8. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

C. Lubricate bearings.

END OF SECTION 23 3423
## DIVISION 26 - ELECTRICAL

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SECTION 26 0010 - ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY

A. This Section includes electrical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 1 Specification Sections.
1.3 REFERENCES

A. All materials shall be new. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:

1. A.N.S.I. - American National Standards Institute
2. A.S.T.M. - American Society for Testing Materials
3. I.C.E.A. - Insulated Cable Engineers Association
4. I.E.E.E. - Institute of Electrical and Electronics Engineers
5. N.E.C. - National Electrical Code
6. N.E.C.A. - National Electrical Contractors Association
7. N.E.M.A. - National Electrical Manufacturer's Association
8. U.L. - Underwriters Laboratories, Inc.

1.4 QUALITY ASSURANCE

A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the electrical systems as specified in the Division 26 Sections and as indicated on Drawings.

1. Contract Documents are complimentary, and what is required by one shall be as binding as if required by all. In the event of inconsistencies or disagreements within the Construction Documents bids shall be based on the most expensive combination of quality and quantity of the work indicated.
2. The Contractor understands that the work herein described shall be complete in every detail.

B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of NFPA, NECA, and UL, unless otherwise indicated.

1. Notify the Architect/Engineer before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations. After entering into Contract, make all changes required to conform to above ordinances, rules and regulations without additional expense to the Owner.

C. Source Limitations: All equipment of the same or similar systems shall be by the same manufacturer.

D. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.

E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.

F. Sequence and Schedule: Work so as to avoid interference with the work of other trades. Be responsible for removing and relocating any work which in the opinion of the Owner’s Representatives causes interference.
1.5 CODES, PERMITS AND FEES

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for electrical work shall be secured and paid for by the Contractor. All work shall conform to all applicable codes, rules and regulations.

B. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed Drawings or diagrams which may be required by the governing authorities. Where the Drawings and/or Specifications indicate materials or construction in excess of code requirements, the Drawings and/or Specifications shall govern.

1.6 DRAWINGS

A. The Drawings show the location and general arrangement of equipment, electrical systems and related items. They shall be followed as closely as elements of the construction will permit.

B. Examine the Drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, conduit, junction boxes and accessories as may be required to meet such conditions.

C. Deviations from the Drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.

D. The architectural and structural Drawings take precedence in all matters pertaining to the building structure, mechanical Drawings in all matters pertaining to mechanical trades and electrical Drawings in all matters pertaining to electrical trades. Where there are conflicts or differences between the Drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.

E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.7 MATERIAL AND EQUIPMENT MANUFACTURERS

A. All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of electrical equipment and shall be of the manufacturer's latest design.

B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, electrical work, and building alterations shall be included in the original Bid. Similar equipment shall be by one manufacturer.

C. Where existing equipment is modified to include new switches, circuit breakers, metering or other components, the new components shall be by the original equipment manufacturer and shall be listed for installation in the existing equipment. Where original equipment manufacturer components are not available, third party aftermarket components shall be listed for the application and submitted to the engineer for approval. Reconditioned or salvaged components shall not be used unless specifically indicated on the drawings.
1.8 INSPECTION OF SITE

A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

1.9 ITEMS REQUIRING PRIOR APPROVAL

A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 1 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.

1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.

2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, electrical, replacement of other components, and building alterations shall be included in the original bid.

B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid.

1.10 SHOP DRAWINGS/SUBMITTALS

A. Submit project-specific submittals for review in compliance with Division 1.

B. All shop Drawings shall be submitted in groupings of similar and/or related items (lighting fixtures, switchgear, etc.). Incomplete submittal groupings will be returned unchecked.

C. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.

D. Submit for approval shop drawings for all electrical systems or equipment but not limited to the items listed below. Where items are referred to by symbolic designation on the Drawings and Specifications, all submittals shall bear the same designation (light fixtures). Refer to other sections of the electrical Specifications for additional requirements.

1. Medium Voltage Cables
2. Wiring Devices
3. Packaged Engine Generators
4. Static Uninterruptible Power Supply
5. Medium Voltage Transformers
6. Medium Voltage Switchgear
7. Transfer Switches
8. Panelboards
9. Dry Type Transformers (600 V and Less)
10. Fuses
11. Fire Alarm
12. Underground Duct and Utility Structures

1.11 COORDINATION DRAWINGS

A. Submit project specific coordination drawings for review in compliance with Division 1 Specification Sections.

1.12 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 1 Specification Sections.

B. Provide complete operation and maintenance instructional manuals covering all electrical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. Four (4) copies of all literature shall be furnished for Owner and shall be bound in ring binder form. Maintenance and operating instructional manuals shall be provided when construction is approximately 75% complete.

C. The operating and maintenance instructions shall include a brief, general description for all electrical systems including, but not limited to:

1. Routine maintenance procedures.
2. Trouble-shooting procedures.
3. Contractor's telephone numbers for warranty repair service.
5. Recommended spare parts lists.
6. Names and telephone numbers of major material suppliers and subcontractors.
7. System schematic drawings on 8-1/2” x 11” sheets.

1.13 RECORD DRAWINGS

A. Submit record drawings in compliance with Division 1.

B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media which have been neatly marked to represent as-built conditions for all new electrical work.

C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request.

1.14 INSTRUCTION OF OWNER PERSONNEL

A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of electrical equipment and systems at agreed upon times. A minimum of 8 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.

B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
C. In addition to individual equipment training provide overview of each electrical system. Utilize the as-built documents for this overview.

D. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction, or as requested by Owner.

1.15 WARRANTY

A. Warranty: Comply with the requirements in Division 1 Specification Sections. Contractor shall warranty that the electrical installation is free from defects and agrees to replace or repair, to the Owner’s satisfaction, any part of this electrical installation which becomes defective within a period of one year (unless specified otherwise in other Division 26 sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.

B. Contractor shall be responsible for any temporary services including equipment and installation required to maintain operation as a result of any equipment failure or defect during warranty period.

C. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

1.16 USE OF EQUIPMENT

A. The use of any equipment, or any part thereof for purposes other than testing even with the Owner's consent, shall not be construed to be an acceptance of the work on the part of the Owner, nor be construed to obligate the Owner in any way to accept improper work or defective materials.

B. Do not use Owner's lamps for temporary lighting except as allowed and directed by the Owner. Equip lighting fixtures with new lamps when the project is turned over to the Owner.

1.17 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.
PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 DEMOLITION WORK

A. All demolition of existing electrical equipment and materials will be done by this Contractor unless otherwise indicated. Include all items such as, but not limited to, electrical equipment, devices, lighting fixtures, conduit, and wiring called out on the Drawings and as necessary whether such items are actually indicated on the Drawings or not in order to accomplish the installation of the specified new work.

B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this work.

C. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Items on which the Owner waives ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.

D. Where equipment or fixtures are removed, outlets shall be properly blanked off, and conduits capped. After alterations are done, the entire installation shall present a "finished" look, as approved by the Architect/Engineer. The original function of the present electrical work to be modified shall not be changed unless required by the specific revisions to the system as specified or as indicated.

E. All electrical work in altered and unaltered areas shall be run concealed wherever possible. Use of surface raceway or exposed conduits will be permitted only where approved by the Architect/Engineer.

3.3 INSTALLATION OF EQUIPMENT

A. Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the Drawings and Specifications, report such conflicts to the Architect/Engineer for resolution.

B. Device Location:
1. Allow for relocation prior to installation of wiring devices and other control devices, for example, receptacles, switches, fire alarm devices, and access control devices, within a 10-foot radius of indicated location without additional cost.

3.4 WORK IN EXISTING BUILDINGS

A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once Work is started in the existing building, shall complete same without interruption so as to return work areas as soon as possible to Owner.

B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage to same at Contractor's expense.

C. Consult with the Owner’s Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than absolutely necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.

D. Prior to starting work in any area, obtain approval for doing so from a qualified representative of the Owner who is designated and authorized by the Owner to perform testing and abatement of all hazardous materials including but not limited to, asbestos. The Contractor shall not perform any inspection, testing, containment, removal or other work that is related in any way whatsoever to hazardous materials under the Contract.

3.5 CHASES AND RECESSES

A. Provided by the architectural trades, but the Contractor shall be responsible for their accurate location and size.

3.6 CUTTING, PATCHING AND DAMAGE TO OTHER WORK

A. Refer to General Conditions for requirements.

B. All cutting, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.7 EXCAVATION AND BACKFILLING

A. Provide all excavation, trenching, tunneling, dewatering and backfilling required for the electrical work. Coordinate the work with other excavating and backfilling in the same area.

B. Where conduit is installed less than 26" below the surface of pavement, provide concrete encasement, 4" minimum coverage, all around or as shown on the electrical Drawings.

C. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.
D. Backfill all excavations inside building, under drives and parking areas with well-tamped granular material. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.

E. Backfill outside building with granular material to a height 12 inches over top of pipe compacted to 95 percent compaction as specified above. Backfill remainder of excavation with unfrozen, excavated material in such a way to prevent settling.

3.8 EQUIPMENT CONNECTIONS

A. Make connections to equipment, motors, lighting fixtures, and other items included in the work in accordance with the approved shop Drawings and rough-in measurements furnished by the manufacturers of the particular equipment furnished. All additional connections not shown on the Drawings, but called out by the equipment manufacturer’s shop Drawings shall be provided.

3.9 CLEANING

A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.

B. Final cleanup shall include, but not be limited to, washing of fixture lenses or louvers, switchboards, substations, motor control centers, panels, etc. Fixture reflectors and lenses or louvers shall be left with no water marks or cleaning streaks.

3.10 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

A. Equipment and materials shall be protected from theft, injury or damage.

B. Protect conduit openings with temporary plugs or caps.

C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by the Owner's representative or Architect/Engineer. Equipment set in place in unprotected areas must be provided with temporary protection.

3.11 EXTRA WORK

A. For any extra electrical work which may be proposed, this Contractor shall furnish to the General Contractor, an itemized breakdown of the estimated cost of the materials and labor required to complete this work. The Contractor shall proceed only after receiving a written order from the General Contractor establishing the agreed price and describing the work to be done. Prior to any extra work which may be proposed, the Electrical Contractor shall submit unit prices (same prices for increase/decrease of work) for the following items: 3/4", 1", 1-1/2" conduit; #12, #10, #8, #6, #2 wire; receptacle, or other devices which may be required for any proposed extra work.

3.12 DRAWINGS AND MEASUREMENTS

A. The Drawings are not intended to be scaled for rough-in measurements nor to serve as Shop Drawings. Field measurements necessary for ordering materials and fitting the installation to the building construction and arrangement are the Contractor’s responsibility. The Contractor shall check latest Architectural Drawings and locate light switches from same where door swings are different from Electrical Drawings.

END OF SECTION 26 0010
SECTION 260513 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cables and related cable splices, terminations, and accessories for medium-voltage (2001 to 35,000 V) electrical distribution systems.

1.3 DEFINITIONS

A. Jacket: A continuous nonmetallic outer covering for conductors or cables.


C. Sheath: A continuous metallic covering for conductors or cables.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.
B. Samples: 16-inch (400-mm) lengths for each type of cable specified.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For each type of cable and accessory.

C. Source quality-control reports.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 FIELD CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

   1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.

   2. Do not proceed with interruption of electric service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide Okonite Company (The) or comparable product by one of the following:

   1. Cables:

      a. Aetna Insulated Wire, Inc.; a Berkshire Hathaway company.
      b. General Cable Technologies Corporation.
      c. Kerite; a Marmon Wire & Cable/Berkshire Hathaway company.
      d. Okonite Company (The).
      e. Prysmian Cables & Systems.
      f. Southwire Company.
2. Cable Splicing and Terminating Products and Accessories:
   a. RTE Components; Cooper Power Systems, Inc.
   b. Thomas & Betts Corporation.
   c. 3M; Electrical Markets Division.
   d. Tyco Electronics; Raychem Products.

C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2 and NFPA 70.

2.3 CABLES

A. Cable Type: Type MV 105.

B. Comply with UL 1072, AEIC CS8, ANSI/ICEA S-93-639/NEMA WC 74, and ICEA S-97-682.

C. Conductor: Copper.

D. Conductor Stranding: Compact round, concentric lay, Class B.

E. Strand Filling: Conductor interstices are filled with impermeable compound.

F. Conductor Insulation: Ethylene-propylene rubber (EPR).
   1. Voltage Rating: 15 kV.
   2. Insulation Thickness: 133 percent insulation level.

G. Shielding: Copper tape, helically applied over semiconducting insulation shield with a minimum of 20% overlap.

2.4 CONNECTORS

A. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.

B. Copper-Conductor Connectors: Copper barrel crimped connectors.

2.5 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.
   1. Class 1 Terminations, Interior: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.
2. Class 1 Terminations, Exterior: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.

2.6 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

D. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.7 SPLICE KITS

A. Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
4. Premolded, EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.
5. Separable multiway splice system with all components for the required splice configuration.

2.8 MEDIUM-VOLTAGE TAPES

A. Ethylene/propylene rubber-based, 30-mil (0.76-mm) splicing tape, rated for 130 deg C operation. Minimum 3/4 inch (20 mm) wide.

2.9 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
2.10 FAULT INDICATORS

A. Indicators: Manually reset fault indicator, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

2.11 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches (1200 to 1800 mm) on the pull rope.

1. **Wire Brush Mandrel**: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.

2. **Rubber Duct Swab**: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.

2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.

4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

E. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

F. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

G. Install cable splices at pull points and elsewhere as indicated; use standard kits.
H. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

I. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
3. Standoff Insulator: At each terminal junction, with one on each terminal.

J. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with two layers of 1-inch (25-mm) wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.

K. Seal around cables passing through fire-rated elements according to Section 078413 "Penetration Firestopping."

L. Install fault indicators on each phase where indicated.

M. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

N. Ground shields of shielded cable at one point only. Maintain shield continuity and connections to metal connection hardware at all connection points.

O. Identify cables according to Section 260553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
3. Perform direct-current High Potential test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.
4. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
5. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.

C. Medium-voltage cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.
WAYNE STATE UNIVERSITY
Electrical Reliability Upgrade
169 - Bioengineering Building
603 - College of Pharmacy
005 - Science Hall

END OF SECTION 260513
SECTION 26 0519 - CONDUCTORS AND CABLES

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

B. Related Sections include the following:
   1. Division 26 Section "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.
   2. Division 26 Section “Electrical Identification” for conductor and cable color-coding.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.

B. Qualification Data: For testing agency.

C. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged by Contractor.

1.4 QUALITY ASSURANCE
A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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

B. Manufacturers, Copper:
   1. Triangle.
   2. Cablec.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

D. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

E. Conductor Material: Copper complying with NEMA WC 70; stranded conductor.

F. Conductor Insulation Types: Type THHN-THWN, complying with NEMA WC 70.

2.2 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Hubbell/Anderson.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M Company; Electrical Products Division.
6. T & B.
7. Burndy.
8. ILSCO.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
PART 3 - EXECUTION

3.1  CONDUCTOR AND INSULATION APPLICATIONS

A. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
B. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
C. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.
D. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.
E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
F. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
G. Underground Feeders and Branch Circuits: XHHW single conductors in conduit.
I. Class 1 Control Circuits: Type THHN-THWN, in raceway.
J. Connection between Variable Frequency Controllers and Motors: Use 600V rated VFC power cable for circuit lengths less than 50 feet and 2000V rated VFC power cable for circuit lengths 50 feet and greater. Support 5’ on center, minimum. Terminate according to cable manufacturer’s recommendations.
K. Isolated Power System Circuits: Use Type XLP in raceway.

3.2  INSTALLATION

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.
C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."
G. Each feeder shall be of the same conductor and insulation material (phase, neutral, and parallel).
H. Identify and color-code conductors and cables according to Division 26 Section "Electrical Identification."
I. All wiring shall be installed in conduit or approved raceway. All raceways shall be provided with a ground conductor unless noted otherwise on the Contract Documents.

J. Use conductor not smaller than 12 AWG for power and lighting circuits. Unless indicated otherwise, all circuits shall be 2#12, 1#12G, ¾"C.

K. Use conductor not smaller than 14 AWG for control circuits, provided by Electrical Contractor.

L. Support communication cables above accessible ceiling, using spring metal clips or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.

M. Use suitable cable fittings and connectors.

N. Neatly train and lace wiring inside boxes, equipment, and panelboards.

O. Clean conductor surfaces before installing lugs and connectors.

P. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

Q. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.

R. Use piercing connector with insulating covers for conductor splices and taps, 8 AWG and larger.

S. Use Sta-Kon connectors to terminate stranded conductors #10 AWG and smaller to screw terminals.

T. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

U. Branch circuits may be combined up to 3 circuits in a homerun conduit.

V. Provide a separate neutral conductor for each circuit.

W. Electrical Contractor shall be responsible for de-rating of conductors as required by N.E.C. when more than three current carrying conductors are installed in a single raceway or cable.

X. AC/MC cable shall not be used.

Y. Between support, hangers and termination no more than 3" deflection from the bottom of the cable to a horizontal line between the support/hanger or termination.

Z. Do not route conductors across roof without prior approval from engineer. Where approved, conductors shall be installed in rigid steel conduit and shall be de-rated for ambient temperature per the NEC.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use compression type terminations for aluminum conductors.
C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

1. Description: Test all feeders rated 100 A and above.
2. Visual and Mechanical Inspection
   a. Inspect cables for physical damage and proper connection in accordance with the one line diagram.
   b. Test cable mechanical connections with an infrared survey.
   c. Check cable color-coding against project Specifications and N.E.C. requirements.

3. Electrical Tests
   a. Perform insulation resistance test on each conductor with respect to ground and adjacent conductors. Applied potential to be 1000 volts dc for 1 minute.
   b. Perform continuity test to insure proper cable connection.

4. Test Values
   a. Minimum insulation resistance values shall be not less than fifty mega-ohms.

B. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 0519
PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.3 REFERENCES
A. ASTM B 3: Specification for Soft or Annealed Copper Wire.
B. ASTM B 8: Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
C. ASTM B 33: Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.


L. NFPA 70B: Recommended Practice for Electrical Equipment Maintenance.

M. TIA/EIA 607: Commercial Building Grounding and Bonding Requirements Standard.

N. UL 467: Grounding and Bonding Equipment.

O. UL 486 A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Data: For the following:
   1. Ground rods.

C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

D. Field Test Reports: Submit written test reports to include the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
   4. Indicate overall system resistance to ground.
   5. Indicate overall Telecommunications system resistance to ground.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 26 "Electrical General Requirements".

B. Accurately record actual locations of grounding electrodes and connections to building steel.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Refer to specification section “Electrical Testing.”
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. Comply with UL 467.

C. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.

D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

E. Comply with ANSI/TIA/EIA-607 “Standard for Commercial Building Grounding and Bonding Requirements for Telecommunications”.


PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Grounding Conductors and Cables:
   a. Refer to Division 26 Section “Conductors and Cables”.

2. Grounding Rods:
   b. Apache Grounding/Erico Inc.
   c. Chance/Hubbell.

3. Mechanical Connectors:
   b. Burndy.
   c. Chance/Hubbell.

4. Exothermic Connections:
   a. Cadweld.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section “Conductors and Cables.”

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
E. Grounding Electrode Conductors: Stranded cable.

F. Underground Conductors: Bare, stranded, copper unless otherwise indicated.

G. Bare Copper Conductors: Comply with the following:

H. Copper Bonding Conductors: As follows:
   1. Bonding Conductor: Stranded copper conductor; size per the NEC.
   2. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; size per the NEC.
   3. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; size per the NEC.

2.3 CONNECTOR PRODUCTS
A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected for the specific application per manufacturer's written instructions.

D. Compression-Type Connectors: Pure, wrought copper, per ASTM B187.

2.4 GROUNDING ELECTRODES
A. Ground Rods: Copper-clad steel.
   1. Size: 1/2 in diameter.
   2. Length: 120 inches.

PART 3 - EXECUTION

3.1 EQUIPMENT GROUNDING
A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

C. In raceways, use insulated equipment grounding conductors.

D. Install equipment grounding conductors in all feeders and circuits. Terminate each end on suitable lugs, bus or bushing.
E. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

F. Verify specific equipment grounding requirements with the manufacturer’s recommendations.

3.2 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer’s written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations

1. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.
2. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.3 INSTALLATION

A. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
1. Verify that final backfill and compaction has been complete before driving ground rods.
2. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
3. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Install in conduit where routed above grade.

C. Separately Derived AC Power Systems: Ground separately-derived ac power system neutrals including distribution transformers and uninterruptible power supplies to grounding electrodes per NFPA 70.

D. Packaged Engine Generator: Refer to grounding details on Drawings.

E. Equipment Grounding: Provide a permanent and continuous bonding of conductor enclosures, equipment frames, power distribution equipment ground busses, cable trays, metallic raceways, and other non-current carrying metallic parts of the electrical system.

3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with transformers/substations by connecting them to underground cable and grounding electrodes. Use not less than a No. 2 AWG conductor for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation.

3.5 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

1. Inspect grounding and bonding system conductors and connections for tightness and proper installation and for compliance with the Drawings and Specifications.
2. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

   a. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal.
   b. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   c. Perform ground-impedance measurements utilizing either the intersecting curves method of the slope method. (Ref. Nos. 40 and 41 in IEEE Std. 81).

3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

   a. Equipment Rated 500 kVA and Less: 10 ohms.
b. Equipment Rated 500 to 1000 kVA: 5 ohms.
c. Equipment Rated More Than 1000 kVA: 3 ohms.
e. Manhole Grounds: 10 ohms.
f. The telecommunications grounding system shall have a maximum resistance of 1 ohm as measured from the TMGB ground to earth ground.

4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.6 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2 Section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 26 0526
SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

  1. Hangers and supports for electrical equipment and systems.
  2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.
   g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      
      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.


2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with:
   a. Two-bolt conduit clamps
   b. Single-bolt conduit clamps
   c. Single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps are not allowed.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel:
   a. Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
   b. Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
   c. Spring-tension clamps.

7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel support systems attached to substrate.

E. Slotted support systems applications:

1. Indoor dry and damp Locations: Painted Steel
2. Outdoors and interior wet locations: Galvanized Steel
3. Corrosive Environments, including pool equipment rooms: Nonmetallic

F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

G. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
H. Obtain permission from Architect/Engineer before using powder-actuated anchors.

I. Obtain permission from Architect/Engineer before drilling or cutting structural members.

J. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

K. Install surface-mounted cabinets and panelboards with minimum of four anchors.

L. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch off wall.

M. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

N. The Contractor shall replace all supports and channels that sag, twist, and/or show signs of not providing proper structural support, to the equipment, it is intended for, as determined by the Owner and Architect/Engineer. All costs associated with replacing supports and steel channels shall be incurred by the Contractor.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 INSTALLATION OF ROOF MOUNTED SUPPORTS

A. Install in accordance with manufacturer’s instructions.

B. If gravel top roof, gravel must be removed around and under support.

C. Consult roofing manufacturer for roof membrane compression capacities. If required, a compatible sheet of roofing material (rubber pad) may be required under rooftop support to disperse concentrated loads and add further membrane protection.

D. Utilize properly sized clamps and accessories to suit conduit sizes.

3.5 CONCRETE BASES

A. Provide concrete bases for all floor mounted electrical equipment.

B. Provide concrete bases for all exterior, grade level electrical equipment, and where indicated.

C. Base/Pad Construction:

   1. Construct per manufacturer’s recommendations for particular equipment, including suggested piers and dowel rods.
2. Construct concrete bases for primary and secondary power distribution equipment per requirements of the electrical utility, where submitted for its review.

D. Anchor equipment to base per both supports and equipment manufacturer’s instructions.

E. Coordinate conduit openings and sleeve locations in base with requirements of equipment to be supported.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of the base.
   2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

3.6 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 0529
SECTION 26 0533 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Division 26 Section, “Underground Ducts and Raceways for Electrical Systems” for exterior duct banks, manholes and underground utility construction.
2. Division 07 Section, “Penetration Firestopping” for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
3. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings, and for access floor boxes and service poles.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

2.2 FIRE ALARM EMT

2.3 NONMETALLIC CONDUIT AND TUBING

2.4 METAL WIREWAYS

2.5 BOXES, ENCLOSURES, AND CABINETS

2.6 HANDBOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

2.7 SLEEVE INSTALLATION FOR RACEWAYS

2.8 SLEEVE SEALS

2.9 GROUT

2.10 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

3.2 INSTALLATION

3.3 INSTALLATION OF UNDERGROUND CONDUIT

3.4 INSTALLATION OF UNDERGROUND HANDBOLES AND BOXES

3.5 SLEEVE INSTALLATION FOR ELECTRICAL AND COMMUNICATIONS PENETRATIONS

3.6 SLEEVE-SEAL INSTALLATION

3.7 FIRESTOPPING

3.8 PROTECTION

3.9 CLEANING
1.3 DEFINITIONS
A. EMT: Electrical metallic tubing.
B. ENT: Electrical nonmetallic tubing.
C. FMC: Flexible metal conduit.
D. IMC: Intermediate metal conduit.
E. LFMC: Liquidtight flexible metal conduit.
F. LFNC: Liquidtight flexible nonmetallic conduit.
G. RNC: Rigid nonmetallic conduit.
H. PVC: Polyvinyl Chloride.
I. HDPE: High Density Polyethylene.

1.4 SUBMITTALS
A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.
C. All work in natatoriums, pool areas and fountain structures shall be in accordance with N.E.C. article 680, “Swimming Pools, Fountains, and Similar Installations.”

1.6 COORDINATION
A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube Triangle Century.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. International Metal Hose.
6. Electri-Flex Co
7. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
8. LTV Steel Tubular Products Company – Manhattan/CDT/Cole-Flex.
11. Wheatland.

B. Rigid Steel Conduit: ANSI C80.1.

C. EMT: ANSI C80.3.

D. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Fittings for EMT: Steel, set-screw type.
2. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

2.2 FIRE ALARM EMT

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

1. Allied Tube Triangle Century.

B. EMT conduit with bright red topcoat; Fire Alarm EMT.

C. EMT and Fittings: ANSI C80.3.

2.3 NONMETALLIC CONDUIT AND TUBING

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

2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corp.
4. Cantex Inc.
7. ElecSys, Inc.
8. Electri-Flex Co.
9. Integral.
10. Kor-Kap.
12. Manhattan/CDT/Cole-Flex.
13. RACO; Division of Hubbell, Inc.
15. Spiralduct, Inc./AFC Cable Systems, Inc.

B. ENT: NEMA TC 13.
C.  RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

D.  ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

E.  LFNC: UL 1660.


2.4 METAL WIREWAYS

A.  Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1.  Hoffman.
   2.  Square D.

B.  Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1.

C.  Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D.  Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E.  Wireway Covers: Hinged type as indicated.

F.  Finish: Manufacturer's standard enamel finish.

2.5 BOXES, ENCLOSURES, AND CABINETS

A.  Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover. Shall be used in all exposed, non-recessed, locations.

B.  Nonmetallic Outlet and Device Boxes: NEMA OS 2. Shall be used in corrosive areas.

C.  Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

D.  Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
   1.  Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

E.  Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A.  Description: Comply with ANSI/SCTE 77.
   2.  Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

5. Cover Legend: Molded lettering, "ELECTRIC", "COMMUNICATIONS" OR as indicated for each system service.

6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Hubbell: Quazite
   b. Armorcast Products Company
   c. Carson Industries LLC
   d. CDR Systems Corporation
   e. NewBasis
   f. Christy Concrete Products

2.7 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.8 SLEEVE SEALS

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

   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex Co.
   4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

   1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   2. Pressure Plates: Carbon steel. Include two for each sealing element.
   3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.
2.9 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.10 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Provide raceways in interior and exterior locations in accordance with the “Raceway Application Matrix” included on the drawings.

B. Boxes and Enclosures, Exterior Aboveground: NEMA 250, Type 3R.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

3.2 INSTALLATION

A. Install conduit in accordance with NECA “National Electrical Installation Standards”.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Install temporary closures to prevent foreign matter from entering raceways.
F. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

G. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

H. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
   1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

I. Raceways Embedded in Slabs:
   1. Raceways embedded in slabs shall be limited to above grade concrete decks. Embedded conduit shall be limited to servicing floor boxes and equipment located in open spaces away from accessible walls.
   2. Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.
   3. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
   4. Space raceways laterally to prevent voids in concrete.
   5. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   6. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   7. Conduits shall run flat. Do not allow conduits to cross.
   8. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.

J. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
   1. Run parallel or banked raceways together on common supports.
   2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

M. Tighten set screws of threadless fittings with suitable tools.

N. Terminations:
   1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
   2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

O. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

P. Provide pull string and 25% spare capacity in every branch circuit conduit.
Q. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where otherwise required by NFPA 70.

R. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

S. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

T. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals. Provide cover clips to cover space between connecting pieces.

U. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

V. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

W. Do not route feeders across roof.

X. Provide a pull box (a handhole for outdoor applications) for each conduit run that exceeds 250 feet. Provide two pull boxes (handholes for outdoor applications) for runs that exceed 500 feet.

Y. Route conduits in finished areas with exposed ceilings at underside of structural deck or as high as possible.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit.
2. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."
3. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
   b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
3.4 INSTALLATION OF UNDERGROUND HANDBOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, 42” below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL AND COMMUNICATIONS PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Through-Penetration Firestop Systems."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
   2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 7 Section "Through-Penetration Firestop Systems."

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Through-Penetration Firestop Systems."

3.8 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.9 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 26 0533
SECTION 26 0543 - UNDERGROUND DUCTS AND UTILITY STRUCTURES

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Manholes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Comply with ANSI C2.

C. Comply with NFPA 70.
1.5 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager’s written permission.

1.6 COORDINATION

A. Coordinate layout and installation of conduits with final arrangement of other utilities, site grading, and surface features as determined in the field.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1 at bends and stub-ups.

B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

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

B. Manufacturers:

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.


D. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section “Electrical Identification.”
PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

3.2 EARTHWORK

A. Excavation and Backfill: Comply with Division 2 Section "Earthwork," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

3.3 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends in rigid conduit with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Basic Electrical Materials and Methods."

E. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

F. Pulling Cord: Install 100-lbf-test nylon cord in ducts, including spares.

G. Direct-Buried Duct Banks:
   1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
   2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4
      [5] spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement
during backfill and yet permit linear duct movement due to expansion and contraction as
temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 2 Section "Earthwork" for pipes less than 6 inches in nominal diameter.

4. Install backfill as specified in Division 2 Section "Earthwork."

5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."

6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.

7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.

8. Set elevation of bottom of duct bank below the frost line.

9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.

10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

   b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

11. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

3.4 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

   2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.6 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
END OF SECTION 26 0543
SECTION 26 0553 - ELECTRICAL IDENTIFICATION

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Identification for raceway and metal-clad cable.
2. Identification for conductors and communication and control cable.
4. Warning labels and signs.
5. Instruction signs.
7. Miscellaneous identification products.

1.3 QUALITY ASSURANCE


B. Comply with NFPA 70.

1.4 COORDINATION


B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Color for Printed Legend:
   1. Power Circuits: Black letters on an orange field.
   2. Legend: Indicate system or service and voltage, if applicable.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 CONDUCTOR, COMMUNICATION AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
   1. Not less than 6 inches wide by 4 mils thick.
   2. Compounded for permanent direct-burial service.
   3. Embedded continuous metallic strip or core.
   4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS


B. Outdoor Equipment Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

2. Tensile Strength: 50 lb, minimum.
3. Temperature Range: Minus 40 to plus 185 deg F.

B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.8 WIRING DEVICE IDENTIFICATION

A. Description: Self adhesive label with black upper case letters on clear polyester label, font size 7.
PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.

B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service and Feeders More Than 400 A: Identify with orange self-adhesive vinyl label.

C. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
   1. Fire Alarm System: Red.
   3. Telecommunication System: Green and yellow.
   4. Control Wiring: Green and red.

D. Power-Circuit Conductor Identification: For conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape and marker tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

E. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number as indicated on Drawings. Identify control circuits by control wire number as indicated on shop drawings.

F. Branch-Circuit Conductor Identification: Mark junction box covers in indelible ink with the panel and breaker numbers of other circuits contained within.

G. Conductor Identification: Locate at each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection or termination point.

   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
   1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
ELECTRICAL IDENTIFICATION

a. Power transfer switches.
b. Controls with external control power connections.

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

K. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Indoor Equipment: Engraved, laminated acrylic or melamine label mechanically secured.
   b. Outdoor Equipment: Stenciled.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled: If included on project. All items may not be on project.
   a. Panelboards, electrical cabinets, and enclosures.
   b. Electrical switchgear and switchboards.
   c. Transformers.
   d. Enclosed circuit breakers.
   e. Power-generating units.
   f. Uninterruptible power supply equipment.

M. Wiring Device Identification Labels: On each faceplate install circuit designation label that is consistent with panelboard directories, and as-built plan drawings. Apply labels to receptacle faceplates centered below bottom outlet. Apply labels to toggle switch faceplates on backside.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location:

1. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
2. Conduit Markers: Provide identification for each power conduit containing conductors rated 400A or greater.

C. Apply identification devices to surfaces after completing finish work.
D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
2. Colors for 208/120-V Circuits:
   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.

3. Colors for 480/277-V Circuits:
   b. Phase B: Orange.
   c. Phase C: Yellow.

4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

I. Label information arrangement for 3 lines of text.

1. Line one shall describe the panel or equipment. Line one example: “DP-XX,” “RP-XX,” “T-XX,” “EF-XX,” etc.
2. Line two shall describe the first disconnecting means feeding this panel or equipment. Line two example: “Fed from DP-XX,” “Fed from RP-XX,” etc.
3. Line three indicates that location of the disconnecting means as identified in line two. Line three example: “First Floor Elect. Rm #XXX.”
4. Line four shall include “Via T-XX” when panel or equipment is fed from a transformer.

J. Examples:

<table>
<thead>
<tr>
<th>RP-1A</th>
<th>EF-1</th>
<th>LP-1A</th>
</tr>
</thead>
<tbody>
<tr>
<td>FED FROM DP-1A</td>
<td>FED FROM MCC-1A</td>
<td>LOCATED IN</td>
</tr>
<tr>
<td>ELECTRICAL ROOM A100</td>
<td>MECHANICAL ROOM F101</td>
<td>ELECTRICAL ROOM A100</td>
</tr>
<tr>
<td>VIA T-1A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

K. Fusible Enclosed Switches and Distribution Equipment: Install self-adhesive vinyl label indicating fuse rating and type on the outside of door on each fused switch.
L. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

M. Degrease and clean surface to receive nameplates.

N. Install nameplate and labels parallel to equipment lines.

O. Secure nameplate to equipment front using screws.

P. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

Q. Identify conduit using field painting where required.

R. Paint red colored band on each fire alarm conduit and junction box.

S. Paint bands 10 feet on center, and 4 inches minimum in width.

END OF SECTION 26 0553
## SECTION 26 0573 – OVERCURRENT DEVICE COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

#### 1.2 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E - Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D prepared by the electrical equipment manufacturer.

C. The scope of the studies shall include all new distribution equipment supplied by the equipment manufacturer under this contract as well as all directly affected existing distribution equipment at the customer facility.

#### 1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
6. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):
1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis

C. The National Fire Protection Association (NFPA)
1. NFPA 70 -National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.4 SUBMITTALS FOR REVIEW/APPROVAL

A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. Five (5) bound copies of the complete final report shall be submitted. Additional copies of the short-circuit input and output data, where required, shall be provided on CD in PDF format.

B. The report shall include the following sections:
1. Executive Summary.
2. Descriptions, purpose, basis and scope of the study.
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
6. Details of the incident energy and flash protection boundary calculations.
7. Recommendations for system improvements, where needed.
8. One-line diagram.

C. Arc flash labels shall be provided in hard copy and a copy of the computer analysis software viewer program is required to provide arc flash labels in electronic format.
1.6 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer.

C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

D. The equipment manufacturer shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.7 COMPUTER SOFTWARE PROGRAMS

A. Computer Software Programs: Subject to compliance with requirements, provide products by one of the following:

   1. EDSA Micro Corporation.
   2. SKM Systems Analysis, Inc.
   3. ESA Inc.
   4. CGI CYME.
   5. Operation Technology, Inc.

PART 2 - PRODUCTS

2.1 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E -Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D prepared by the equipment manufacturer.

2.2 DATA COLLECTION

A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner.

D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data to satisfy the study requirements.
2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY


B. Transformer design impedances shall be used when test impedances are not available.

C. Provide the following:
   1. Calculation methods and assumptions
   2. Selected base per unit quantities
   3. One-line diagram of the system being evaluated
   4. Source impedance data, including electric utility system and motor fault contribution characteristics
   5. Tabulations of calculated quantities
   6. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
   1. Electric utility’s supply termination point
   2. Incoming switchgear
   3. Unit substation primary and secondary terminals
   4. Low voltage switchgear
   5. Motor control centers
   6. Standby generators and automatic transfer switches
   7. Branch circuit panelboards
   8. Other significant locations throughout the system.

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to short circuit ratings
   2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
   3. Notify design engineer in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:
   1. Electric utility’s overcurrent protective device
2. Medium voltage equipment overcurrent relays
3. Medium and low voltage fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer’s tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points, where applicable
9. Pertinent generator short-circuit decrement curve and generator damage point
10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.6 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:

1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
3. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X"d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
4. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage
   b. Calculated fault current magnitude and angle
   c. Fault point X/R ratio
   d. Equivalent impedance

2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage
   b. Calculated symmetrical fault current magnitude and angle
   c. Fault point X/R ratio
   d. Calculated asymmetrical fault currents
      1) Based on fault point X/R ratio
      2) Based on calculated symmetrical value multiplied by 1.6
      3) Based on calculated symmetrical value multiplied by 2.7
   e. Equivalent impedance

3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage
   b. Calculated symmetrical fault current magnitude and angle
c. Fault point X/R ratio
d. No AC Decrement (NACD) Ratio
e. Equivalent impedance
f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis
g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:
   a. Current transformer ratio
   b. Current setting
   c. Time setting
   d. Instantaneous setting
   e. Recommendations on improved relaying systems, if applicable.

2. Circuit Breakers:
   a. Adjustable pickups and time delays (long time, short time, ground)
   b. Adjustable time-current characteristic
   c. Adjustable instantaneous pickup
   d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations

1. Arcing fault magnitude
2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. The contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify design engineer in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

A. The contractor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label shall include the following information, at a minimum:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date.

D. Labels shall be machine printed, with no field markings.

E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided.
3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For medium voltage switches one arc flash label shall be provided

F. Labels shall be field installed by the contractor.

END OF SECTION 26 0573
SECTION 26 0999 - ELECTRICAL TESTING

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Related Sections include the following:
1. Division 26 Section “Electrical General Requirements.”
2. Division 26 Section “Conductors and Cables.”
3. Division 26 Section “Medium Voltage Cables.”
4. Division 26 Section “Grounding and Bonding.”
5. Division 26 Section “Packaged Engine Generators.”
6. Division 26 Section “Medium-Voltage Transformers.”
7. Division 26 Section “Medium Voltage Switchgear.”
8. Division 26 Section “Transfer Switch.”
9. Division 26 Section “Switchboards.”
10. Division 26 Section “Panelboards.”
11. Division 26 Section “Dry Type Transformers (600V and Less).”
12. Division 26 Section “Fuses.”

1.2 SECTION INCLUDES

A. The Electrical Contractor shall engage the services of a recognized corporately independent N.E.T.A. certified testing firm for the purpose of performing inspections and tests as herein specified.

B. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

C. It is the intent of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design Specifications.

D. The test and inspections shall determine suitability for energization.
E. Equipment to be tested and inspected shall be the equipment shown on the one line diagram and schedules as required by part three of each individual Specification Section. In addition, all equipment that is part of an emergency distribution system shall be tested.

1.3 REFERENCES

A. All inspections and tests shall be in accordance with the latest version of the following codes and standards except as provided otherwise herein.

1. National Electrical Manufacturer’s Association - NEMA
3. Institute of Electrical and Electronic Engineers - IEEE
7. State and Local Codes and Ordinances
8. Insulated Cable Engineers Association - ICEA
9. Association of Edison Illuminating Companies - AEIC
10. Occupational Safety and Health Administration
11. National Fire Protection Association - NFPA
   a. ANSI/NFPA 70: National Electrical Code
   b. ANSI/NFPA 70B: Electrical Equipment Maintenance
   c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces

1.4 QUALIFICATIONS

A. The testing firm shall be a corporately independent testing organization, which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The lead, on site, technical person and at least 50% of the on site crew shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies in Electrical Power Distribution System Testing.

D. The testing firm shall only utilize technicians who are regularly employed by the firm on a full-time basis for testing services.

E. The Contractor shall submit proof of the above qualifications with bid proposal.

F. The terms used herewithin such as Test Agency, Test Contractor, Testing Laboratory, or Contractor Test Company, shall be construed to mean the testing organization.

G. Acceptable Testing Firms:

1. Northern Electrical Testing; Phone (248) 689-8980.
2. Utilities Instrumentation Services; Phone (734) 482-1450.
3. Emerson/High Voltage Maintenance Corporation; Phone (248) 305-5596.
4. Powertech Services, Inc.; Phone (810) 720-2280.
5. Magna Electric; Phone (248) 667-9492.

1.5 PERFORMANCE REQUIREMENTS

A. The Electrical Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the power requirements.

B. The Electrical Contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

C. The testing firm shall notify the Owner's Representative prior to commencement of any testing.

D. Any system, material or workmanship, which is found defective on the basis of acceptance tests, shall be reported to the Engineer. The Electrical Contractor shall correct all defects.

E. The testing organization shall maintain a written record of all tests and shall assemble and certify a final test report.

F. Safety and Precautions

1. Safety practices shall include, but are not limited to, the following requirements:
   a. Occupational Safety and Health Act.
   c. Applicable state and local safety operating procedures.
   d. NETA Safety/Accident Prevention Program.
   e. Owner's safety practices.
   f. National Fire Protection Association - NFPA 70E.
   g. American National Standards for Personnel Protection.

2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.

3. The testing organization shall have a designated safety representative on the project to supervise operations with respect to safety.

1.6 TEST INSTRUMENT CALIBRATION

A. Test Instrument Calibration

1. The testing firm shall have a calibration program, which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.

3. Instruments shall be calibrated in accordance with the following frequency schedule:
   a. Field instruments: Analog - 6 months maximum Digital - 12 months maximum
   b. Laboratory instruments: 12 months
   c. Leased specialty equipment: 12 months (Where accuracy is guaranteed by Lessor)

4. Dated calibration labels shall be visible on all test equipment.

5. Records must be kept up-to-date which show date and results of instruments calibrated or tested.

6. An up-to-date instrument calibration instruction and procedures shall be maintained for each test instrument.

7. Calibrating standard shall be of higher accuracy than that of the instrument tested.
B. Field Test Instrument Standards

1. All equipment used for testing and calibration procedures shall exhibit the following characteristics:
   a. Maintained in good visual and mechanical condition.
   b. Maintained in safe, operating condition.

C. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition.
2. Selection of metering equipment should be based on knowledge of the waveform of the variable being measured. Digital multi-meters may be average of RMS sensing and may include or exclude the dc component. When the variable contains harmonics of dc offset and, in general, any deviation from a pure sine wave, average sensing, average measuring RMS scaled meters may be misleading. Use of RMS measuring meters is recommended.
3. Field test metering used to check power system meter calibration must have any accuracy higher than that of the instrument being checked.
4. Accuracy of metering in test equipment shall be appropriate for the test being performed.
5. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

1.7 TEST REPORTS

A. A test report shall be generated for each piece of major equipment or groups of equipment and shall include the following:
   1. A list of visual and mechanical inspections required by Division 26 Specification Sections in a checklist or similar format.
   2. Test reports, including test values where applicable, for all required electrical tests. Clearly indicate where test values fall outside of the limits of recommended values.
   3. Summary and interpretation of test results detailing problems located and recommended corrective measures.
   4. Record of infrared scan and photos showing potential problem locations.
   5. Signed and dated by the testing firm field superintendent stating that all required tests have been completed.

B. Test reports shall be furnished to the Architect/Engineer within 14 days of the completion each test on an ongoing basis. Original copies of the reports shall be furnished directly to the Architect/Engineer by the testing company prior to formal submittal via the Contractors.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 THERMOGRAPHIC SURVEY

A. Visual and Mechanical Inspection
   1. Remove all necessary covers prior to scanning.
   2. Inspect for physical, electrical, and mechanical condition.
B. Equipment to be Scanned
   1. All components of the distribution system down to and including branch circuit panelboards and motor control centers. Return 3 months after equipment has been energized and loaded to do a final scan of all equipment.

C. Provide report indicating the following:
   1. Problem area (location of "hot spot").
   2. Temperature rise between "hot spot" and normal or reference area.
   3. Cause of heat rise.
   4. Phase unbalance, if present.
   5. Areas scanned.

D. Test Parameters
   1. Scanning distribution system with ability to detect 1°C between subject area and reference at 30°C.
   2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
   3. Infrared surveys should be performed during periods of maximum possible loading but not less than twenty percent (20%) of rated load of the electrical equipment being inspected.

E. Test Results
   1. Interpretation of temperature gradients requires an experienced technician. Some general guidelines are:
      a. Temperature gradients of 37°F to 44.6°F indicate possible deficiency and warrant investigation.
      b. Temperature gradients of 37°F to 59°F indicate deficiency; repair as time permits.
      c. Temperature gradients of 61°F and above indicate major deficiency; repair immediately.

END OF SECTION 26 0999
SECTION 26 1200 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of transformers with medium-voltage primaries:

1. Liquid-filled distribution and power transformers.
2. Dry-type distribution and power transformers.

1.3 DEFINITIONS


1.4 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, utility or manufacturer's anchorage and base recommendations, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.
B. Source quality-control test reports.

C. Follow-up service reports.

D. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C2.


E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.7 PROJECT CONDITIONS

A. Service Conditions: IEEE C37.121, usual service conditions except for the following:

1. Altitudes above 3300 feet.
2. Exposure to explosive environments.
3. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
4. Exposure to excessively high or low temperatures.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 "Hangers and Supports for Electrical Systems."

B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2. GE Electrical Distribution & Control.
3. Siemens Industries, Inc.
4. Square D; Schneider Electric.

2.2 DRY-TYPE DISTRIBUTION AND POWER TRANSFORMERS

A. Description: NEMA ST 20, IEEE C57.12.01, ANSI C57.12.50, UL 1562 listed and labeled, dry-type, 2-winding transformers.

1. Indoor, ventilated, vacuum-pressure impregnated.

B. Primary Connection: Air terminal compartment with removable door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.

C. Secondary Connection: Air terminal compartment with removable door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.

D. Secondary Connection: Transition terminal compartment with connection pattern to match switchgear.

E. Insulation Materials: IEEE C57.12.01, rated at 220 deg C.

F. Insulation Temperature Rise: 115 deg C, maximum rise above 40 deg C.

G. Basic Impulse Level: Comply with U.L. 1062.

H. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.

I. Cooling System: Class AA, self-cooled, complying with IEEE C57.12.01.

J. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.

K. Impedance: 5.75 percent.

2.3 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Electrical Identification."

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to ANSI C57.12.50.
B. Factory Tests: Perform the following factory-certified tests on each transformer:

1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
2. Ratios on rated-voltage connection and on tap extreme connections.
4. No-load loss at rated voltage on rated-voltage connection.
5. Excitation current at rated voltage on rated-voltage connection.
6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
8. Induced potential.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers and anchor to concrete bases according to utility or manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Section "Hangers and Supports for Electrical Systems."

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."
B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing"

B. Visual and Mechanical Inspection

1. Compare equipment nameplate information with single line diagram.
2. Inspect for physical damage, cracked insulators, leaks, tightness of connections, and general mechanical and electrical conditions.
3. Verify proper auxiliary device operation.
4. Verify proper liquid level in all tanks and bushings.
5. Perform specific inspections and mechanical tests as recommended by manufacturer.
6. Verify proper equipment grounding.

C. Electrical Tests

1. Perform insulation resistance tests, winding-to-winding and windings-to-ground, utilizing a meg-ohmmeter with test voltage output as shown in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Test duration shall be for 10 minutes with resistance values tabulated at 30 seconds, 1 minute, and 10 minutes. Calculate Polarization index.
2. Perform a turns ratio test between windings at all tap positions. The final tap setting is to be set at the secondary system rated voltage at full load or as directed by the Architect/Engineer.
3. Insulating liquid shall be sampled in accordance with ASTM D-923. Sample shall be laboratory tested for:
   a. Dielectric breakdown voltage: ASTM D-877 or ASTM D-1816
   b. Acid neutralization number: ASTM D-974
   c. Interfacial tension: ASTM D-971 or ASTM D-2285
   d. Color: ASTM D-1500
   e. Visual Condition: ASTM D-1524
   f. Perform dissolved gas analysis (DGA) in accordance with ANSI/IEEE C57.104 or ASTM D-3612 for transformers 500 kVA and larger.
   g. PPM water: ASTM D-1533.
4. Perform insulation power factor tests or dissipation factor tests on all windings and bushings. Overall dielectric-loss and power factor ($C_H$, $C_L$, $C_{HL}$) shall be determined. Test voltages should be limited to the line to ground voltage rating of the transformer winding.
5. Perform tests and adjustments on tap-changer, fan and pump controls, and alarm function.
6. Verify proper core grounding if accessible.
7. Perform percent oxygen test on the nitrogen gas blanket for 3000 kVA or larger.

D. Test Values

1. Perform insulation resistance tests in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Results to be temperature corrected in accordance with Table 10.14.
2. The polarization index should be used for future reference.
3. Turns ratio test results shall not deviate more than one half percent (0.5%) from either the adjacent coils or the calculated ratio.
4. Maximum power factor of liquid filled transformers corrected to 20°C shall be in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.3.
5. Bushing power factors and capacitances that vary from nameplate values by more than ten percent (10%) should be investigated.
6. Dielectric fluid should comply with N.E.T.A. Acceptance Testing Specifications, Table 10.4.

E. Remove and replace malfunctioning units and retest as specified above.

F. Test Reports: Prepare written reports to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: Perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.

2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:

   a. Adjust transformer taps.
   b. Prepare written request for voltage adjustment by electric utility.

3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.


END OF SECTION 26 1200
1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes metal-clad, circuit-breaker switchgear with the following optional components, features, and accessories:

1. Copper, silver-plated main bus at connection points.
2. Communication modules.
3. Analog instruments.
5. Relays.
8. Control battery system.
1.3 DEFINITIONS


B. GFCI: Ground-Fault Circuit Interrupter.

1.4 SUBMITTALS

A. Product Data: For each type of switchgear and related equipment, include the following:
   1. Rated capacities, operating characteristics, furnished specialties, and accessories for individual interrupter switches and circuit breakers.
   2. Utility or manufacturer’s anchorage and base recommendations.

B. Shop Drawings: For each type of switchgear and related equipment, include the following:
   1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:
      a. Tabulation of installed devices with features and ratings.
      b. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
      c. Drawing of cable termination compartments showing preferred locations for conduits and indicating space available for cable terminations.
      d. Floor plan drawing showing locations for anchor bolts.
      e. Current ratings of buses.
      f. Short-time and short-circuit ratings of switchgear assembly.
      g. Nameplate legends.
   2. Wiring Diagrams: For each type of switchgear and related equipment, include the following:
      a. Power, signal, and control wiring.
      b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
      c. Schematic control diagrams.
      d. Diagrams showing connections of component devices and equipment.
      e. Schematic diagrams showing connections to remote devices.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where piping and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Identify field measurements.

D. Samples: Representative portion of mimic bus with specified finish. Manufacturer’s color charts showing colors available for mimic bus.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For switchgear and switchgear components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section “Operation and Maintenance Data,” include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Source Limitations: Obtain each type of switchgear and associated components through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with IEEE C2.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections of lengths that can be moved past obstructions in delivery path.

B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:

1. Ambient temperature not exceeding 122 deg F.

B. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.
C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager’s written permission.

1.8 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 “Hangers and Supports for Electrical Systems.”

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Six of each type and rating used. Include spares for future transformers, control power circuits, and fusible devices.
2. Indicating Lights: Six of each type installed.
3. Touchup Paint: Three containers of paint matching enclosure finish, each 0.5 pint.

B. Maintenance Tools: Furnish tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include the following:

1. Fuse-handling tool.
2. Extension rails, lifting device, transport or dockable dolly or mobile lift, and all other items necessary to remove circuit breaker from housing and transport to remote location.
3. Racking handle to move circuit breaker manually between connected and disconnected positions, and a secondary test coupler to permit testing of circuit breaker without removal from switchgear.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Description: Factory assembled and tested, and complying with IEEE C37.20.1.

B. Ratings: Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system.

C. System Voltage: 13.2 kV nominal; 15 kV maximum.
2.2 METAL-ENCLOSED INTERRUPTER SWITCHGEAR

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

1. Eaton Corporation; Cutler-Hammer Products.
2. Siemens Industries, Inc.
3. Square D; Schneider Electric.

B. Comply with IEEE C37.20.3.

C. Comply with IEEE C37.20.7. Provide arc-resistant switchgear, Type 1.


E. Ratings: Comply with standard ratings designated in IEEE C37.20.3 for maximum-rated voltage specified.


F. Interrupter Switches: Stationary, gang operated, and suitable for application at maximum short-circuit rating of integrated switchgear assembly.

1. Rating: 600-A continuous duty and load break.
2. Duty-Cycle, Fault Closing: 40,000 asymmetrical A.
3. Switch Action: No external arc and no significant quantities of ionized gas released into the enclosure.
4. Switch Construction: Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.
5. Phase Barriers: Full length of switchblades and fuses for each pole; designed for easy removal; allow visual inspection of switch components if barrier is in place.
6. Protective Shields: Cover live components and terminals.
7. Fuses: De-energized if switch is open.

G. Mechanical Interlock: Prevent opening switch compartment door unless switchblades are open, and prevent closing switch if door is open.

H. Window: Permit viewing switchblade positions if door is closed.

I. Power Fuses: Comply with the following and with applicable requirements in NEMA SG 2:

1. Indicator: Integral with each fuse to indicate when it has blown.
2. Mounting: Positively held in position with provision for easy removal and replacement from front without special tools.
3. Expulsion Fuses: Furnished in disconnect-type mountings and renewable with replacement fuse units. Gases emitted on interruption are controlled and silenced by chambers designed for that purpose.

2.3 METAL-CLAD, CIRCUIT-BREAKER SWITCHGEAR

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

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Distribution & Control.
3. Siemens Industries, Inc.
4. Square D; Schneider Electric.

B. Comply with IEEE C37.20.3.

C. Comply with IEEE C37.20.7. Provide arc-resistant switchgear, Type 2.

D. Nominal Interrupting-Capacity Class: 500 MVA.

E. Ratings: Comply with IEEE C37.04.


F. Circuit Breakers: Three-pole, single-throw, electrically operated, drawout-mounting units using three individual, vacuum-sealed interrupter modules and including the following features:

1. Designed to operate at rated voltage to interrupt fault current within its rating within [three] [five] cycles of trip initiation. For systems with X/R ratio of 17 or less, transient voltage during interruption shall not exceed twice the rated line-to-ground voltage of the system.
2. Contact-Wear Indicator: Readily accessible to field maintenance personnel.
3. Minimum of six Type A and six Type B spare contacts.
4. Interchangeability: Circuit breakers are interchangeable with vacuum circuit breakers of same current and interrupting ratings.
5. Operating Mechanism: Electrically charged, mechanically and electrically trip-free, stored-energy operated.
   a. Closing speed of moving contacts to be independent of both control and operator.
   b. Design mechanism to permit manual charging and slow closing of contacts for inspection or adjustment.
      1) Control Power: 120-V ac for closing and tripping.
   c. Provide shunt trip capability independent of overcurrent trip.

G. Test Accessories: Relay and meter test plugs.

H. Low-DC-Voltage Alarm: Switchgear shall have a monitor for dc control power voltage with a remote alarm located where indicated. Alarm shall sound if voltage falls to an adjustable value to indicate an impending battery failure. Factory set alarm value at 80 percent of full-charge voltage.

I. Grounding and Testing Device: Suitable for phasing out, testing, and grounding switchgear bus or feeder if device is installed in place of circuit breaker. Include the following:

1. Portable Grounding and Testing Device: Interchangeable with drawout-mounting, medium-voltage circuit breakers to provide interlocked electrical access to either bus or feeder; electrically operated.
2. System control cabinet permanently mounted near switchgear.
3. Portable Remote-Control Station: For grounding and testing device.
4. Control-Cabinet Coupler Cable: Of adequate length to connect device inserted in any switchgear cubicle and control cabinet.
5. Remote-Control Coupler Cable: 50 feet long to connect control cabinet and portable remote-control station.
6. Permanent Control Power Wiring: From control cabinet to power source.
7. Protective Cover: Fabricated of heavy-duty plastic and fitted to device.
8. Approval of Grounding and Testing Device System: Obtain approval of final system design from utility company and agency designated by Owner to handle future maintenance of medium-voltage switchgear.
2.4 FABRICATION

A. Outdoor Enclosure: Galvanized steel, weatherproof construction; integral structural-steel base frame with factory-applied asphaltic undercoating.
   1. Each compartment shall have the following features:
      a. Structural design and anchorage adequate to resist loads imposed by 125-mph wind.
      b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
      c. Louvers equipped with insect and rodent screen and filter, and arranged to permit air circulation while excluding rodents and exterior dust.
      d. Hinged front door with locking provisions.

B. Enclosure Finish for Outdoor Units: Manufacturer’s standard finish under surfaces treated with corrosion resistant undercoating. Paint color shall be per Owner provided paint chip color.

C. Bus Transition Unit: Arranged to suit bus and adjacent units.

D. Incoming-Line Unit: Arranged to suit incoming line.

E. Outgoing Feeder Units: Arranged to suit distribution feeders.

F. Auxiliary Compartments: Arranged to suit house meters, relays, controls, and auxiliary equipment; isolated from medium-voltage components.

G. Key Interlocks: Arranged to effect interlocking schemes indicated.

H. Provisions for Future Key Interlocks: Mountings and hardware required for future installation of locks, where indicated.

2.5 COMPONENTS

A. Main Bus: Copper, silver plated at connection points; full length of switchgear.

B. Ground Bus: Copper, silver plated or copper, tin plated; minimum size 1/4 by 2 inches; full length of switchgear.

C. Bus Insulation: Covered with flame-retardant insulation.

   1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
   2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

E. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems, listed and labeled by an NRTL, and with the following features:
1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.

2. Switch-selectable digital display with the following features:
   a. Phase Currents, Each Phase: Plus or minus 1 percent.
   b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
   c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
   d. Three-Phase Real Power: Plus or minus 2 percent.
   e. Three-Phase Reactive Power: Plus or minus 2 percent.
   f. Power Factor: Plus or minus 2 percent.
   g. Frequency: Plus or minus 0.5 percent.
   h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
   i. Accumulated energy, in megawatt hours, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

3. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements according to Division 26 Section "Electrical Power Monitoring and Control."

4. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

   1. Install in cable termination compartments in each phase of circuit.
   2. Coordinate rating with circuit voltage.

G. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
   1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
   2. Conductors sized according to NFPA 70 for duty required.

H. Accessories
   1. 1 - Maintenance tool for manually charging the breaker closing spring and manually opening the shutter.
   2. 1 - Levering crank for moving the breaker between test and connected positions.
   3. 1 - Test jumper for electrically operating the breaker while out of its compartment.
   4. 1 - Breaker lifting yoke used for attachment to breaker for lifting breaker on or off compartment rails.
   5. 1 - Set of rail extensions and rail clamps.
   6. Provide infrared windows at each section of gear, suitable to perform infrared readings at the lugs and bus, when energized, without opening gear to exposed live parts.

2.6 IDENTIFICATION

A. Materials: Refer to Division 26 Section "Electrical Identification." Identify units, devices, controls, and wiring.

2.7 SOURCE QUALITY CONTROL

A. Before shipment of equipment, perform the following tests and prepare test reports:
1. Production tests on circuit breakers according to ANSI C37.09.
2. Production tests on completed switchgear assembly according to IEEE C37.20.2.

B. Assemble switchgear and equipment in manufacturer's plant and perform the following:

1. Functional tests of all relays, instruments, meters, and control devices by application of secondary three-phase voltage to voltage circuits and injection of current in current transformer secondary circuits.
2. Functional test of all control and trip circuits. Connect test devices into circuits to simulate operation of controlled remote equipment such as circuit-breaker trip coils, close coils, and auxiliary contacts. Test proper operation of relay targets.

C. Prepare equipment for shipment.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

2.8 FACTORY FINISHES

A. Finish: Manufacturer's standard color finish applied to equipment before shipping. Provide color chip color for final color selection by Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive switchgear for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchgear and anchor to concrete bases according to utility, manufacturer’s written instructions, seismic codes at project, N.E.C.A. 430-2006 and requirements in Division 26 section “Hangers and Supports for Electrical Systems.”

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section “Electrical Identification.”

B. Diagram and Instructions:

1. Frame under clear acrylic plastic on front of switchgear.
a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.4 CONNECTIONS

A. Cable terminations at switchgear are specified in Division 26 Section "Medium-Voltage Cables."

B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Sections "Conductors and Cables" and "Medium-Voltage Cables."

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect switchgear, wiring, components, connections, and equipment installation. Test and adjust components and equipment.
2. Assist in field testing of equipment including pretesting and adjusting of automatic power factor correction units.

C. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing."

1. Visual and Mechanical Inspection

   a. Inspect for physical, electrical and mechanical condition.
   b. Compare equipment nameplate information with construction document one line diagram and report discrepancies.
   c. Check for proper anchorage, required area clearances, physical damage, and proper alignment.
   d. Inspect all bus connections for high resistance by infrared survey after equipment has been energized.
   e. Test all electrical and mechanical interlock systems for proper operation and sequencing.

       1) Closure attempt shall be made on locked open devices. Opening attempt shall be made on locked closed devices.

   f. Inspect accessible insulators for evidence of physical damage or contaminated surfaces.
   g. Verify that fuse and/or circuit breaker sizes and types correspond to Drawings.
h. Verify proper ground connection to ground mat.
i. Verify proper barrier and shutter installation and operation.
j. Lubrication
   1) Verify appropriate contact lubricant on moving current carrying parts.
   2) Verify appropriate lubrication on moving and sliding surfaces.

k. Exercise all active components.
l. Inspect all mechanical indicating devices for proper operation.
m. Verify that current and potential transformer ratios correspond to Drawings.

2. Electrical Tests

a. Perform insulation resistance tests on each bus section, phase-to-phase and phase-to-ground for one (1) minute.
b. Perform an over-potential test on each bus section, each phase-to-ground, for one (1) minute at values manufacturer's recommended potential.
c. Perform phasing check on double-ended switchgear to ensure proper bus phasing from each source.
d. Determine accuracy of volt and amp readings for all meters and verify multipliers
e. Perform control wiring performance test. Use the elementary diagrams of the switchgear to identify each remote control and protective device. Conduct tests to verify satisfactory performance of each control feature.
f. Perform secondary voltage energization test on all control power circuits and potential circuits. Check voltage levels at each point on terminal boards and at each terminal on devices.
g. Perform current injection tests on the entire current circuit in each section of switchgear.
   1) Perform current tests by primary injection, where possible, with magnitudes such that a minimum of 1.0 ampere flows in the secondary circuit.
   2) Where primary injection is impractical, utilize secondary injection with a minimum current of 1.0 ampere.
   3) Test current at each device.

h. Control Power Transformers - Dry Type

   1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
   2) Verify proper primary and secondary fuse ratings.
   3) Verify proper interlock function and contact operation.
   4) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to proper secondary voltage. Check potential at all devices.
   5) Verify proper secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.

i. Perform tests on all instrument transformers as required elsewhere in this Specification.

j. Potential Transformer Circuits

   1) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to proper secondary voltage. Check for proper potential at all devices.
   2) Verify secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.

D. Test Values
1. Insulation resistance test to be performed in accordance with N.E.T.A. Acceptance Testing Specifications, Table 100.1. Values of insulation resistance less than manufacturer's minimum should be investigated.

2. Over-potential test voltages shall be applied in accordance with N.E.T.A. Acceptance Testing Specifications, Table 100.2. Test results are evaluated on a go, no-go basis by slowly raising the test voltage to the required value. The final test voltage shall be applied for one (1) minute.

E. Report test results in writing.

F. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

A. Set field-adjustable, protective-relay trip characteristics according to results in Division 26 Section "Overcurrent Protective Device Coordination."

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 26 1300
1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 750 kVA:

1. Distribution transformers.
2. Buck-boost transformers.
3. Isolation transformers.
4. Control and signal transformers.

B. Related Section includes the following:

1. Division 26 Section "Electrical General Requirements."
2. Division 26 Section "Grounding and Bonding."
3. Division 26 Section "Conductors and Cables."
4. Division 26 Section "Raceways and Boxes."

1.3 REFERENCES

A. ANSI/IEEE C57.12.9: Test Code for Dry-Type Distribution and Power Transformers
B. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum)
C. NEMA ST 1: Specialty Transformers
D. NEMA ST 20: Dry Type Transformers for General Applications
E. NEMA TP 1: Guide for Determining Energy Efficiency for Distribution Transformers
H. NFPA 70: National Electrical Code
I. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors
J. UL 486B: Wire Connectors for Use with Aluminum Conductors
K. UL 506: Specialty Transformers
L. UL 1561: Dry-Type General Purpose and Power Transformers

1.4 SUBMITTALS
A. Product Data Include rated nameplate data, capacities, weights, dimensions, utility or manufacturer’s anchorage and base recommendations, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
   1. Transformer Inrush: Provide time-current coordination curves demonstrating transformer inrush and ANSI damage curves with primary overcurrent device selections to clear inrush yet still protecting damage curve.
B. Shop Drawings: Wiring and connection diagrams.
C. Qualification Data: Testing agency.
D. Source quality-control test reports. Include loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.
E. Output Settings Reports: Record of tap adjustments specified in Part 3.

1.5 QUALITY ASSURANCE
A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined in OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Transformer Inrush: Provide time-current coordination curves demonstrating transformer inrush and ANSI damage curves with primary overcurrent device selections to clear inrush yet still protecting damage curve.
2. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise onsite testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C 57.12.91.

D. Comply with NFPA 70.

E. Energy-Efficient Transformers Rated 15 kVA and Larger: Certified as meeting NEMA TP 1, Class 1 efficiency levels when tested according to NEMA TP 2.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer’s written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

B. Store, protect, and handle products to site under provisions of Division 26 section “Electrical General Requirements.”

C. Deliver transformers individually wrapped for protection and mounted on shipping skids.

D. Accept transformers on site. Inspect for damage.

E. 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.

F. Handle in accordance with manufacturer’s written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 “Hangers and Supports for Electrical Systems.”

B. Coordinate installation of wall-mounting and structure-hanging supports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2. GE Electrical Distribution & Control.
3. Siemens Industries, Inc.
4. Square D/Groupe Schneider NA.
2.2 MATERIALS

A. Cores: Grain-oriented, non-aging silicon steel.

B. Coils: Continuous windings without splices, except for taps.
   1. Internal Coil Connections: Brazed or pressure type.
   2. Coil Material: Copper.

C. Vibration Isolation: Isolate core and coil from enclosure using vibration-absorbing mounts.

D. Grounding: Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

2.3 DISTRIBUTION TRANSFORMERS

A. Description: Factory-assembled and tested, air cooled, dry-type transformer rated for 60 Hz operation. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers with base KVA as indicated without the use of internal cooling fans.

C. Provide transformers that are internally braced to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems".

D. Cores: One leg per phase.

E. Indoor Enclosure: Ventilated, NEMA 250, Type 2. Provide lifting eyes or brackets.

F. Indoor Transformer Enclosure Finish: Comply with NEMA 250 for "Indoor Corrosion Protection."
   1. Finish Color: Gray.

G. Insulation Class (15 kVA and larger): 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature TP-1 compliant.

H. Insulation Class (less than 15 kVA): 185 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

I. Basic Impulse Level: 10 kV.

J. Taps for Transformers Smaller Than 3 kVA: None.

K. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

L. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

M. Case Temperature: Do not exceed 35 degrees C rise above ambient at warmest point.

N. Mounting: Suitable for mounting as indicated.

O. Wall Brackets: Manufacturer's standard brackets.
2.4 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Provide the following factory tests on each unit provided in accordance with NEMA ST 20:
   1. Voltage ratio.
   2. Polarity and phase relation.
   3. No load losses.
   4. Impedance (501 kVA and larger).
   5. Applied and induced potential.

C. Provide the factory tests on the actual transformers provided or on similar units identical to those provided in accordance with NEMA ST 20:
   1. Impedance (less than 501 kVA).
   2. Temperature rise.
   3. Audible sound level.
   4. Full load losses.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls and floors for suitable mounting conditions where transformers will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

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

B. Install floor mounted transformers on and anchor to concrete bases according to manufacturer's recommendations, seismic codes at Project, and requirements in Division 26 section "Vibration and Seismic Controls for Electrical Systems."
   1. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

C. Identification: Engraved metal or laminated-plastic nameplate mounted with corrosion resistant screws. Provide nameplate according to Division 26 Section “Electrical Identification” indicating the following:
3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

C. Provide conduit according to Division 26 Section "Raceways and Boxes" for connections to transformer case. Make conduit connections to side panel of enclosure.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Check for damage and tighten connections prior to energizing transformer.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

1. Verify that electrical wiring installation complies with manufacturer’s written installation requirements.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing" for transformers 75KVA and above:

1. Visual and Mechanical Inspection
   
   a. Inspect for physical damage, cracked insulators, tightness of connections, defective wiring and general mechanical and electrical conditions.
   
   b. Verify proper core grounding.
   
   c. Verify proper equipment grounding.
   
   d. Compare equipment nameplate with single line diagram and report discrepancies.

2. Electrical Tests
   
   a. Perform insulation resistance tests, winding-to-winding and windings-to-ground, utilizing a meg-ohmmeter with test voltage output in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Test duration shall be for 10 minutes with resistance values tabulated at 30 seconds, 1 minute, and 10 minutes. Calculate Polarization index.
   
   b. Perform a turns ratio test between windings at every tap position. The final tap setting is to be set at the secondary system rated voltage at full load or as directed by the Architect/Engineer.
   
   c. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

3. Test Values
a. Perform insulation resistance tests in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Results to be temperature corrected in accordance with Table 10.14.

b. The polarization index should be above 1.2 unless an extremely high value is obtained initially, such that when doubled will not yield a meaningful value.

c. Turns ratio test results shall not deviate more than one half percent (0.5%) from either the adjacent coils or the calculated ratio.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 5 percent. Submit recording and tap settings as test results.

B. Adjust buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.


END OF SECTION 26 2200
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Isolation power panelboards.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. RFI: Radio-frequency interference.
D. RMS: Root mean square.
E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, surge protective device, accessory, and component indicated. Include dimensions and manufacturers’ technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Related Submittals:

1. Provide overcurrent device coordination study to demonstrate proper overcurrent device ratings, adjustments, and settings.

C. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

   a. Enclosure types and details for types other than NEMA 250, Type 1.
   b. Bus configuration, current, and voltage ratings.
   c. Short-circuit current rating of panelboards and overcurrent protective devices.
   d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

D. Field quality-control test reports including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:

1. Manufacturer’s written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.
C. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Six spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

   a. Eaton Corporation; Cutler-Hammer Products.
   c. Siemens Industries, Inc.
   d. Square D.

2.2 MANUFACTURED UNITS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Mounting as noted on panel schedules. NEMA PB 1, Type 1.

1. Cabinet Front: Flush or surface cabinet as noted on the Drawings.

   a. Siemens/Eaton – Figure 4 hinge to box w/piano hinge.
   b. GE – FGB (front hinge to box).
   c. Square D – Continuous piano hinge trim.
2. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

C. Phase and Ground Buses:
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box as called out on panel schedules.

D. Conductor Connectors: Suitable for use with conductor material.
1. Main and Neutral Lugs: Mechanical type.
2. Ground Lugs and Bus Configured Terminators: Compression type.
3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
4. Double Lugs: Mechanical type mounted at location of main incoming lugs.

E. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

F. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 PANELBOARD SHORT-CIRCUIT RATING
A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 DISTRIBUTION PANELBOARDS
A. Main bus bars, neutral and ground, shall be copper and sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.

B. Doors: Secured with vault-type latch with tumblers lock; keyed alike. Omit for fused-switch panelboards.

C. Main Overcurrent Protective Devices: Circuit breaker.

D. Branch Overcurrent Protective Devices:
   1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
   2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
   3. Fused switches.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS
A. Main bus bars, neutral and ground, shall be sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.

B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
2.6 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.


      a. Circuit Breakers 250A and Larger: Magnetic trip element with front-mounted, field-adjustable trip setting with restricted access cover.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

   1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   2. Do not use tandem circuit breakers.

C. Circuit Breaker Selection for Transformer Primary Protection:

   1. Circuit Breaker Selection for Transformer Primary Protection: Provide circuit breakers with time-current characteristics to clear transformer inrush currents while still providing protection for the ANSI through-fault protection curve. Provide circuit breakers with adjustable magnetic trip or electronic trip units as necessary to provide time-current curve shaping to achieve long time trip indicated on drawings, inrush coordination and damage protection.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."

C. Mount top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.

D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Install overcurrent protective devices and controllers.

   1. Set field-adjustable switches and circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Stub four 1-inch (27-GRC) empty conduits from recessed panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads or created by retrofitting. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Coordinate final directory room names and numbers with Owner.

C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters. Perform electrical tests on all breakers and switches 200A and above or that constitute a component of an emergency distribution system. Main circuit breakers in branch circuit panelboards 225A and below are not required to be tested.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

E. Testing and Certification (Isolation Power Panels)

1. Provide manufacturer's engineer or technician for final testing of Isolated Power Panel and the related system as follows.

   a. Simulate faults at each receptacle to ascertain correct function of the L.I.M.
   b. Check the calibration of the L.I.M. meter and record readings.
   c. Record and date all data in permanent log book.
   d. Certify that the system is properly installed and in correct working order.
   e. Turn over to the hospital maintenance department a set of test equipment consisting of a ground integrity tester, current leakage tester, and plug in the L.I.M. tester.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 2416
SECTION 26 2500 - ENCLOSED BUS ASSEMBLIES

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following:
1. Feeder-bus assemblies.
2. Plug-in bus assemblies.

1.3 DEFINITIONS
A. SPD: Surge Protective Device.

1.4 SUBMITTALS
A. Product Data: Include technical descriptions, dimensions, rated capacities, weights, finishes, and accessories for the following:
1. Feeder-bus assemblies.
2. Plug-in bus assemblies.

B. Shop Drawings: For each type of and plug-in device.
1. Show fabrication and installation details for enclosed bus assemblies. Include plans, elevations, and sections of components. Designate components and accessories, including clamps, brackets, hanger rods, connectors, fire stops, weather stops, straight lengths, and fittings.

2. Indicate required clearances, method of field assembly, and location and size of each field connection.

3. Detail connections to switchgear, switchboards, transformers, and panelboards.


C. Product Certificates: For each type of enclosed bus assembly, signed by product manufacturer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For enclosed bus assemblies to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain enclosed bus assemblies and plug-in devices through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA BU 1, "Busways."

E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle enclosed bus assemblies according to NEMA BU 1.1, "General Instructions for Proper Handling, Installation, Operation and Maintenance of Busway Rated 600 Volts or Less."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. General Electric Company; Electrical Distribution & Control Division.
2.2 PLUG-IN DEVICES

A. Fusible Switches: NEMA KS 1, heavy duty; with rejection-type fuse clips to accommodate specified fuses; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position. See Division 26 Section "Fuses" for fuses and fuse installation requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install bus-assembly plug-in units. Support connecting conduit independent of plug-in unit.

3.2 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 ADJUSTING

A. Set field-adjustable, circuit-breaker trip ranges and overload relay trip settings as indicated.

3.4 CLEANING

A. After completing system installation, clean enclosed bus assemblies, supports, and accessories. Inspect exposed finishes and repair damaged finishes. Remove scratches, burrs, and surface defects.

3.5 PROTECTION

A. Provide final protection to ensure that moisture does not enter bus assembly.

END OF SECTION 26 2500
1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Single and duplex receptacles
2. Ground-fault circuit interrupter receptacles
3. Integral surge suppression receptacles
4. Isolated-ground receptacles.
6. Device wall plates.
7. Pin and sleeve connectors and receptacles.
8. Floor service fittings
9. Poke-through assemblies
10. Access floor boxes
11. Service poles.
12. Receptacles with integral USB charger.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.
C. PVC: Polyvinyl chloride.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 REFERENCES


D. NEMA FB 11: Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.

E. NEMA WD 1: General Requirements for Wiring Devices.


G. UL 20: General-Use Snap Switches.

H. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

I. UL 486B: Wire Connectors for Use with Aluminum Conductors.

J. UL 498: Electrical Attachment Plugs and Receptacles.

K. UL 943: Ground Fault Circuit Interrupters.

L. NECA 130-2010: Installing and Maintaining Wiring Devices.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer’s catalog information showing dimensions, colors, and configurations for each type of product indicated.

1.6 QUALITY ASSURANCE

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

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.
1.7 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 RECEPTACLES

A. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498. Configuration 5-20R duplex receptacle.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hubbell Incorporated; Wiring Device-Kellems HBL 5362.
      b. Bryant 5362.
      c. Pass & Seymour/Legrand; Wiring Devices Division 5362

B. GFCI Receptacles: Straight blade, non-feed-through type, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hubbell Incorporated; Wiring Device-Kellems GF8300.
      b. Bryant.
      c. Pass & Seymour/Legrand; Wiring Devices Division 2095HG.

2.2 WALL PLATES

A. Manufacturers:
   1. Provide wall plates and corresponding wiring devices from same manufacturer.

B. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces:
      a. 0.035-inch- (1-mm-) thick, satin-finished stainless steel
      b. Steel with white baked enamel, suitable for field painting
      c. Smooth, high-impact thermoplastic
      d. 0.04-inch- (1-mm-) thick, brushed brass with factory polymer finish
      e. 0.05-inch- (1.2-mm-) thick anodized aluminum
      f. 0.04-inch- (1-mm-) thick steel with chrome-plated finish
3. Material for Unfinished Spaces:
   a. Galvanized steel

4. Material for Wet Locations: Gasketed Thermoplastic with spring-loaded cover, and listed and labeled for use in "wet locations."
   a. Manufacturers:
      1) Bryant RB5752-0 (polycarbonate), Hubbell.
      2) Pass & Seymour WIUC10C (polycarbonate)
      3) ArrowHart WIU-1 (polycarbonate).
      4) Red Dot CKNM (polycarbonate).

5. Material for Wet Locations: Gasketed Cast aluminum with spring-loaded cover, and listed and labeled for use in "wet locations."
   a. Manufacturers:
      1) Red Dot Model CKSUV, Thomas & Betts.
      2) ArrowHart WIUM-Series.

2.3 FINISHES

A. Color:
   1. Wiring Devices Connected to Normal Power System: Brown, unless otherwise indicated or required by NFPA 70.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Prior to installation of devices, verify wall openings are neatly cut and will be completely covered by wall plates, clean debris from outlet boxes and provide extension rings to bring outlet boxes flush with finished surface.

C. Install devices and assemblies level, plumb, and square with building lines.

D. Arrangement of Devices:
   1. Coordinate locations of outlet boxes provided under Division 26 Section "Raceways and Boxes" to obtain mounting heights indicated on Drawings.
   2. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top.
   3. Where multiple switches, dimmers, and/or occupancy sensors are adjacent to each other, provide a single cover plate. Custom fabricate, if required, for all combinations. Provide separate boxes or barriers as required for the application.
   4. Install horizontally mounted receptacles with grounding pole on the left.
5. Install GFCI receptacles so that the “Push To Test” and “Reset” designations can be read correctly. If printed in both directions, install with ground pole on top.
6. Install switches with OFF position down.

E. Install cover plates on switch, receptacle, and blank outlets in finished areas.

F. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

G. Remove wall plates and protect devices and assemblies during painting.

H. Coordinate installation of access floor boxes with access floor system provided by Architectural trades.

I. Install properly oriented access floor boxes into cutouts in access floor tiles and secure to tiles per Manufacturer’s instructions.

J. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

K. Adjust devices and wall plates to be flush and level. Three corners of wall plates must be in contact with wall surfaces. Devices shall be solidly mounted against the box.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Electrical Identification."

1. Receptacles: Identify panelboard and circuit number from which served. Use adhesive label as specified in Division 26 Section “Electrical Identification” with black-filled lettering on face of wall plate, and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding." Connect wiring device grounding terminal to outlet box with bonding jumper. Use of quick ground strap or screw is not acceptable.

B. Connect wiring according to Division 26 Section "Conductors and Cables." Connect wiring devices by wrapping conductor around screw terminal or by using back wiring and tightening the screw securely.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Inspect each wiring device for defects.
2. Operate each wall switch with circuit energized and verify proper operation.
3. After installing wiring devices and after electrical circuitry has been energized, test each receptacle for proper polarity, ground continuity, and compliance with requirements.
4. Test each GFCI receptacle for proper operation with both local and remote fault simulations according to manufacturer's written instructions.
B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 26 2726
SECTION 262813 - FUSES

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following:

1. Cartridge fuses rated 600 V and less for use in switchboards.

1.3 SUBMITTALS
A. Product Data: Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Time-current curves, coordination charts and tables, and related data.
4. Fuse size for elevator feeders and elevator disconnect switches.

B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:
   a. Let-through current curves for fuses with current-limiting characteristics.
   b. Time-current curves, coordination charts and tables, and related data.
   c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with:
   1. NEMA FU 1 – Low Voltage Cartridge Fuses.
   2. NFPA 70 – National Electrical Code.
   3. UL 198C – High-Interrupting-Capacity Fuses, Current-Limiting Types.
   4. UL 198E – Class R Fuses.
   5. UL 512 – Fuseholders.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Quantity equal to 10% percent of each fuse type and size, but no fewer than 5 of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Bussmann, Inc.
3. Ferraz Shawmut, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

1. Service Entrance: Class L, fast acting T, fast acting.
2. Feeders: Class L, fast acting.
3. Motor Branch Circuits: Class RK5, time delay.
4. Other Branch Circuits: Class RK5, time delay.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fuses shall be shipped separately. Any fuses shipped installed in equipment, shall be replaced by the Electrical Contractor with new fuses as specified above prior to energization at no additional expense to Owner. All fuses shall be stored in moisture free packaging at job site and shall be installed immediately prior to energization of the circuit in which it is applied.

B. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

A. Install labels indicating fuse rating and type on outside of the door on each fused switch.

END OF SECTION 26 2813
THIS SECTION APPLIES TO COLLEGE OF PHARMACY DIESEL GENERATOR

SECTION 26 3213P - PACKAGED ENGINE GENERATORS - DIESEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged engine generator sets for standby power supply with the following features:

1. Diesel engine.
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Outdoor enclosure.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged engine generator sets for standby power supply with the following features:

1. Diesel engine.
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Outdoor enclosure.
1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

1.4 SUBMITTALS

A. Product Data: Include the following:
   1. Data on features, components, accessories ratings, and performance.
   2. Thermal damage curve for generator.
   3. Time-current characteristic curves for generator protective device.
   4. Manufacturer’s anchorage and base recommendations.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Submit shop drawings showing plan and elevation views with overall interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.
   2. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
   3. Internal Wiring Diagrams: For engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, remote radiator, and remote annunciator.

C. Source quality-control test reports.
   1. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
   3. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
   5. Certified report of exhaust emissions showing compliance with applicable EPA regulations.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. Include the following:
   1. List of tools and replacement items recommended to be stored at the Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
   2. Include instructions for normal operation, routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

F. Warranty: Special warranty specified in this Section.
1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged generator sets and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 37.

E. Comply with NFPA 70.

F. UL2200 Listed and labeled

G. Comply with NFPA 110 requirements for Level 2 emergency power supply system.

H. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

1. Provide engines used for standby applications that carry certification of compliance with current EPA emissions requirements or provide engines which comply with EPA emissions requirements and provide the necessary field testing to certify EPA emissions compliance.

I. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 "Hangers and Supports for Electrical Systems."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion and Owner's Acceptance and Start-Up.

1.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide cost breakdown for 12, 24 and 36 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts and supplies as used in manufacture and installation of original equipment.
1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One full set plus one of each.
2. Indicator Lamps: One full set plus one of each.
3. Filters: One full set plus one of each.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide Caterpillar; Engine Div. or a comparable product by one of the following:

1. Caterpillar; Engine Div.
2. Kohler Co; Generator Division.

2.2 ENGINE-GENERATOR SET

A. Packaged engine-generator set shall be a coordinated assembly of compatible components.

B. Safety Standard: Comply with ASME B15.1 and UL 2200.

C. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components.

D. Capacities and Characteristics:

1. Power Output Ratings: 2500 kW, 13,200V, 3 PH, 3 W
2. Output Connections: Three-phase, three wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

E. Generator-set performance for sensitive loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
2. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
3. Steady-State Voltage Operational Bandwidth: 2 percent of rated output voltage from no load to full load.
4. Steady-State Voltage Modulation Frequency: Less than 1 Hz.
5. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
6. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.

7. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

8. Transient Frequency Performance: Less than 2-Hz variation for a 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.

9. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. The telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

10. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, the system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.


12. Start Time: Comply with NFPA 110, Level 2, system requirements.

F. Provide guards for all external rotating parts to prevent accidental injury. Guards shall be securely bolted to the generator but removable for maintenance. Guards shall be painted with a rust inhibiting primer and an epoxy based gloss topcoat. Guards shall comply with Michigan OSHA requirements.

G. Service Conditions:

1. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

   a. Ambient Temperature: Minus 15 to plus 40 deg C.
   b. Relative Humidity: 0 to 95 percent.
   c. Altitude: Rated for altitude at project location.

2.3 ENGINE

A. Fuel: Fuel oil, Grade DF-2

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: The following items are mounted on engine or skid:

   1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
   2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
   3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Engine Fuel System:

   2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
   3. Provide dual 5 micron fuel filters at fuel supply line.
   4. Provide pressure gauge on suction and discharge sides of both filters and shut-off valves at both sides of each filter.
E. Coolant Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F (32 degrees C), and suitable for operation on 120 volts AC.

F. Governor: Adjustable Isosynchronous with speed sensing.

G. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
   1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
   2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
   3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
   4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
      a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
      b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

H. Muffler/Silencer: Hospital grade, critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Minimum sound attenuation of 25 dB at 500 Hz.
   2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less.
   3. Muffler/Silencer to be mounted inside outdoor enclosure.
   4. Exhaust to be side discharge at radiator area.

I. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

J. Starting System: 24-V electric, with negative ground.
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. Cranking Cycle: As required by NFPA 110 for system level specified.
   4. Battery: Flooded cell type with adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
   7. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
      a. Operation: Equalizing-charging rate of 20 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall
then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.


e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30:

B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:

1. Tank level indicator.
2. Capacity: Fuel tank size shall be 400 gallons.
3. Vandal-resistant fill cap.
5. Dual fuel filters.
6. Provide monitor of fuel tank for 50% and 80% fuel level. Interface with Siemens Building Management System.
7. The tank mounted Fuel Oil 4/20 mA level sensor and associated intrinsically safe circuitry to be provided and installed by Generator manufacture. Siemens is responsible to connect into the protected side of the fuel level sensor 4/20 mA signal only.
8. A 50% and 80% fuel level intrinsically safe circuitry is to be provided and installed by Generator manufacture. Siemens is responsible to connect into the protected side of circuit for dry contacts only.

C. Tank Installation Guidelines per the State of Michigan DEQ.

1. All sub base tanks are to include overfill spill containment, leak monitor system and 90% high level alarm with annunciation at the fill location. All fill and vent openings are to be located exterior to the generator enclosure. Fill point must provide a minimum of 5 gallon spill containment. A 2” airspace shall be maintained between the concrete pad and the bottom of the containment area of the base. The bottom of the sub base must be coated with approved corrosion resistant mastic. Sub base shall be marked with 3” tall letters per Michigan DEQ guidelines. Fuel piping including flexible line must be steel or fire rated with a UL listing. Insure installation location maintains proper clearances to building and building openings.

2. Contractor shall submit final approved shop drawing of generator and remote fill station to the MDEQ for plan review and permit application. Contractor shall contact MDEQ for all inspections as required by MDEQ and submit final MDEQ certificate to the owner and engineer. Include in bid price cost associated for MDEQ permit and inspections.

2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation:
1. When mode-selector switch on the control and monitoring panel is in the automatic position, remote control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set.

2. When mode-selector switch is switched to the on position the generator set starts.

3. When mode-selector switch is switched to the off position it initiates generator set shutdown.

4. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

5. Operation of a remote emergency-stop switch also shuts down generator set.

B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

C. Indicating and Protective Devices and Controls:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
9. Generator-voltage adjusting rheostat.
10. Run-off-automatic switch
11. Overspeed shutdown device.
12. Coolant high-temperature shutdown device.
13. Coolant low-level shutdown device.
14. Oil low-pressure shutdown device.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.

D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

E. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.

1. Overcrank
2. Coolant low temperature
3. High engine temperature pre-alarm.
4. High engine temperature
5. Low lube oil pressure pre-alarm
6. Low lube oil pressure
7. Overspeed
8. Low fuel main tank
9. Low coolant level
10. Generator set supplying load
11. Control switch not in auto position
12. High battery voltage
13. Low cranking voltage
14. Low voltage in battery
15. Battery charge AC failure

F. Remote Alarm Annunciator:
WAYNE STATE UNIVERSITY
169 - Bioengineering Building
603 - College of Pharmacy
005 - Science Hall

Electrical Reliability Upgrade
Issued for Bids
PBA Project No. 2013.0288.00
PBA Project No. 2014.0097.00
PBA Project No. 2014.0175.00
August 26, 2014

1. Labeled LED shall identify each alarm event.
2. Common audible signal shall sound for alarm conditions.
3. Silencing switch in face of panel shall silence signal without altering visual indication.
4. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
5. Cabinet and faceplate shall be surface mounted with brushed stainless steel.

G. Remote Emergency-Stop Switch: Flush; wall mounted, to be provided by generator manufacturer and installed by electrical contractor.

2.6 GENERATOR MONITORING

A. Emergency and standby power systems will have the ability to be remotely monitored 7 days per week, 24 hours per day. Supplier is to provide all necessary hardware and network services to ensure the monitoring capability specified in the following sections. The monitoring system contained herein is intended to report operational events and critical alarms to operators and service personnel at locations other than EPS Service Room or remote annunciation location.

1. Approved Supplier of Monitoring Systems
   a. The monitoring hardware, network, and interface shall be supplied by the supplier of the engine-generator.
   b. The supplier shall have a service and support network capable of supporting the entire on-site system.

2. Remote Control and Monitoring system shall be interconnected by a communications system designed specifically for control and monitoring of the entire on-site power system. All data and control functions listed in this section shall be available from the network. The network shall be able to initiate testing of individual on-site power system elements including generator set and automatic transfer switch(es). System shall be able to report status information, alarms and performance of the installed on-site power system. Monitoring systems that monitor only individual components of the on-site power system, such as engine-generators (only) or automatic transfer switch (only) shall not be acceptable.

3. Network Monitor: The distributed control and monitoring system shall enable local on-site monitoring by a computer using Internet Explorer, version 6.0 or higher via a standard Ethernet (TCP/IP) connection. Distributed Control and Monitoring network supplier shall provide any plug-in or support files required. Remote dial-up monitoring shall also be available as an option.

4. Password Protection: There shall be a minimum of two levels of password protection.

5. Multiple Monitors: The network shall be support simultaneously connected monitoring PC’s meeting the minimum specified standard via a local Ethernet connection. The network system shall be designed in such a manner as each monitoring PC shall not effect the operation of the network or the any other PC’s or servers connected to the network. When connected, no single PC shall be allowed to dominate the network (take control of the network) or effect the operation of the on-site power system.

6. Alarm Notification: The distributed control and monitoring system shall be send notifications of alarm conditions either via numerical page or e-mail. Notification message should include at a minimum: site number, device type, device number, and alarm code.

B. Generator set monitoring: The Distributed control and monitoring system shall provide real-time engine-generator set operating data, alarms and status information. Alarm and status information shall be date and time stamped and automatically entered into an events log or alarm log as appropriate. These logs shall be provisioned to include:

<table>
<thead>
<tr>
<th>Engine Data</th>
<th>AC Generator Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Pressure</td>
<td>AC Voltage L1-N</td>
</tr>
<tr>
<td>Oil Temperature</td>
<td>AC Voltage L2-N</td>
</tr>
</tbody>
</table>
Coolant Temperature          AC Voltage L3-N
Starting Battery Voltage     AC Voltage L1-L2
Engine Run Time Hours        AC Voltage L2-L3
Engine Starts                AC Voltage L3-L1
Engine Speed, RPM            Frequency, Hz
                                 Current L1
                                 Current L2
                                 Current L3
Power Factor
Kilowatts
Apparent Power, kVA
Reactive Power, kVAR
Energy, MW-Hours

1  NFPA 110 LEVEL ONE ANNUNCIATION

Fail to Start         Genset Supplying Load
Low Coolant Temperature Switch OFF (Not-In-Auto)
High Coolant Temperature Pre-Alarm AC Charger Fail
High Coolant Temperature Shutdown High DC Voltage Warning
Low Oil Pressure Pre-Alarm Low DC Voltage Warning
Low Oil Pressure Shutdown Common Alarm
Overspeed Shutdown    Genset Running
Low Fuel Warning      Low coolant level

2  ADDITIONAL ALARMS (WHERE SUPPORTED BY GENEST)

High AC Voltage Shutdown Reverse Power Shutdown
Low AC Voltage Shutdown Reverse kVAR
Underfrequency Shutdown Ground Fault
Overcurrent Shutdown   Fail to Synchronize
Short Circuit Shutdown Failure to Close Warning
Overload Warning
Emergency Stop
Load Demand

C. Distributed Control and Monitoring network supplier shall provide telecommunications interfaces for remote monitoring of the on-site network. These interfaces shall be Ethernet, gateways, modems or other industry standard Telecommunications interface. The Telecommunications interface shall support “dial-in” communications from either the remote central monitoring location or direct connection from an authorized user.

1. The supplier of the Distributed Control and Monitoring network shall have a service and support network capable of supporting the entire on-site Distributed Control and Monitoring network. The service and support network shall include local service organizations, with factory trained service and support technicians. The supplier shall maintain local service parts and maintenance parts and components for the installed Distributed Control and Monitoring network.

D. The supplier shall publish a schedule of training for user personnel. The supplier shall provide initial operational training on-site at no additional charge.
2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Protector: Microprocessor-based unit that continuously monitors current level in each phase of generator output, integrates generator heating effect over time, and predicts when thermal damage of the alternator will occur. When signaled by the protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from the load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when the generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates the generator to 300 percent of rated full-load current for up to 10 seconds.
3. As the overcurrent heating effect on the generator approaches the thermal damage point of the unit, the protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

B. Generator shall be provided with relay and CT’s to coordinate with downstream medium voltage circuit breaker. CT’s provided to match medium voltage circuit breaker manufacturer.

C. Ground-Fault Indication: Comply with NFPA 70, Article 700-7(d). Integrate ground-fault alarm indication with other generator-set alarm indications.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with ANSI/NEMA MG 1

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: ANSI/NEMA MG 1: Class H.

D. Temperature Rise: 105 degrees C standby.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: ANSI/NEMA MG 1, open drip proof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Manual adjustment on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.
2.9 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Prefabricated or pre-engineered walk-in Level 2 enclosure with the following features:

1. Level 2 - 78 dba @ 23’ (free field).
2. Enclosure shall be Drop Over/Walk-In Style Modular Panel construction.
3. Enclosure shall have air intake and discharge plenums required to meet sound level.
4. Enclosure Roof Shall Be Modular Construction & have removable sections.
5. Enclosure Roof Designed for 200 LBS SQ./FT. Loads.
7. Enclosure C-Channel Base Frame shall be 6"H Welded 7GA Steel Construction W/ Lifting Eyes.
8. Panel construction shall be 14GA 3” Galvanized (Minimum).
9. 3” 6LB CU./ FT. UL listed Rockwool acoustic / thermal insulation (Fire Resistant).
10. 22GA Galvanized perforated interior liner.
11. Enclosure hardware shall be Zinc Plated or Stainless Steel.
12. (4)- 32”W X 72”H Enclosure Access Doors W/ Key / Pad Locking Handles and hasp for owner provided deadbolt.
13. (1)- Remote Mounted Control Panel Access Door W/ Window & Key / Pad Locking Handle.
14. Enclosure doors shall have interior Push Bar release handles for Walk-In Style Enclosure.
15. Enclosure door hinges shall be stainless steel & powder coated black.
16. Enclosure door hold backs shall be polished stainless steel W/ spring loaded returns.
17. Enclosure doorways shall have anti slip thresholds.
21. Enclosure shall have (1) 100A 120/240V Single Phase Load Center.
22. Generator Block Heater & Battery Charger shall be wired to the load center.
23. (4) AC Lights W/ Vapor tight fixtures & (2) three way light switches wired to the load center (Located inside doorways).
24. (2) GFCI Receptacles wired to the load center (Located inside doorways).
25. 5KW Enclosure Space Heater W/ adjustable thermostat wired to the load center.
26. Plumb Oil & Coolant drains to exterior of enclosure & provide internal ball valves for each.
27. Extend Crankcase Breather Tubes into Radiator Discharge Plenum.
28. Provide access platforms at service doors.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

C. Enclosure Powder Coat Process:

1. Run panels through 8 Stage wash line. Process removes laser scale then does an Alkaline Wash & Rinse then a NANO technology Phosphate free coating is applied for increased Powder adhesion.
2. After wash parts shall be ran through dehydration over at 335 degrees
3. After dehydration parts shall be run through dual action powder paint booth & sprayed with TGIC Ultra Durable Powder.
4. Parts shall be run through Curing Oven at 400-420 degrees for 25 Min.
5. 2.5-3.5 Mil of powder on each panel
6. 1200 Salt Spray Hours
2.10 VIBRATION ISOLATION DEVICES

   A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

2.11 FINISHES

   A. Indoor and Outdoor Enclosures and Components: Custom enamel over corrosion-resistant pretreatment and compatible standard primer. Provide color chip color for final color selection by Owner.

2.12 SOURCE QUALITY CONTROL

   A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

   B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor for a minimum of 2 hours per unit. Include the following tests:

      1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
      2. Full load run.
      3. Maximum power.
      4. Voltage regulation.
      5. Transient and steady-state governing.
      7. Safety shutdown.
      8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

   C. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

   A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

   B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

   C. Proceed with installation only after unsatisfactory conditions have been corrected.

   D. Beginning of installation means Installer accepts existing conditions.
3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with vibration isolation devices on concrete base.
   1. Size concrete base as recommended by generator manufacturer.
   2. The top of the concrete pad shall be a minimum of 4" above finished grade or adjacent finished floor.
   4. Concrete base construction is specified in Division 16 Section "Hangers and Supports for Electrical Systems."

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Install fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

B. Connect engine exhaust pipe to engine with flexible connector.

C. Connect fuel piping to engines with a gate valve and union and flexible connector.
   1. Natural- gas piping, valves, and specialties for gas piping inside the building are specified in Division 23 Section "Fuel Gas Piping."

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 IDENTIFICATION

A. Identify system components according to Division 20 Section "Mechanical Identification" and Division 26 "Section Electrical Identification."

3.5 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing."

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Perform the following field tests and inspections and prepare test reports:

1. Provide full load test utilizing portable resistor test bank, for four hours minimum. Simulate various load scenarios of generator units running at different loads. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown, and return to normal. Coordinate with Division 26 Section "Transfer Switches"

2. During test, record the following at 20 minute intervals:

   a. Kilowatts.
   b. Amperes.
   c. Voltage.
   d. Coolant temperature.
   e. Room temperature.
   f. Frequency.
   g. Oil pressure.

3. Test alarm and shutdown circuits by simulating conditions.

4. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.15.2.1 and 7.22.1 (except for vibration baseline test). Certify compliance with test parameters.

5. Perform tests recommended by manufacturer.

6. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, the following:


7. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.

8. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

9. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

10. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.

11. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
12. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

E. Coordinate tests with tests for transfer switches and run them concurrently.

F. Test instruments shall have been calibrated within the last 12 months, traceable to standards of the National Institute for Standards and Technology, and adequate for making positive observation of test results. Make calibration records available for examination on request.

G. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

I. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

J. Remove and replace malfunctioning units and retest as specified above.

K. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

L. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

M. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

N. A Knowledgeable Generator Manufacturers representative must be present at time of start-up to accomplish a two party commissioning test on the following items to meet the sequence of operations:

1. Demonstrate the physical Generator points indicating Run and Alarm.
2. Demonstrate a physical ATS change of state.
3. Demonstrate a 50% and 80% fuel level condition.
4. Demonstrate variations regarding the 4/20 mA fuel level readings.

3.6 DEMONSTRATION

A. Provide systems demonstration for Owner, Construction Manager and Electrical Engineer. Schedule system demonstration with owner seven days in advance.

B. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide emergency power.
C. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1 Section "Demonstration and Training."

1. Provide a minimum of two 3-hour training sessions for the Owner's personnel. One session shall be conducted at time of start-up, the other within three months of start-up.

2. Training shall include: Review of maintenance procedures and schedule, trouble shooting procedures, demonstration of all alarm and safety functions with appropriate actions to be taken, and review of regular testing and exercising schedule including inspection and observation procedures.

3. Coordinate with demonstration and training required in Division 26 section “Transfer Switches”.

3.7 CLEANING

A. Clean engine and generator surfaces. Replace oil and fuel filters.

END OF SECTION 26 3213P
THIS SECTION APPLIES TO SCIENCE HALL DIESEL GENERATOR

SECTION 26 3213SH - PACKAGED ENGINE GENERATORS - DIESEL

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes packaged engine generator sets for standby power supply with the following features:
   1. Diesel engine.
   2. Unit-mounted cooling system.
   3. Unit-mounted control and monitoring.
   4. Outdoor enclosure.
1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

1.4 SUBMITTALS

A. Product Data: Include the following:
   1. Data on features, components, accessories ratings, and performance.
   2. Thermal damage curve for generator.
   3. Time-current characteristic curves for generator protective device.
   4. Manufacturer’s anchorage and base recommendations.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Submit shop drawings showing plan and elevation views with overall interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.
   2. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
   3. Internal Wiring Diagrams: For engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, remote radiator, and remote annunciator.

C. Source quality-control test reports.
   1. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
   3. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
   5. Certified report of exhaust emissions showing compliance with applicable EPA regulations.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. Include the following:
   1. List of tools and replacement items recommended to be stored at the Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
   2. Include instructions for normal operation, routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

F. Warranty: Special warranty specified in this Section.
1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged generator sets and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 37.

E. Comply with NFPA 70.

F. UL2200 Listed and labeled

G. Comply with NFPA 110 requirements for Level 2 emergency power supply system.

H. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
   1. Provide engines used for standby applications that carry certification of compliance with current EPA emissions requirements or provide engines which comply with EPA emissions requirements and provide the necessary field testing to certify EPA emissions compliance.

I. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion and Owner's Acceptance and Start-Up.

1.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide cost breakdown for 12, 24 and 36 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts and supplies as used in manufacture and installation of original equipment.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: One full set plus one of each.
2. Indicator Lamps: One full set plus one of each.
3. Filters: One full set plus one of each.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide Generac or a comparable product by one of the following:

1. Caterpillar; Engine Div.
2. Kohler Co; Generator Division.

2.2 ENGINE-GENERATOR SET

A. Packaged engine-generator set shall be a coordinated assembly of compatible components.

B. Safety Standard: Comply with ASME B15.1 and UL 2200.

C. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components.

D. Capacities and Characteristics:

1. Power Output Ratings: 450 kW, 480 Y/277 V, 3 PH, 4 W
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

E. Generator-set performance for sensitive loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
2. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
3. Steady-State Voltage Operational Bandwidth: 2 percent of rated output voltage from no load to full load.
4. Steady-State Voltage Modulation Frequency: Less than 1 Hz.
5. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
6. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
7. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
WAYNE STATE UNIVERSITY                  PETER BASSO ASSOCIATES, INC.
Electrical Reliability Upgrade            Issued for Bids
169 - Bioengineering Building            PBA Project No. 2013.0288.00
603 - College of Pharmacy                PBA Project No. 2014.0097.00
005 - Science Hall                       PBA Project No. 2014.0175.00
August 26, 2014

8. Transient Frequency Performance: Less than 2-Hz variation for a 50 percent step-load increase or
decrease. Frequency shall recover and remain within the steady-state operating band within three
seconds.

9. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2
percent total with no slot ripple. The telephone influence factor, determined according to
NEMA MG 1, shall not exceed 50 percent.

10. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, the
system shall supply a minimum of 300 percent of rated full-load current for not less than 10
seconds and then clear the fault automatically, without damage to winding insulation or other
generator system components.

11. Excitation System: Permanent magnet generator driven brushless exciter. Performance shall be
unaffected by voltage distortion caused by nonlinear load.

12. Start Time: Comply with NFPA 110, Level 2, system requirements.

F. Provide guards for all external rotating parts to prevent accidental injury. Guards shall be securely bolted
to the generator but removable for maintenance. Guards shall be painted with a rust inhibiting primer and
an epoxy based gloss topcoat. Guards shall comply with Michigan OSHA requirements.

G. Service Conditions:

1. Environmental Conditions: Engine-generator system shall withstand the following environmental
conditions without mechanical or electrical damage or degradation of performance capability:
   a. Ambient Temperature: Minus 15 to plus 40 deg C.
   b. Relative Humidity: 0 to 95 percent.
   c. Altitude: Rated for altitude at project location.

2.3 ENGINE

A. Fuel: Fuel oil, Grade DF-2

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: The following items are mounted on engine or skid:
   1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while
      passing full flow.
   2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall
      be capable of full flow and is designed to be fail-safe.
   3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no
      disassembly and without use of pumps, siphons, special tools, or appliances.

D. Engine Fuel System:
   1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and
      load conditions.
   2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to
      source.
   3. Provide dual 5 micron fuel filters at fuel supply line.
   4. Provide pressure gauge on suction and discharge sides of both filters and shut-off valves at both
      sides of each filter.

E. Coolant Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to
maintain engine jacket water at 90 degrees F (32 degrees C), and suitable for operation on 120 volts AC.
F. Governor: Adjustable Isosynchronous with speed sensing.

G. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
   1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
   2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
   3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gauge glass and petcock.
   4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
      a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
      b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

H. Muffler/Silencer: Hospital grade, critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Minimum sound attenuation of 25 dB at 500 Hz.
   2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less.
   3. Muffler/Silencer to be mounted inside outdoor enclosure.

I. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and “blocked filter” indicator.

J. Starting System: 24-V electric, with negative ground.
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. Cranking Cycle: As required by NFPA 110 for system level specified.
   4. Battery: Flooded cell type with adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
   7. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
      a. Operation: Equalizing-charging rate of 20 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.


e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30:

B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:

1. Tank level indicator.
2. Capacity: Fuel tank size shall not exceed 1100 gallons. Fuel for 40 hours' continuous operation at 100 percent rated power output.
3. Vandal-resistant fill cap.
5. Dual fuel filters.
6. Provide monitor of fuel tank for 50% and 80% fuel level. Interface with Siemens Building Management System.
7. The tank mounted Fuel Oil 4/20 mA level sensor and associated intrinsically safe circuitry to be provided and installed by Generator manufacture. Siemens is responsible to connect into the protected side of the fuel level sensor 4/20 mA signal only.
8. A 50% and 80% fuel level intrinsically safe circuitry is to be provided and installed by Generator manufacture. Siemens is responsible to connect into the protected side of circuit for dry contacts only.

C. Tank Installation Guidelines per the State of Michigan DEQ.

1. All sub base tanks are to include overfill spill containment, leak monitor system and 90% high level alarm with annunciation at the fill location. All fill and vent openings are to be located exterior to the generator enclosure. Fill point must provide a minimum of 5 gallon spill containment. A 2" airspace shall be maintained between the concrete pad and the bottom of the containment area of the base. The bottom of the sub base must be coated with approved corrosion resistant mastic. Sub base shall be marked with 3" tall letters per Michigan DEQ guidelines. Fuel piping including flexible line must be steel or fire rated with a UL listing. Insure installation location maintains proper clearances to building and building openings.

2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation:

1. When mode-selector switch on the control and monitoring panel is in the automatic position, remote control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set.
2. When mode-selector switch is switched to the on position the generator set starts.
3. When mode-selector switch is switched to the off position it initiates generator set shutdown.
4. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.
5. Operation of a remote emergency-stop switch also shuts down generator set.

B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

C. Indicating and Protective Devices and Controls:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
9. Generator-voltage adjusting rheostat.
10. Run-off-automatic switch
11. Overspeed shutdown device.
12. Coolant high-temperature shutdown device.
13. Coolant low-level shutdown device.
14. Oil low-pressure shutdown device.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.

D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

E. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.

1. Overcrank
2. Coolant low temperature
3. High engine temperature pre-alarm.
4. High engine temperature
5. Low lube oil pressure pre-alarm
6. Low lube oil pressure
7. Overspeed
8. Low fuel main tank
9. Low coolant level
10. Generator set supplying load
11. Control switch not in auto position
12. High battery voltage
13. Low cranking voltage
14. Low voltage in battery
15. Battery charge AC failure

F. Remote Alarm Annunciator:

1. Labeled LED shall identify each alarm event.
2. Common audible signal shall sound for alarm conditions.
3. Silencing switch in face of panel shall silence signal without altering visual indication.
4. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
5. Cabinet and faceplate shall be surface mounted with brushed stainless steel.

G. Remote Emergency-Stop Switch: Flush; wall mounted, to be provided by generator manufacturer and installed by electrical contractor.

2.6 GENERATOR MONITORING

A. Emergency and standby power systems will have the ability to be remotely monitored 7 days per week, 24 hours per day. Supplier is to provide all necessary hardware and network services to ensure the monitoring capability specified in the following sections. The monitoring system contained herein is intended to report operational events and critical alarms to operators and service personnel at locations other than EPS Service Room or remote annunciation location.

1. Approved Supplier of Monitoring Systems
   a. The monitoring hardware, network, and interface shall be supplied by the supplier of the engine-generator.
   b. The supplier shall have a service and support network capable of supporting the entire on-site system.

2. Remote Control and Monitoring system shall be interconnected by a communications system designed specifically for control and monitoring of the entire on-site power system. All data and control functions listed in this section shall be available from the network. The network shall be able to initiate testing of individual on-site power system elements including generator set and automatic transfer switch(es). System shall be able to report status information, alarms and performance of the installed on-site power system. Monitoring systems that monitor only individual components of the on-site power system, such as engine-generators (only) or automatic transfer switch (only) shall not be acceptable.

3. Network Monitor: The distributed control and monitoring system shall enable local on-site monitoring by a computer using Internet Explorer, version 6.0 or higher via a standard Ethernet (TCP/IP) connection. Distributed Control and Monitoring network supplier shall provide any plug-in or support files required. Remote dial-up monitoring shall also be available as an option.

4. Password Protection: There shall be a minimum of two levels of password protection.

5. Multiple Monitors: The network shall be support simultaneously connected monitoring PC’s meeting the minimum specified standard via a local Ethernet connection. The network system shall be designed in such a manner as each monitoring PC shall not effect the operation of the network or the any other PC’s or servers connected to the network. When connected, no single PC shall be allowed to dominate the network (take control of the network) or effect the operation of the on-site power system.

6. Alarm Notification: The distributed control and monitoring system shall be send notifications of alarm conditions either via numerical page or e-mail. Notification message should include at a minimum: site number, device type, device number, and alarm code.

B. Generator set monitoring: The Distributed control and monitoring system shall provide real-time engine-generator set operating data, alarms and status information. Alarm and status information shall be date and time stamped and automatically entered into an events log or alarm log as appropriate. These logs shall be provisioned to include:

<table>
<thead>
<tr>
<th>Engine Data</th>
<th>AC Generator Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Pressure</td>
<td>AC Voltage L1-N</td>
</tr>
<tr>
<td>Oil Temperature</td>
<td>AC Voltage L2-N</td>
</tr>
<tr>
<td>Coolant Temperature</td>
<td>AC Voltage L3-N</td>
</tr>
<tr>
<td>Starting Battery Voltage</td>
<td>AC Voltage L1-L2</td>
</tr>
<tr>
<td>Engine Run Time Hours</td>
<td>AC Voltage L2-L3</td>
</tr>
</tbody>
</table>
## 1 NFPA 110 LEVEL ONE ANNUNCIATION

<table>
<thead>
<tr>
<th>Alarm Type</th>
<th>Action Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fail to Start</td>
<td>Genset Supplying Load</td>
</tr>
<tr>
<td>Low Coolant Temperature Pre-Alarm</td>
<td>Switch OFF (Not-In-Auto)</td>
</tr>
<tr>
<td>High Coolant Temperature Pre-Alarm</td>
<td>AC Charger Fail</td>
</tr>
<tr>
<td>High Coolant Temperature Shutdown</td>
<td>High DC Voltage Warning</td>
</tr>
<tr>
<td>Low Oil Pressure Pre-Alarm</td>
<td>Low DC Voltage Warning</td>
</tr>
<tr>
<td>Low Oil Pressure Shutdown</td>
<td>Common Alarm</td>
</tr>
<tr>
<td>Overspeed Shutdown</td>
<td>Genset Running</td>
</tr>
<tr>
<td>Low Fuel Warning</td>
<td>Low coolant level</td>
</tr>
</tbody>
</table>

## 2 ADDITIONAL ALARMS (WHERE SUPPORTED BY GENEST)

<table>
<thead>
<tr>
<th>Alarm Type</th>
<th>Action Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>High AC Voltage Shutdown</td>
<td>Reverse Power Shutdown</td>
</tr>
<tr>
<td>Low AC Voltage Shutdown</td>
<td>Reverse kVAR</td>
</tr>
<tr>
<td>Underfrequency Shutdown</td>
<td>Ground Fault</td>
</tr>
<tr>
<td>Overcurrent Shutdown</td>
<td>Fail to Synchronize</td>
</tr>
<tr>
<td>Short Circuit Shutdown</td>
<td>Failure to Close Warning</td>
</tr>
<tr>
<td>Overload Warning</td>
<td></td>
</tr>
<tr>
<td>Emergency Stop</td>
<td></td>
</tr>
<tr>
<td>Load Demand</td>
<td></td>
</tr>
</tbody>
</table>

### C. Distributed Control and Monitoring network supplier shall provide telecommunications interfaces for remote monitoring of the on-site network. These interfaces shall be Ethernet, gateways, modems or other industry standard Telecommunications interface. The Telecommunications interface shall support "dial-in" communications from either the remote central monitoring location or direct connection from an authorized user.

1. The supplier of the Distributed Control and Monitoring network shall have a service and support network capable of supporting the entire on-site Distributed Control and Monitoring network. The service and support network shall include local service organizations, with factory trained service and support technicians. The supplier shall maintain local service parts and maintenance parts and components for the installed Distributed Control and Monitoring network.

### D. The supplier shall publish a schedule of training for user personnel. The supplier shall provide initial operational training on-site at no additional charge.

### 2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

#### A. Generator Circuit Breaker: Insulated-case, electrically operated, electronic-trip type; 100 percent rated; complying with UL 489.

2. Trip Settings: Matched to generator thermal damage curve as closely as possible.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Mount unit in enclosure to meet ANSI/NEMA 250, Type 1 requirements. Adjacent to or integrated with control and monitoring panel.
   a. Where multiple output circuit breakers are provided, the output circuit breaker and load wiring that serves the emergency branch and the fire pump circuit, when required, shall be physically separated from breakers serving standby branches.

B. Ground-Fault Indication: Comply with NFPA 70, Article 700-7(d). Integrate ground-fault alarm indication with other generator-set alarm indications.

C. Circuit breakers shall be by the same manufacturer and shall be of one of the following manufacturers:
   1. Eaton Corporation; Cutler-Hammer Products.
   3. Siemens Industries, Inc.
   4. Square D.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with ANSI/NEMA MG 1

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: ANSI/NEMA MG 1: Class H.

D. Temperature Rise: 105 degrees C standby.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: ANSI/NEMA MG 1, open drip proof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
   1. Manual adjustment on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.

2.9 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable with pad locks and hasp for owner provided deadbolt and provide adequate access to...
components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

1. Provide sound attenuating Level 2 enclosure to meet the sound criteria specified in Part 1.5., “Quality Assurance”

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.

2.10 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

2.11 FINISHES

A. Indoor and Outdoor Enclosures and Components: Custom enamel over corrosion-resistant pretreatment and compatible standard primer. Provide color chip color for final color selection by Owner.

2.12 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor for a minimum of 2 hours per unit. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
7. Safety shutdown.
8. Provide 14 days’ advance notice of tests and opportunity for observation of tests by Owner's representative.

C. Report factory test results within 10 days of completion of test.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Beginning of installation means Installer accepts existing conditions.

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with vibration isolation devices on concrete base.
   1. Size concrete base as recommended by generator manufacturer.
   2. The top of the concrete pad shall be a minimum of 4" above finished grade or adjacent finished floor.
   4. Concrete base construction is specified in Division 16 Section "Hangers and Supports for Electrical Systems."

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Install fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

B. Connect engine exhaust pipe to engine with flexible connector.

C. Connect fuel piping to engines with a gate valve and union and flexible connector.
   1. Natural- gas piping, valves, and specialties for gas piping inside the building are specified in Division 23 Section "Fuel Gas Piping."

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
3.4 IDENTIFICATION

A. Identify system components according to Division 20 Section "Mechanical Identification" and Division 26 "Section Electrical Identification."

3.5 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing"

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Perform the following field tests and inspections and prepare test reports:
   1. Provide full load test utilizing portable resistor test bank, for four hours minimum. Simulate various load scenarios of generator units running at different loads. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown, and return to normal. Coordinate with Division 26 Section "Transfer Switches"
   2. During test, record the following at 20 minute intervals:
      a. Kilowatts.
      b. Amperes.
      c. Voltage.
      d. Coolant temperature.
      e. Room temperature.
      f. Frequency.
      g. Oil pressure.
   3. Test alarm and shutdown circuits by simulating conditions.
   4. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.15.2.1 and 7.22.1 (except for vibration baseline test). Certify compliance with test parameters.
   5. Perform tests recommended by manufacturer.
   6. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, the following:
   7. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
      a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
      b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
c. Verify acceptance of charge for each element of the battery after discharge.
d. Verify that measurements are within manufacturer's specifications.

8. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
9. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
10. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
11. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
12. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

E. Coordinate tests with tests for transfer switches and run them concurrently.

F. Test instruments shall have been calibrated within the last 12 months, traceable to standards of the National Institute for Standards and Technology, and adequate for making positive observation of test results. Make calibration records available for examination on request.

G. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

I. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

J. Remove and replace malfunctioning units and retest as specified above.

K. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

L. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

M. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

N. A Knowledgeable Generator Manufactures representative must be present at time of start-up to accomplish a two party commissioning test on the following items to meet the sequence of operations:

1. Demonstrate the physical Generator points indicating Run and Alarm.
2. Demonstrate a physical ATS change of state.
3. Demonstrate a 50% and 80% fuel level condition.
4. Demonstrate variations regarding the 4/20 mA fuel level readings.

3.6 DEMONSTRATION

A. Provide systems demonstration for Owner, Construction Manager and Electrical Engineer. Schedule system demonstration with owner seven days in advance.

B. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide emergency power.

C. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1 Section “Demonstration and Training.”

1. Provide a minimum of two 3-hour training sessions for the Owner’s personnel. One session shall be conducted at time of start-up, the other within three months of start-up.

2. Training shall include: Review of maintenance procedures and schedule, trouble shooting procedures, demonstration of all alarm and safety functions with appropriate actions to be taken, and review of regular testing and exercising schedule including inspection and observation procedures.

3. Coordinate with demonstration and training required in Division 26 section “Transfer Switches”.

3.7 CLEANING

A. Clean engine and generator surfaces. Replace oil and fuel filters.

END OF SECTION 26 3213D
PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes three-phase, on-line, double-conversion, static-type, UPS installations complete with transient voltage surge suppression, input harmonics reduction, rectifier-charger, battery, battery disconnect device, inverter, static bypass transfer switch, external maintenance bypass/isolation switch.

1.3 DEFINITIONS
A. EMI: Electromagnetic interference.
B. LCD: Liquid-crystal display.
C. LED: Light-emitting diode.
D. THD: Total harmonic distortion.
E. UPS: Uninterruptible power supply.

1.4 SUBMITTALS

A. Product Data: Include data on features, components, ratings, and performance for each UPS component indicated.
B. Shop Drawings: Detail assemblies of equipment indicating dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
C. Qualification Data: For manufacturer and testing agency.
D. Manufacturer Certificates: For each product, signed by manufacturers.
E. Factory Test Reports: Comply with specified requirements.
F. Field Quality-Control and Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.
G. Operation and Maintenance Data: For UPS units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section “Operation and Maintenance Data, include the following:
   1. Lists of spare parts and replacement components recommended being stored at Project site for ready access.
   2. Detailed operating instructions covering operation under both normal and abnormal conditions.
H. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs with eight hours (8) maximum response time.
C. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
D. Source Limitations: Obtain the UPS and associated components specified in this Section from a single manufacturer with responsibility for entire UPS installation.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. UL Compliance: Listed and labeled under UL 1778.

G. NFPA Compliance: Mark UPS components as suitable for installation in computer rooms according to NFPA 75.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

B. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

1.7 WARRANTY

A. Special Battery Warranties: Specified form in which manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.

1. Warranted Cycle Life for VLRA Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F:

<table>
<thead>
<tr>
<th>Discharge Rate</th>
<th>Discharge Duration</th>
<th>Discharge End Voltage</th>
<th>Cycle Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 hours</td>
<td>8 hours</td>
<td>1.75</td>
<td>40 cycles</td>
</tr>
<tr>
<td>1 hour</td>
<td>1 hour</td>
<td>1.75</td>
<td>80 cycles</td>
</tr>
<tr>
<td>15 minutes</td>
<td>45 seconds</td>
<td>1.67</td>
<td>2700 cycles</td>
</tr>
</tbody>
</table>

B. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within special warranty period.

1. Special Warranty Period: Two years from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.

1. Fuses: One for every 10 of each type and rating, but no fewer than 1 of each.
2. Cabinet Ventilation Filters: One complete set.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.2 PERFORMANCE DESCRIPTION

A. Automatic operation includes the following:

1. Normal Conditions: Supply the load with ac power flowing from the normal ac power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
2. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter ac power output to the load without switching or disturbance.
3. If normal power fails, energy supplied by the battery through the inverter continues supply-regulated ac power to the load without switching or disturbance.
4. When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
5. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to float-charge mode.
6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal ac supply circuit without disturbance or interruption.
7. If a fault occurs in the system supplied by the UPS, and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.
8. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.
9. If the battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:

1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.
2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.

C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection between the following three conditions without interrupting supply to the load during switching:

1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through either the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.
2.3 SERVICE CONDITIONS

A. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.

1. Ambient Temperature for Electronic Components: 32 to 104 deg F.
2. Ambient Temperature for Battery: 41 to 95 deg F.
3. Relative Humidity: 0 to 95 percent, noncondensing.

2.4 PERFORMANCE REQUIREMENTS

A. The UPS shall perform as specified in this Article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 2.8, under the following conditions or combinations of the following conditions:

1. Inverter is switched to battery source.
2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.
3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
5. Load is 50 percent unbalanced continuously.

B. Minimum Duration of Supply: If battery is sole energy source supplying rated full UPS load current at 80 percent power factor, duration of supply is 30 minutes.

C. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10, minus 15 percent from nominal voltage.

D. Overall UPS Efficiency: Equal to or greater than 86 percent at 100 percent load, 85 percent at 75 percent load, and 84 percent at 50 percent load.

E. Maximum Acoustical Noise: 65db "A" weighting, emanating from any UPS component under any condition of normal operation, measured 1 meter from nearest surface of component enclosure.

F. Maximum Energizing Inrush Current: Six times the full-load current.

G. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or minus 2 percent over the full range of battery voltage.

H. Output Frequency: 60 Hz, plus or minus 0.5 percent over the full range of input voltage, load, and battery voltage.

I. Limitation of harmonic distortion of input current to the UPS shall be as follows:

1. Description: Either a tuned harmonic filter or an arrangement of rectifier-charger circuits shall limit THD to 3 percent, maximum, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.

J. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent RMS total and 3 percent RMS for any single harmonic, for 100 percent rated nonlinear load current with a load crest factor of 2.8.

K. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, and 150 percent for 30 seconds in all operating modes.
L. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 100 ms:

1. 50 Percent: Plus or minus 5 percent.
2. 100 Percent: Plus or minus 5 percent.
3. Loss of AC Input Power: Plus or minus 1 percent.
4. Restoration of AC Input Power: Plus or minus 1 percent.

M. Input Power Factor: A minimum of 0.85 lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current.


2.5 UPS SYSTEMS

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

1. Toshiba International Corporation through Ancona Controls (Beth Ancona 248-672-8002)
   Voluntary alternate UPS manufacturer’s will not be accepted.

B. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

C. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.

D. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

E. Surge Suppression: Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch, and maintenance bypass/isolation switch. Protect rectifier-charger, inverter, controls, and output components.

1. Use factory-installed surge suppressors tested according to IEEE C62.41, Category B.
2. Additional Surge Protection: Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41. Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand stresses imposed by 40-Hz, 180 percent voltage surges described in IEEE C62.41.

F. UPS Cabinet Ventilation: fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.

G. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum. Neutral line conductor sized for 200% of line rating.

2.6 RECTIFIER-CHARGER

A. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.
C. Rectifier-Charger Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.

D. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.

2.7 INVERTER

A. Description: Pulse-width modulated, with sinusoidal output.

B. Description: Pulse-width modulated, with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

2.8 STATIC BYPASS TRANSFER SWITCH

A. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.

B. Switch Rating: Continuous duty at the rated full UPS load current, minimum.

2.9 BATTERY

A. Description: VLRA, heavy-duty industrial units in styrene acrylonitrile containers mounted on three-tier, acid-resistant, painted steel racks. Assembly includes battery disconnect switch, intercell connectors, hydrometer syringe, and thermometer with specific gravity-correction scales.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. EnerSys, Inc.
   c. HOPPECKE.
   d. Mitsubishi Electric Automation, Inc.
   e. Powerware; an Invensys Company.
   f. SAFT.

2.10 CONTROLS AND INDICATIONS

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.

C. Indications: Plain-language messages on a digital LCD or LED.

1. Quantitative indications shall include the following:
   a. Input voltage, each phase, line to line.
2. Basic status condition indications shall include the following:
   a. Normal operation.
   b. Load-on bypass.
   c. Load-on battery.
   d. Inverter off.
   e. Alarm condition.

3. Alarm indications shall include the following:
   a. Bypass ac input overvoltage or undervoltage.
   b. Bypass ac input overfrequency or underfrequency.
   c. Bypass ac input and inverter out of synchronization.
   d. Bypass ac input wrong-phase rotation.
   e. Bypass ac input single-phase condition.
   f. Bypass ac input filter fuse blown.
   g. Internal frequency standard in use.
   h. Battery system alarm.
   i. Control power failure.
   j. Fan failure.
   k. UPS overload.
   l. Battery-charging control faulty.
   m. Input overvoltage or undervoltage.
   n. Input transformer overtemperature.
   o. Input circuit breaker tripped.
   p. Input wrong-phase rotation.
   q. Input single-phase condition.
   r. Approaching end of battery operation.
   s. Battery undervoltage shutdown.
   t. Maximum battery voltage.
   u. Inverter fuse blown.
   v. Inverter transformer overtemperature.
   w. Inverter overtemperature.
   x. Static bypass transfer switch overtemperature.
   y. Inverter power supply fault.
   z. Inverter transistors out of saturation.
   aa. Identification of faulty inverter section/leg.
   bb. Inverter output overvoltage or undervoltage.
   cc. UPS overload shutdown.
   dd. Inverter current sensor fault.
   ee. Inverter output contactor open.
   ff. Inverter current limit.

4. Controls shall include the following:
   a. Inverter on-off.
   b. UPS start.
   c. Battery test.
d. Alarm silence/reset.

e. Output-voltage adjustment.

D. Dry-form "C" contacts shall be available for remote indication of the following conditions:

1. UPS on battery.
2. UPS on-line.
3. UPS load-on bypass.
4. UPS in alarm condition.
5. UPS off (maintenance bypass closed).

E. Emergency Power Off Switch: Capable of local operation and operation by means of activation by external dry contacts.

2.11 MAINTENANCE BYPASS/ISOLATION SWITCH

A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.

1. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
2. Switch shall electrically isolate other UPS components to permit safe servicing.

B. Comply with NEMA PB 2 and UL 891.

C. Switch Rating: Continuous duty at rated full UPS load current.

D. Mounting Provisions: Separate wall- or floor-mounted unit.

E. Key interlock requires unlocking maintenance bypass/isolation switch before switching from normal position with key that is released only when the UPS is bypassed by the static bypass transfer switch. Lock is designed specifically for mechanical and electrical component interlocking.

2.12 MONITORING BY REMOTE STATUS AND ALARM PANEL

A. Description: Labeled LEDs on panel faceplate indicate five basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication.

1. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.

2.13 SOURCE QUALITY CONTROL

A. Factory test complete UPS system before shipment. Use actual batteries that are part of final installation. Include the following:

1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
4. Overload test.
5. Power failure test.
B. Observation of Test: Give 14 days’ advance notice of tests and provide opportunity for Owner's representative to observe tests at Owner's option.

C. Report test results. Include the following data:

1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install UPS system per N.E.C.A. 411-2006.

B. Install system components on 4-inch- high concrete bases. Concrete base construction requirements are specified in Division 26 Section "Hangers and Supports for Electrical Systems."

C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

D. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

3.2 GROUNDING

A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.

3.3 IDENTIFICATION

A. Identify components and wiring according to Division 26 Section "Electrical Identification."

1. Identify each battery cell individually.

3.4 BATTERY EQUALIZATION

A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation including connections, and to assist in field testing. Report results in writing.
B. Electrical Tests and Inspections: Perform tests and inspections according to manufacturer's written instructions and as listed below to demonstrate condition and performance of each UPS component:

1. Inspect interiors of enclosures, including the following:
   a. Integrity of mechanical and electrical connections.
   b. Component type and labeling verification.
   c. Ratings of installed components.

2. Test manual and automatic operational features and system protective and alarm functions.
3. Test communication of status and alarms to remote monitoring equipment.

C. Electrical Tests and Inspections: Perform tests and inspections by an independent testing agency meeting the qualifications specified in Part 1 "Quality Assurance" Article according to manufacturer's written instructions and as listed below to demonstrate condition and performance of each UPS component:

1. Inspect interiors of enclosures, including the following:
   a. Integrity of mechanical and electrical connections.
   b. Component type and labeling verification.
   c. Ratings of installed components.

2. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated, within the previous six months according to NIST standards.
   a. Simulate malfunctions to verify protective device operation.
   b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
   c. Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.
   d. Test output voltage under specified transient-load conditions.
   e. Test efficiency at 50, 75, and 100 percent of rated loads.
   f. Test remote status and alarm panel functions.
   g. Test battery-monitoring system functions.

D. Retest: Correct deficiencies and retest until specified requirements are met.

E. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 26 3353
THIS SECTION APPLIES TO COLLEGE OF PHARMACY DIESEL GENERATOR

SECTION 26 3600P - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and higher, including the following:

1. Automatic transfer switches with integral bypass isolation switch.
2. Remote annunciation system.
3. Furnish and install closed transition transfer switches (CTTS) with number of poles, amperage, voltage, withstand and close-on ratings as shown on the plans. Each CTTS shall consist of Medium voltage (5 kV through 15 kV) freestanding metal-clad switchgear with vacuum circuit
breakers and a microprocessor controller to provide automatic operation. All transfer switches and controllers shall be the products of the same manufacturer.

4. The CTTS shall transfer the load without interruption (closed transition) by momentarily connecting both sources of power only when both sources are present and acceptable. The maximum interconnection time is 100 milliseconds. The CTTS shall operate as a conventional break-before-make (open transition) switch when the power source serving the load fails.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Wiring Diagrams: Single-line diagram. Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

C. Field quality-control test reports.

D. Operation and Maintenance Data: Submit under provision of Section “Electrical General Requirements”. For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section “Closeout Procedures,” include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.
3. Include instructions for operating equipment under emergency conditions.
4. Document ratings of equipment and each major component.
5. Include routine preventive maintenance and lubrication schedule.
6. List special tools, maintenance materials, and replacement parts

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: Refer to specification section “Electrical Testing”.

C. Source Limitations: Obtain automatic transfer switches, bypass/isolation switches, non-automatic transfer switches, remote annunciators, and remote annunciator and control panels through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for emergency service under UL 1008, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

F. UL 1008 - Standard for Automatic Transfer Switches, unless requirements of those specifications are stricter.
G. NFPA 70 - National Electrical Code, including use in emergency and standby systems in accordance with Articles 517, 700, 701 and 702

H. NFPA 99 - Essential Electrical Systems for Health Care Facilities

I. NFPA 110 - Standard for Emergency and Standby Power Systems


L. NEMA Standard ICS2-447 - AC Automatic Transfer Switches

M. IEC - Standard for Automatic Transfer Switches

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of the transfer switch and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.6 EXTRA MATERIALS/ACCESSORIES

A. Submit one racking handle(s)* per Medium Voltage CTTS line-up. Charging handle to be furnished on each breaker mechanism. * Any additional racking handles shall be specified.

B. Provide one circuit breaker lifting device.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide Emerson; ASCO Power Technologies, LP or a comparable product by one of the following:

1. Contactor Transfer Switches:

   a. Emerson; ASCO Power Technologies, LP
   b. Caterpillar; Engine Div.
   c. Generac Power Systems, Inc.
   d. GE Zenith Controls.
   e. Kohler Co.; Generator Division.
   g. Russelectric, Inc.
   h. Eaton.
2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

<table>
<thead>
<tr>
<th>Switch Rating</th>
<th>Minimum WCR with &quot;any breaker&quot; rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-200</td>
<td>10,000</td>
</tr>
<tr>
<td>260-400</td>
<td>35,000</td>
</tr>
<tr>
<td>600-800</td>
<td>50,000</td>
</tr>
<tr>
<td>1000-1200</td>
<td>65,000</td>
</tr>
<tr>
<td>1600-4000</td>
<td>100,000</td>
</tr>
</tbody>
</table>

1. Provide fault-current and withstand ratings in accordance with UL 1008 standard's 1½ and 3 cycle long-time ratings. Transfer switches which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.

2. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels have communication capability matched with remote device.

D. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

F. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.

2. Switch Action: Double throw; mechanically held in both directions.

3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

H. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

I. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
J. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

K. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.
   1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

L. Enclosures: General-purpose NEMA 250, Type 3R, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCH

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.


D. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

E. Automatic Closed-Transition Transfer Switches: Include the following functions and characteristics:
   1. Fully automatic make-before-break operation.
   2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
   3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.
      a. Initiation occurs without active control of generator.
      b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

   4. Failure of power source serving load initiates automatic break-before-make transfer.

F. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

G. AUTOMATIC TRANSFER-SWITCH FEATURES
   1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes. Provides automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

5. Test Switch: Simulates normal-source failure.

6. Switch-Position Pilot Lights: Indicate source to which load is connected.


8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

9. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

10. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.

11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
   a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
   b. Push-button programming control with digital display of settings.
   c. Integral battery operation of time switch when normal control power is not available.

13. Provide selective load disconnect control circuit (24 VDC output) to operate 0 to 5 minutes (field adjustable) before transfer of the automatic transfer switch and to reset 0-5 minutes (field adjustable) after transfer, in either direction. The two time delays shall be independently adjustable. This circuit shall be supplied on all transfer switches. For switches that feed elevator loads, provide double-pole/double-throw output relay for interface purposes that is driven by above control circuitry.

14. Transfer inhibit: Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal.

2.4 BYPASS/ISOLATION SWITCH

A. Comply with requirements for Level 1 equipment according to NFPA 110.
B. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

1. Means to lock the bypass/isolation switch in the position that isolates the transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.

2. Separate bypass and isolation handles shall be utilized to provide clear distinction between the two functions. The bypass handle shall provide three operating modes: "Bypass to Normal", "Automatic" and "Bypass to Emergency." Bypass to the load-carrying source shall be affected without any interruption of power to the load (make-before-break contacts). Load break-type bypass for ATS test and isolation shall not be acceptable. The operating speed of the bypass contacts shall be the same as that of the associated automatic transfer switch and shall be independent of the speed at which the manual bypass handle is operated. In the "Automatic" mode, bypass contacts shall be all open so they will not be subjected to fault currents.

3. The isolation handle shall provide three operating modes: "Closed", "Test" and "Open". The "Test" mode shall permit testing of the entire emergency power system, including the automatic transfer switch(es), without any interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.

4. When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch allowing transfer and retransfer of the load between the two available sources without the feedback of load-regenerated voltage to the transfer switch. This transfer/retransfer operation shall comply with Paragraph 42.7 of UL 1008.

5. Bypass Switch Ratings: Match automatic transfer switch for electrical ratings.

6. Drawout Arrangement Electrically Operated for Transfer Switch: Provides physical separation from live parts and accessibility for testing and maintenance operations.

7. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.

8. Contact temperatures of bypass/isolation switches do not exceed those of automatic transfer-switch contacts when they are carrying rated load.

9. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.

10. Legend: Manufacturer's standard legend for control labels and instruction signs give detailed operating instructions.

11. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

C. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

2.5 METAL-CLAD SWITCHGEAR ASSEMBLY

A. The metal-clad switchgear shall consist of a Type 3R Outdoor Non-Walk-In enclosure containing circuit breakers and the necessary accessory components all factory assembled (except for necessary shipping splits) and operationally checked. The assembly shall be a self-supporting and floor mounted on a level concrete pad. The integrated switchgear assembly shall withstand the effects of closing, carrying and interrupting currents up to the assigned maximum short circuit rating.

B. System Voltage: 15 kV nominal, three-phase grounded**, 60 Hz.

C. Maximum Design Voltage: 15.0 kV.
D. Impulse Withstand (Basic Impulse Level): 95 kV.

E. Power Frequency Withstand: 36 kV, 1 minute test.

F. Main Bus Ampacity: 1200 amps, continuous.

G. Momentary Current Ratings: Equal to the circuit breaker close and latch rating, 50 kAIC @ 15 kV.

**Specifier to insert description, either "solidly grounded" or a specific type of impedance grounding.
NOTE: This will be important when specifying Surge Arresters.**

2.6 COMPONENTS

A. Stationary Structure

1. The switchgear shall comprise a minimum of two (for 1200A) sections including one breaker compartment and one auxiliary compartment with potential assemblies for Normal and Emergency sources assembled to form a rigid self-supporting completely enclosed structures providing steel barriers between sections.

2. The first (for 1200A) section(s) is/are divided by metal barriers into the following compartments:
   (a.) Circuit breaker, main bus and cable. The section may have up to two circuit breaker compartments for a 1200 ampere rating (a.) Circuit breaker, one set of transformer assembly, main bus and cable.

B. Circuit Breaker Compartment

1. Each circuit breaker compartment shall be designed to house a horizontal drawout metal-clad vacuum circuit breaker. The stationary primary disconnecting contacts are to be silver-plated copper and mounted within glass polyester support bushings. The movable contacts and springs shall be mounted on the circuit breaker element for ease of inspection/maintenance.

2. Entrance to the stationary primary disconnecting contacts shall be automatically covered by metal shutters when the circuit breaker is withdrawn from the connected position to the test or disconnected position or removed from the circuit breaker compartment. Extend a ground bus into the circuit breaker compartment to automatically ground the breaker frame with high-current spring type grounding contacts located on the breaker chassis when in the test and connected positions. Guide rails for positioning the circuit breaker and all other necessary hardware are to be an integral part of the circuit breaker compartment. Blocking devices shall interlock breaker frame sizes to prevent installation of a lower ampere rating or interrupting capacity element into a compartment designed for one of a higher rating. It shall be possible with indoor switchgear to install a circuit breaker into a bottom compartment without use of a transport truck or lift device.

C. Ground Bus

1. A ¼ inch x 2 inch copper ground bus shall extend through the entire length of the transfer switch.

D. Main Bus Compartment

   **Note to Specifier: All 3000 A bus will be silver-plated copper**

1. The main bus is to be rated 1200 amps and be fully insulated for its entire length with an epoxy coating by the fluidized bed process. The conductors are to be silver-plated copper and be of a bolted not welded design. Access to this compartment is gained from the front or rear of the structure by removing a steel barrier. Provide standard provisions for future extension, as applicable.

E. Doors and Panels
1. Relays, control switches, etc., shall be mounted on a formed front-hinged panel for each circuit breaker compartment. Front doors shall include features to facilitate quick and complete removal or reinstallation of entire front door assembly. Door hinges shall have removable pins. Where allowable, all control circuits (except, for example, current transformers and grounding) shall be wired via plugs/receptacles prior to termination.

F. Circuit Breakers
1. The circuit breakers shall be rated 15 kV nominal volts, 15000 maximum volts, 60 Hz, with a continuous current rating of 1200 amps and a maximum symmetrical interrupting rating* of 25kA/500MVA - 15 kV system. Furnish vacuum circuit breakers with one vacuum interrupter per phase. Breakers of same type and rating shall be completely interchangeable. The circuit breaker shall be operated by means of a stored energy mechanism which is normally charged by a universal motor but can also be charged by the manual handle supplied on each breaker for manual emergency closing or testing. The closing speed of the moving contacts is to be independent of both the control voltage and the operator. Provide a full front shield on the breaker. Secondary control circuits shall be connected automatically with a self-aligning, self-engaging plug and receptacle arrangement when the circuit breaker is racked into the connected position. Provision shall be made for secondary control plug to be manually connected in test position. A minimum of 4 auxiliary contacts (2a 2b), shall be provided for external use. 6 additional cell-mounted auxiliary contacts MOC type for external use shall be provided. The racking mechanism to move the breaker between positions shall be operable with the front door closed and position indication shall be visible with door closed.

* Maximum symmetrical kA interrupting ratings are based on Table 1 of C37.06-1997. MVA ratings are nominal reference values for comparison only.

2. An interlocking system shall be provided to prevent racking a closed circuit breaker to or from any position. An additional interlock shall automatically discharge the stored-energy operating mechanism springs upon removal of the breaker out of the compartment.

3. The circuit breaker control voltage shall be: 250 volts DC, 120 volts ac - one capacitor trip unit provided for each circuit breaker with ac control power.

G. Instrument Transformers
1. Voltage transformers are drawout mounted with primary current-limiting fuses and shall have ratio as indicated. The transformers shall have mechanical rating equal to the momentary rating of the circuit breakers and shall have metering accuracy per ANSI Standards.

2. Current transformers*: Each breaker compartment shall have provision for mounting of optional current transformers per phase* (ANSI standard relay accuracy). The current transformer assembly shall be insulated for the full voltage rating of the switchgear. The current transformers wiring shall be 12 AWG minimum.

*Relaying and metering accuracy shall conform to ANSI Standards.

H. Control Wiring
1. The switchgear shall be wired with Type SIS 12 AWG minimum. The control wiring shall be UL listed and have VW-1 flame retardant rating. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.

2.7 FABRICATION

A. Construction: Each equipment bay shall be a separately constructed cubicle assembled to form a rigid freestanding unit with sufficient bracing to minimize distortion. Minimum sheet metal thickness shall be 11 gauge steel on all exterior surfaces. Adjacent bays shall be securely bolted together to form an integrated rigid structure. The rear covers shall be removable to assist installation and maintenance of bus and cables.
B. The metal-clad switchgear shall be fully assembled, inspected and tested at the factory prior to shipment. Large line-ups shall be split to permit normal shipping and handling as well as for ease of rejoining at the job site.

2.8 FACTORY FINISHING

A. All steel parts shall be cleaned and a zinc-phosphate (outdoor equipment) pre-treatment applied prior to paint application.

B. Paint color shall be ANSI-61. Provide color chip for selection by owner; TGIC polyester powder applied electrostatically through air. Following paint application, parts shall be baked to produce a hard durable finish. The average thickness of the paint film shall be 2.0 mils. Paint film shall be uniform in color and free from blisters, sags, flaking and peeling.

C. Adequacy of paint finish to inhibit the buildup of rust on ferrous metal materials shall be tested and evaluated per paragraphs 5.2.8.1-7 of ANSI C37.20.2-1987. Salt spray withstand tests in accordance with ASTM #D-1654 and #B-117 shall be periodically performed on a sample to confirm conformance with the corrosion resistance standard of at least 2500 hours minimum (outdoor equipment).

2.9 MICROPROCESSOR CONTROLLER

A. The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.

B. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.

C. All customer connections shall be wired to a common terminal block to simplify field-wiring connections.

D. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

- EN 55011  Emission standard - Group 1, Class A
- EN 50082-2  Generic immunity standard, from which:
- EN 61000-4-2  Electrostatic discharge (ESD) immunity
- ENV 50140  Radiated Electro-Magnetic field immunity
- EN 61000-4-3  Radiated RF Electromagnetic Field Immunity
- EN 61000-4-4  Electrical fast transient (EFT) immunity
- EN 61000-4-5  Surge transient immunity
- EN 61000-4-6  Conducted Radio-Frequency field immunity
- EN 61000-4-11  Voltage Dips, Interruption and Variations Immunity

2.10 ENCLOSURE

A. All standard and optional door-mounted switches and pilot lights shall be 16-mm industrial grade type or equivalent for easy viewing & replacement.
2.11 CONTROLLER DISPLAY AND KEYPAD

A. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:

1. Nominal line voltage and frequency
2. Single or three phase sensing
3. Operating parameter protection
4. Transfer operating mode configuration
   (Open transition, Closed transition, or Delayed transition)
To appropriately trained operators, all instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

2.12 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sources</th>
<th>Dropout / Trip</th>
<th>Pickup / Reset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undervoltage</td>
<td>N&amp;E,3φ</td>
<td>70 to 98%</td>
<td>85 to 100%</td>
</tr>
<tr>
<td>Overvoltage</td>
<td>N&amp;E,3φ</td>
<td>102 to 115%</td>
<td>2% below trip</td>
</tr>
<tr>
<td>Underfrequency</td>
<td>N&amp;E</td>
<td>85 to 98%</td>
<td>90 to 100%</td>
</tr>
<tr>
<td>Overfrequency</td>
<td>N&amp;E</td>
<td>102 to 110%</td>
<td>2% below trip</td>
</tr>
<tr>
<td>Voltage unbalance</td>
<td>N&amp;E</td>
<td>5 to 20%</td>
<td>1% below dropout</td>
</tr>
</tbody>
</table>

B. Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20°C to 60°C.

C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

D. Source differential sensing shall be provided for the closed transition operating mode. The sensor shall enable transfer/re-transfer between live sources in the closed transition mode only when the two sources have a maximum voltage differential of 5%, frequency differential of 0.2 Hz and are within 5 electrical degrees.

E. Closed transition transfer shall be accomplished with no power interruption and without altering or actively controlling standby generator set.

F. The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).

G. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.

2.13 AUTOMATIC AND USER SUPERVISED NON-AUTOMATIC CONTROL

A. Open, Closed, and Delayed Transition Switching Solutions provide complete automatic control of the transfer switch. Because ASCO 7000 Series Transfer Switches are constructed as Metal-Clad
Switchgear, they also include full function Non-Automatic Control to permit safe, electrically interlocked user supervised operation.

B. A Transfer Switch Automatic-Manual selector switch allows the user to place the transfer switch in a fully manual mode of operation. The Normal and Emergency Source Circuit Breakers may then be operated using the circuit breaker control switches on the front of each circuit breaker compartment. This provides electrically interlocked operation to ensure that both circuit breakers cannot be closed simultaneously. Additionally, the Normal or Emergency Source Circuit Breakers may be tripped open by the circuit breaker control switches at any time during Automatic or Manual operation.

C. Included Components:
      a. Trip, Close, and Pull to Lock
      b. Closed LED – Red
      c. Open LED – Green
      d. Tripped LED – Amber (When Optional Protective Relaying is provided)
   3. Controls Not In Auto LED (Indicates Automatic Operating Mode Disabled).

2.14 TIME DELAYS

A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.

B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

C. An adjustable time delay of 0 to 6 seconds to override momentary emergency source outage to delay all retransfer signals during initial loading of engine generator set.

D. Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 10 hours. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

E. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

F. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:
   1. Prior to transfer only.
   2. Prior to and after transfer.
   3. Normal to emergency only.
   4. Emergency to normal only.
   5. Normal to emergency and emergency to normal.
   6. All transfer conditions or only when both sources are available.

G. The controller shall also include the following user-adjustable time delays for optional Closed Transition and Delayed Transition operation:
1. FailToSyncTD: failure to synchronize normal and emergency sources prior to closed transition transfer.
2. XtdParallelTD: extended parallel condition of both power sources during closed transition operation.

H. All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.
I. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

2.15 ADDITIONAL FEATURES

A. A three position momentary-type test switch shall be provided for the test / automatic / reset modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.

B. A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

C. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the CTTS is connected to the normal source and one contact closed, when the CTTS is connected to the emergency source.

D. LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the CTTS is connected to the normal source (green) and one to indicate when the CTTS is connected to the emergency source (red).

E. LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.

The following features shall be built-in to the controller, but capable of being activated through keypad programming or the serial port only when required by the user:

F. Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

G. Engine Exerciser - The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:
   1. Enable or disable the routine.
   2. Enable or disable transfer of the load during routine.
   3. Set the start time:
      - Time of day
      - Day of week
      - Week of month (1st, 2nd, 3rd, 4th, alternate or every)
      a. Set the duration of the run.
4. At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

The following feature shall be built into the controller, but capable of being activated through keypad programming or the communications interface port.

H. Terminals shall be provided for a remote contact which opens to signal the CTTS to transfer to emergency.

I. System Status - The controller LCD display shall include a “System Status” screen which shall be readily accessible from any point in the menu by depressing the “ESC” key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example,

Normal Failed
Load on Normal
TD Normal to Emerg
2min15s

Controllers that require multiple screens to determine system status or display “coded” system status messages, which must be explained by references in the operator’s manual, are not permissible.

J. Self Diagnostics - The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

K. Communications Interface – The controller shall be capable of interfacing, through an optional serial communication module, with a network of transfer switches, locally (up to 4000 ft.) or remotely through modem serial communications. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.

L. Data Logging – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:

1. Event Logging
   a. Data and time and reason for transfer normal to emergency.
   b. Data and time and reason for transfer emergency to normal.
   c. Data and time and reason for engine start.
   d. Data and time engine stopped.
   e. Data and time emergency source available.
   f. Data and time emergency source not available.

2. Statistical Data
   a. Total number of transfers.
   b. Total number of transfers due to source failure.
   c. Total number of days controller is energized.
   d. Total number of hours both normal and emergency sources are available.

M. Communications Module - A full duplex RS485 interface shall be installed in the CTTS controller to enable serial communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices. The serial communication interface shall be equal to ASCO Accessory 72A.
2.16 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel annunciates conditions for indicated transfer switches. Annunciation includes the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Switch position.
3. Switch in test mode.
4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.
2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.17 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounted Switch: Anchor to floor by bolting.

1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 2 inches (50 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated. Cast anchor-bolt inserts into bases. Comply with Division 3 Section "Cast-in-Place Concrete."

B. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

C. Identify components according to Division 26 Section "Electrical Identification."

3.2 WIRING TO REMOTE COMPONENTS

A. Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."
C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing."

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.22.3. Certify compliance with test parameters.
   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
   e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
   f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
   g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
   a. Verify grounding connections and locations and ratings of sensors.
   b. Observe reaction of circuit-interrupting devices when simulated fault current is applied at sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.
3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Section "Closeout Procedures."

1. Coordinate this training with that for generator equipment.

END OF SECTION 26 3600
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches with integral bypass isolation switch.
2. Remote annunciation system.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Wiring Diagrams: Single-line diagram. Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

C. Field quality-control test reports.

TRANSFER SWITCHES - SCIENCE HALL 263600SH - 1
D. Operation and Maintenance Data: Submit under provision of Section “Electrical General Requirements”. For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section “Closeout Procedures,” include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.
3. Include instructions for operating equipment under emergency conditions.
4. Document ratings of equipment and each major component.
5. Include routine preventive maintenance and lubrication schedule.
6. List special tools, maintenance materials, and replacement parts

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: Refer to specification section “Electrical Testing”.

C. Source Limitations: Obtain automatic transfer switches, bypass/isolation switches, non-automatic transfer switches, remote annunciators, and remote annunciator and control panels through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for emergency service under UL 1008, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

F. UL 1008 - Standard for Automatic Transfer Switches, unless requirements of those specifications are stricter.

G. NFPA 70 - National Electrical Code, including use in emergency and standby systems in accordance with Articles 517, 700, 701 and 702

H. NFPA 99 - Essential Electrical Systems for Health Care Facilities

I. NFPA 110 - Standard for Emergency and Standby Power Systems


L. NEMA Standard ICS2-447 - AC Automatic Transfer Switches

M. IEC - Standard for Automatic Transfer Switches
1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of the transfer switch and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide Emerson; ASCO Power Technologies, LP or a comparable product by one of the following:

1. Contactor Transfer Switches:
   a. Emerson; ASCO Power Technologies, LP
   b. Caterpillar; Engine Div.
   c. Generac Power Systems, Inc.
   d. GE Zenith Controls.
   e. Kohler Co.; Generator Division.
   g. Russelectric, Inc.
   h. Eaton.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

<table>
<thead>
<tr>
<th>Switch Rating</th>
<th>Minimum WCR with &quot;any breaker&quot; rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-200</td>
<td>10,000</td>
</tr>
<tr>
<td>260-400</td>
<td>35,000</td>
</tr>
<tr>
<td>600-800</td>
<td>50,000</td>
</tr>
<tr>
<td>1000-1200</td>
<td>65,000</td>
</tr>
<tr>
<td>1600-4000</td>
<td>100,000</td>
</tr>
</tbody>
</table>

1. Provide fault-current and withstand ratings in accordance with UL 1008 standard's 1½ and 3 cycle long-time ratings. Transfer switches which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.

2. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
C. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels have communication capability matched with remote device.

D. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

F. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
   1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
   2. Switch Action: Double throw; mechanically held in both directions.
   3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

H. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

I. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

J. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

K. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.
   1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

L. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated. Paint color shall be ANSI-61 per Owner provided paint chip color.

2.3 AUTOMATIC TRANSFER SWITCH

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.


D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
E. Automatic Closed-Transition Transfer Switches: Include the following functions and characteristics:

1. Fully automatic make-before-break operation.
2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.
   a. Initiation occurs without active control of generator.
   b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.
4. Failure of power source serving load initiates automatic break-before-make transfer.

F. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

G. AUTOMATIC TRANSFER-SWITCH FEATURES

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes. Provides automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulates normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
10. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
11. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day
exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.

b. Push-button programming control with digital display of settings.

c. Integral battery operation of time switch when normal control power is not available.

12. Provide selective load disconnect control circuit (24 VDC output) to operate 0 to 5 minutes (field adjustable) before transfer of the automatic transfer switch and to reset 0-5 minutes (field adjustable) after transfer, in either direction. The two time delays shall be independently adjustable. This circuit shall be supplied on all transfer switches. For switches that feed elevator loads, provide double-pole-double-throw output relay for interface purposes that is driven by above control circuitry.

13. Transfer inhibit: Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal.

2.4 BYPASS/ISOLATION SWITCH

A. Comply with requirements for Level 1 equipment according to NFPA 110.

B. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

1. Means to lock the bypass/isolation switch in the position that isolates the transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.

2. Separate bypass and isolation handles shall be utilized to provide clear distinction between the two functions. The bypass handle shall provide three operating modes: "Bypass to Normal", "Automatic" and "Bypass to Emergency." Bypass to the load-carrying source shall be affected without any interruption of power to the load (make-before-break contacts). Load break-type bypass for ATS test and isolation shall not be acceptable. The operating speed of the bypass contacts shall be the same as that of the associated automatic transfer switch and shall be independent of the speed at which the manual bypass handle is operated. In the "Automatic" mode, bypass contacts shall be all open so they will not be subjected to fault currents.

3. The isolation handle shall provide three operating modes: "Closed", "Test" and "Open". The "Test" mode shall permit testing of the entire emergency power system, including the automatic transfer switch(es), without any interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.

4. When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch allowing transfer and retransfer of the load between the two available sources without the feedback of load-regenerated voltage to the transfer switch. This transfer/retransfer operation shall comply with Paragraph 42.7 of UL 1008.

5. Bypass Switch Ratings: Match automatic transfer switch for electrical ratings.

6. Drawout Arrangement Electrically Operated for Transfer Switch: Provides physical separation from live parts and accessibility for testing and maintenance operations.

7. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.

8. Contact temperatures of bypass/isolation switches do not exceed those of automatic transfer-switch contacts when they are carrying rated load.
9. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.
10. Legend: Manufacturer's standard legend for control labels and instruction signs give detailed operating instructions.
11. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

C. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

2.5 REMOTE ANNUNCIATOR SYSTEM
A. Functional Description: Remote annunciator panel annunciates conditions for indicated transfer switches. Annunciation includes the following:
1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Switch position.
3. Switch in test mode.
4. Failure of communication link.
B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
1. Indicating Lights: Grouped for each transfer switch monitored.
2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.6 SOURCE QUALITY CONTROL
A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Floor-Mounted Switch: Anchor to floor by bolting.
1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 2 inches (50 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated. Cast anchor-bolt inserts into bases. Comply with Division 3 Section "Cast-in-Place Concrete."
B. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
C. Identify components according to Division 26 Section “Electrical Identification”.
3.2 WIRING TO REMOTE COMPONENTS

A. Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing."

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.22.3. Certify compliance with test parameters.


   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
   e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
   f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
   g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
   a. Verify grounding connections and locations and ratings of sensors.
   b. Observe reaction of circuit-interrupting devices when simulated fault current is applied at sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Section "Closeout Procedures."

1. Coordinate this training with that for generator equipment.

END OF SECTION 26 3600
SECTION 26 4313 – SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes SPDs for low-voltage power, control, and communication equipment.

B. Related Sections include the following:

1. Division 26 Section "Wiring Devices" for devices with integral SPDs.

1.3 REFERENCES


E. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).

F. NEMA LS 1: Low Voltage Surge Protection Devices.


J. UL 1283: Electromagnetic Interference Filters.


1.4 DEFINITIONS


B. SVR: Suppressed voltage rating.

C. SPD: Surge Protective Devices.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

   1. Include rated capacities, operating weights, dimensions, mounting provisions, operating characteristics, furnished specialties, and accessories.
   2. Provide connection details and wiring diagrams indicating how SPD device is integrated within panelboards and switchgear.

B. Product Certificates: For surge protective devices, signed by product manufacturer certifying compliance with the following standards:

   1. UL 1283.
   2. UL 1449.

C. Field quality-control test reports, including the following:

   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Failed test results and corrective action taken to achieve requirements.

D. Operation and Maintenance Data: For surge protective devices to include in emergency, operation, and maintenance manuals.

E. Warranties: Special warranties specified in this Section.
1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain SPD’s and accessories through one source from a single manufacturer. SPD units integral to switchboards, distribution panelboards and branch circuit panelboards shall be warranted and supported by the panelboard manufacturer.

B. Product Options: Electrical performance of SPD is based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Factory Testing: The specified system shall be factory-tested prior to shipment. Testing of each system shall include but not be limited to quality control checks, "Hi-Pot" tests per UL requirements, IEEE C62.41 Category B and C surge tests, UL ground leakage tests and operational and calibration tests.


F. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices." Provide independent test reports demonstrating complete system performance showing compliance.


1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Construction Manager not less than seven days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Construction Manager’s written permission.

B. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Frequency: 47 to 63 Hz.
3. Operating Temperature: -40 to 140 deg F (-40 to 60 deg C).
4. Humidity: 0 to 95 percent, noncondensing.
5. Altitude: Less than 20,000 feet (6090 m) above sea level.

1.8 COORDINATION

A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

B. Coordinate surge protection devices with Division 26 Section "Electrical Power Monitoring and Control."
1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2. General Electric Company.
3. Siemens Industries, Inc.
4. Square D; Schneider Electric.

2.2 SURGE PROTECTIVE DEVICE

A. Surge Protection Device Description: Sine-wave-tracking type, with the following features and accessories:

1. MOV technology for each suppression mode.
2. Fuses, rated at 200-kA interrupting capacity. Provide fusing for each suppression path.
3. Fabrication using bolted compression lugs for internal wiring. No plug-in component modules, quick disconnect terminals or printed circuit boards shall be used in current-carrying paths.
4. Integral disconnect switch which has been tested to the surge current rating of the SP to match or exceed the fault current rating of the board. Use of circuit breakers for disconnecting means is acceptable.
5. LED indicator lights for power and protection status for each phase mounted in panelboard front cover:
   a. Green indicates fully operational circuit.
   b. Red indicates loss of protection.
6. EMI-RFI Noise Rejection: based on MIL-STD-E220A, 50-ohm standard Insertion Loss Test:
   a. 34dB at 100 kHz.
   b. 51dB at 1 MHz.
   c. 54dB at 10 MHz.
   d. 48dB at 100 MHz.
7. The maximum continuous operating voltage (MCOV) for all voltage configurations shall be 115% if nominal or greater.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.

B. Peak Single-Impulse Surge Current Rating for service entrance equipment (C3 Rating): 320 kA per phase; 160 kA per mode based on a single pulse, IEEE C62.41 standard 8 x 20 microsecond waveform. Device shall not suffer more than 10% deviation in clamping voltage at specified surge current.

C. Peak Single-Impulse Surge Current Rating for service entrance equipment (B2 Rating): 240 kA per phase; 120 kA per mode based on a single pulse, IEEE C62.41 standard 8 x 20 microsecond waveform. Device shall not suffer more than 10% deviation in clamping voltage at specified surge current.

D. Minimum Repetitive Surge Current Capability: 10,000 for service entrance and 5,000 for distribution panels and panelboards impulse per mode in accordance with ANSI/IEEE C62.41 and ANSI/IEEE C62.45 utilizing a Category C3 bi-wave at one minute intervals without suffering either performance degradation or more than 10% deviation of specified UL 1449 Suppression Voltage Ratings at specified surge current.

E. Connection Means:

1. Integral: Bus mounted, parallel connection
2. External: Cable connection, parallel wired.

F. Protection modes and UL 1449 Listed and Recognized Component Surge Voltage Rating for grounded wye circuits with voltages of 480Y/277V, 3-phase, 4-wire circuits shall not exceed the following:

1. Line to Neutral: 1200V
2. Line to Ground: 1200V
3. Neutral to Ground: 1200V
4. Line to Line: 2000V

G. Protection modes and UL 1449 Listed and Recognized Component Surge Voltage Rating for grounded wye circuits with voltages of 208Y/120V, 3-phase, 4-wire circuits shall not exceed the following:

1. Line to Neutral: 700V
2. Line to Ground: 700V
3. Neutral to Ground: 700V
4. Line to Line: 1500V

H. Protection modes and UL 1449 Listed and Recognized Component Surge Voltage Rating for 240/120V, single phase, 3-wire circuits shall not exceed the following:

1. Line to Neutral: 700V
2. Line to Ground: 700V
3. Neutral to Ground: 700V

I. Protection modes and UL 1449 Listed and Recognized Component SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall not exceed the following:

1. Line to Neutral: 700 V, 1500 V from high leg.
2. Line to Ground: 700 V.
3. Neutral to Ground: 700 V.

J. Protection modes and UL 1449 Listed and Recognized Component SVR for voltages of 480V, 3-phase, 3-wire, delta circuits shall not exceed the following:

1. Line to Line: 2000V
2. Line to Ground: 2000V.
2.3 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

A. Surge protective devices shall be factory installed in all new distribution equipment.

B. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

C. Install devices for service entrance equipment and panelboards with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide a dedicated disconnect for suppressor as indicated on one line or in panel schedules.

3.2 PLACING SYSTEM INTO SERVICE

A. Do not energize or connect distribution equipment to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL

A. Testing: Perform the following field tests and inspections and prepare test reports. Test all service entrance and electronic grade panelboard suppressors.

1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.

2. Complete startup checks according to manufacturer's written instructions.

3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.

   a. Visual and Mechanical Inspection

      1) Inspect for physical damage and compare nameplate data with Drawings and Specifications.

      2) Inspect for proper mounting and adequate clearances.

      3) Check ground lead on each device for individual attachment to ground bus or ground electrode.

   B. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain surge protection devices. Refer to Division 1.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Exterior luminaires with lamps and ballasts.
2. Luminaire-mounted photoelectric relays.
3. Poles and accessories.
4. Luminaire lowering devices.

B. Related Sections include the following:

1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.
EXTERIOR LIGHTING

1.3 DEFINITIONS

A. CRI: Color-rendering index.

B. HID: High-intensity discharge.

C. Luminaire: Complete lighting fixture, including ballast housing if provided.

D. Pole: Luminaire support structure, including tower used for large area illumination.

E. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.

B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4.

C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4.

D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.

1. Wind speed for calculating wind load for poles 50 feet or less in height is 110 mph.

1.5 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.

2. Details of attaching luminaires and accessories.

3. Details of installation and construction.

4. Luminaire materials.

5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.

   a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

   b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. Ballasts, including energy-efficiency data.

7. Lamps, including life, output, and energy-efficiency data.

8. Materials, dimensions, and finishes of poles.

9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

10. Anchor bolts for poles.

11. Manufactured pole foundations.

B. Shop Drawings:
1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.

C. Samples for Verification: For products designated for sample submission in Exterior Lighting Device Schedule. Each sample shall include lamps and ballasts.

D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

E. Qualification Data: For agencies providing photometric data for lighting fixtures.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


E. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.

D. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.
1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
   2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: To match existing poles.

N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
   2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
   3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
   4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
      a. Color: Dark bronze.
2.3 FLUORESCENT BALLASTS AND LAMPS

A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures 0 deg F and higher.

B. Ballast Characteristics:

1. Power Factor: 90 percent, minimum.
2. Sound Rating: A.
3. Total Harmonic Distortion Rating: Less than 10 percent.
6. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.

C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures minus 20 deg F and higher.

D. Fluorescent Lamps: Low-mercury type. Comply with the EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

2.4 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F.
3. Normal Ambient Operating Temperature: 104 deg F.
4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

B. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.

2.5 HID LAMPS

A. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.

2.6 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-4.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers’ mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
   3. Anchor-Bolt Template: Plywood or steel.

D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.7 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; 1-piece construction up to 40 feet in height with access handhole in pole wall.
   1. Shape: Square, straight.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
   1. Adapter fitting welded to pole and bracket, then bolted together with galvanized-steel bolts.
   2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
   3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet above finished grade.

F. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.

G. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

H. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

I. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.

J. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
K. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

L. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.


PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION


B. Install lamps in each luminaire.

C. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

D. Adjust luminaires that require field adjustment or aiming.

3.2 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.


3. Trees: 15 feet.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 3 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers, unless otherwise indicated.
4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

3.3 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding."

B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding."

3.4 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

   d. IESNA LM-64, "Photometric Measurements of Parking Areas."
   e. IESNA LM-72, "Directional Positioning of Photometric Data."

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 26 5600
DIVISION 27 - COMMUNICATIONS

270010  TELECOMMUNICATIONS GENERAL REQUIREMENTS
270110  TELECOMMUNICATIONS INTERIOR PATHWAYS
270150  TELECOMMUNICATIONS CABLELING
270170  CABLE PLANT ADMINISTRATION AND TESTING

END OF TABLE OF CONTENTS
1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 SUMMARY

A. This Section includes telecommunications general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 1 Specification Sections.

1.3 COORDINATION WITH OTHER TRades

A. The Contractor shall coordinate the installation of the telecommunications wiring devices, equipment, supports, pathways etc., with all other trades prior to installation. Verify and coordinate routing of conduits, wireways, etc., intended to support routings of telecommunications cabling.
1.4 DRAWINGS

A. The drawings show the location and general arrangement of equipment, electrical systems and related items. They shall be followed as closely as elements of the construction will permit.

B. Examine the drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, conduit, junction boxes and accessories as may be required to meet such conditions.

C. Deviations from the drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer and WSU C & IT.

D. The architectural and structural drawings take precedence in all matters pertaining to the building structure, mechanical drawings in all matters pertaining to mechanical trades and electrical drawings in all matters pertaining to electrical trades. Where there are conflicts or differences between the drawings for the various trades, report such conflicts or differences to the Architect/Engineer and WSU C & IT for resolution.

1.5 INSPECTION OF SITE

A. Visit the site, examine and verify the conditions under which the work must be conducted before submitting proposal.

B. The submitting of a proposal implies that the contractor has visited the site and understands the conditions under which the work must be conducted.

1.6 CONTRACT BREAKDOWN

A. WSU Facilities Department retains the installation and coordination for all projects initiated by that department. WSU C & IT retains the installation and coordination for all projects not initiated by WSU Facilities.

B. Within two (2) weeks following award of contract, submit to the Architect/Engineer for approval a contract amount breakdown. Breakdown shall be submitted on a form similar to the form available at the Architect's/Engineer's office. All requests for payment shall be based on the approved breakdown.

1.7 TEMPORARY FACILITIES

A. Provide and remove upon completion of the project, in accordance with the general conditions, a complete temporary telephone service during construction, as required.

1.8 ALTERNATES

A. See Alternate Section and other applicable parts of the specifications.

1.9 GUARANTEE

A. Contractor guarantees that the installation is free from defects and agrees to replace or repair, any part of this installation which becomes defective within a period of one year following final acceptance, provided that such failure is due to defects in the equipment, material or installation or to follow the specifications and drawings. File with the Owner any and all guarantees from the equipment manufacturers.
1.10 CODES, PERMITS AND FEES

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for telecommunications work shall be secured and paid for by the contractor. All work shall conform to all applicable codes, rules and regulations.

B. Rules of local service providers shall be complied with. Check with the local exchange carrier supplying service to the installation and determine all raceways and devices required including, but not limited to, all terminal cabinets, backboards, space requirements, etc.

C. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed drawings or diagrams which may be required by the governing authorities. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern.

1.11 STANDARDS OF MATERIAL AND WORKMANSHIP:

A. All materials shall be new. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:

- A.N.S.I. American National Standards Institute
- A.S.T.M. American Society for Testing Materials
- BICSI Building Industry Consulting Services International
- I.C.E.A. Insulated Cable Engineer’s Association
- I.E.E.E. Institute of Electrical and Electronics Engineers
- N.E.C. National Electrical Code
- N.E.M.A. National Electrical Manufacturer's Association
- TIA/EIA Telecommunications Industry Association/Electronic Industries Association
- U.L. Underwriters Laboratories, Inc.
- NFPA National Fire Protection Agency

B. Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the Trades involved.

C. All equipment of the same or similar systems shall be by the same manufacturer.

1.12 RECORD DRAWINGS

A. Provide complete operating and maintenance instruction manuals covering all telecommunications equipment herein specified, together with parts lists. All literature shall be furnished in triplicate for Owner and shall be bound in book or ring binder form as directed by Architect/Engineer.

B. The operating and maintenance instructions shall include a brief, general description for all electrical systems including, but not limited to:

1. Routine maintenance procedures.
2. Trouble-shooting procedures.
3. Contractor's telephone numbers for warranty repair service.
4. Shop drawings.
5. Recommended spare parts lists.
6. Names and telephone numbers of major material suppliers.

C. Provide revised telecommunications working drawings indicating "as-built" conditions. Drawings shall indicate all changes that have occurred during construction. Properly identify backbone and horizontal wiring.
pathways. Locate all network and workstation devices. Identify all devices on plan with proper labeling. "As-Built" drawings shall be submitted on AutoCAD 2000 or compatible electronic format. Provide two copies paper and one copy electronic.

D. Provide certified test records for all installed cable showing compliance with specifications. Provide in single bound volume arranged by function and geographic location. Also provide test records in electronic format.

1.13 MATERIAL AND EQUIPMENT MANUFACTURERS

A. All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of telecommunications equipment and shall be of the manufacturer's latest design.

B. No substitutions will be allowed without WSU C & IT approval.

1.14 SHOP DRAWINGS/SUBMITTALS

A. All shop drawings shall be submitted in groupings of similar and/or related items (cable and connectors, etc.). Incomplete submittal groupings will be returned unchecked.

B. Provide detailed layout shop drawings (on transparent media) of backbone and horizontal cabling distribution, pathways, equipment room layouts, details and related information necessary of installation and maintenance. After review by the Engineer and WSU C & IT, a copy of drawings will be stamped and returned to the contractor.

C. Submit for approval eight (8) copies of shop drawings for all telecommunications systems or equipment but not limited to the items listed below. Where items are referred to by symbolic designation on the drawings and specifications, all submittals shall bear the same designation. Refer to other sections of the specifications for additional requirements.

1. Structured cabling system components
2. Structured cable system raceways and supports.
3. Labeling equipment.
4. Conduit, innerduct, junction and pullboxes.
5. Surface raceway components.

1.15 USE OF EQUIPMENT

A. The use of any equipment or any part thereof for purposes other than testing even with the Owner’s consent shall not be construed to be an acceptance of the work on the part of the Owner, nor be construed to obligate the Owner in any way to accept improper work or defective materials.

1.16 WORK PROVIDED BY OTHERS

A. Conduit, sleeves, boxes, floor boxes, surface raceways and grounding shall be provided by the Electrical Contractor under Division 26.

B. Coordinate installation of telecommunications work with work provided by Electrical Contractor in paragraph A above.
C. It is the responsibility of the Telecommunications Contractor to coordinate with the Electrical Contractor when submitting bids. The Telecommunications Contractor shall be responsible for immediately notifying the General Contractor of any improper application or installation of all items affecting the telecommunications system.

D. The Owner will provide network electronics equipment in all Communication Rooms and all voice cross-connect jumpers as required.

1.17 CONTRACTOR QUALIFICATIONS

A. The Installing Contractor for each communications system shall have a minimum of 5 years of experience with the types of systems specified.

B. The Installing Contractor shall submit a reference list consisting of a minimum of 3 installations of equivalent size and complexity of this contract. The reference list shall contain the following information for each installation:

1. Name of project, square footage, location and brief description of systems.
2. Date of completed installation.
3. Contact name and phone number of facility representative.
4. Total bid amount of each system installed.
5. Final contract amount of each system installed, including all change orders and bulletins.

C. The Installing Contractor shall submit with the bid the names and registration numbers of members of the firm that have a valid membership and are certified with BICSI as registered Communications Distribution Designers (RCDD). This contractor shall identify at least one RCDD assigned to this project in the bid.

D. The bidding, shop drawing submittal, procurement of materials, the installation as-builts and record documents shall be reviewed and overseen by the RCDD(s) assigned to the project.

E. The contractor’s bid, shop drawing submittals, as-builts and record documents shall bear the valid seal of the RCDD(s) assigned to this project.

F. All calculations, shop drawings, testing, certification and as-built documents shall be directly supervised by the licensed Technician/Engineer assigned to the project.

G. The Contractor must provide a copy of the manufacturer’s certification that the contractor is currently certified to install and warranty the proposed system.

PART 2 - PRODUCTS

NOT APPLICABLE.

PART 3 - EXECUTION

3.1 INSTALLATION OF EQUIPMENT

A. Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the drawings and specifications, report such conflicts to the Architect/Engineer and WSU C & IT for resolution.
3.2 WORK PERFORMED BY OTHERS

A. Electrical Contractor shall install 4” sq. cast boxes. Minimum 1” trade size conduit (or as indicated on drawings) stubbed 12” above ceiling with 6” radius (or as required by TIA/EIA – 569), with a 90 degree bend at top in the direction towards route destination, and plastic bushing for recessed location.

B. The Owner will provide network equipment in all Communication Rooms as required.

C. The Owner will provide all voice cross-connect jumpers.

3.3 DEMOLITION WORK

A. All demolition of existing telecommunications cable, equipment and materials shall be specified by C&IT and done by this Contractor unless otherwise indicated. Include all items such as, but not limited to, cable, patch panels, devices, and wiring called out on the Drawings and as necessary whether such items are actually indicated on the Drawings or not in order to accomplish the installation of the specified new work.

B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this work.

C. None of the recovered material shall be reused in the new work.

D. Where equipment or fixtures are removed, outlets shall be properly blanked off, and conduits capped. After alterations are done, the entire installation shall present a “finished” look, as approved by the Architect/Engineer. The original function of the present systems to be modified shall not be changed unless required by the specific revisions to the system as specified or as indicated.

E. Reroute cable as required to maintain service. Where walls and ceilings are to be removed and shown on the Drawings, the conduit is to be cut off by the Electrical Trades so that the abandoned conduit in these walls and ceilings may be removed with the walls and ceilings by the Architectural Trades. All dead-end conduit runs shall be plugged at the remaining outlet boxes or at the panels.

F. Where new walls and/or floors are installed which interfere with existing telecommunications outlets, devices, etc., this Contractor shall adjust, extend and reconnect such items are required to maintain continuity of same.

G. All electrical work in altered and unaltered areas shall be run concealed wherever possible. Use of surface meal raceway or exposed conduits will be permitted only where approved by the Architect/Engineer and as specifically indicated on the Drawings.

3.4 WORK IN EXISTING BUILDINGS

A. The Owner will provide access to existing buildings as required. However, this contractor, once work is started in the existing building, shall complete same without interruption so as to return work areas as soon as possible to Owner.

B. Adequately protect and preserve all existing and newly installed work. Promptly repair any damage to same at this contractor’s expense.

C. Consult with the Owner’s Project Coordinator and C & IT Project Coordinator as to the methods of carrying on the work so as not to interfere with the Owner’s operation anymore than absolutely necessary. Accordingly, all telecommunication services shall be kept in operation as long as possible and the services shall only be interrupted at such times as will be designated by the Owner’s representative.
3.5 COORDINATION

A. Install work to avoid interference with work of other trades including, but not limited to, architectural, mechanical and electrical trades. Remove and relocate any work that causes interference at this contractor's expense. Disputes regarding the cause of interference will be resolved by the Owner’s representative or Architect/Engineer.

3.6 CHASES AND RECESSES

A. Chases and recesses shall be provided by the Architectural Trades, but this contractor shall be responsible for coordinating their accurate location and size.

3.7 SLEEVES

A. Provide and install EZ path fire stop system wherever conduits or cabling pass through fire rated walls, floors or cables pass through openings in walls.

B. All sleeves through the floor are to extend 4 inches above floor, unless otherwise noted. Provide escutcheons at each sleeve in finished areas and adequate spacing between sleeves to accommodate escutcheons.

3.8 CUTTING, PATCHING AND DAMAGE TO OTHER WORK

A. Refer to General Conditions for requirements.

B. All cutting, patching and repair work shall be done by the contractor.

3.9 CLEANING

A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.

B. Final cleanup shall include, but not be limited to, cleaning all telecommunications equipment spaces, devices, cover plates, and removing all scrap cable and debris from pathways.

3.10 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

A. Equipment and materials shall be protected from theft, injury or damage.

B. Protect conduit openings with temporary plugs or caps.

C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by the Owner’s representative or Architect. Equipment set in place in unprotected areas must be provided with temporary protection.

3.11 EXTRA WORK

A. For any extra telecommunications work that may be proposed, this contractor shall furnish to the General Contractor, an itemized breakdown of the estimated cost of the materials and labor required to complete this work. This contractor shall proceed only after receiving a written order from the General Contractor establishing the agreed price and describing the work to be done.
3.12 DRAWINGS AND MEASUREMENTS

A. These Specifications and accompanying drawings are intended to describe and provide for finished work. They are intended to be cooperative, and what is called for by either shall be as binding as if called for by both. The Contractor will understand that the work herein described shall be complete in every detail.

B. The drawings are not intended to be scaled for rough-in measurements or to serve as Shop Drawings. Field measurements, necessary for ordering materials and fitting the installation to the building construction and arrangement, shall be taken by this contractor.

END OF SECTION 270010
SECTION 270110 - TELECOMMUNICATIONS INTERIOR PATHWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

B. Related Sections include the following:

1. Division 27 Section “Telecommunications General Requirements.”

1.2 REFERENCES


C. ANSI/TIA/EIA 568-A - Commercial Building Telecommunications Cabling Standard


E. ANSI/TIA/EIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications


G. BICSI – Building Industry Consulting Services International.

1.3 SUBMITTALS

A. Submit all structured cabling system raceways and supports identified in this section under provisions of Section 17010.

B. Product Data: Provide for products specified and required.
C. Shop Drawings: Indicate project specific part numbers, dimensions, support points, fittings and finishes.

1.4 PROJECT RECORD DOCUMENTS

A. Submit all structured cabling system raceways and supports identified in this section under provisions of Section 17010.

B. Accurately record equipment layout and cable layouts in all telecommunication spaces.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 17010.

B. Protect products from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.6 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Verify routing and termination locations of conduits, and cable pathways prior to rough-in.

1.7 DESCRIPTION OF SYSTEMS

A. Communications cabling systems pathways shall be installed in accordance with ANSI/TIA/EIA 569-A.

B. Horizontal cabling (cabling from the telecommunications room to the work area outlet) pathways shall consist of conduit, J-hooks as indicated on drawings and as required.

C. Where the accessible ceiling systems are used as the primary pathway, cabling shall be installed in main cable tray runs as indicated on the drawings, with individual work area cables routed exposed and supported as specified herein.

PART 2 - PRODUCTS

2.1 CONDUIT REQUIREMENTS

A. Refer to specification 16130 for conduit specifications.

B. Provide plastic bushings for all conduit terminations serving telecommunications cabling.

2.2 SLEEVES

A. Riser sleeves through floor between telecommunication rooms shall be 4” trade size rigid steel conduit with bushings at each end.

B. Riser sleeves shall be stubbed down to telecommunication mounting backboard at approximately 8'-6” AFF, extending up through floor slab and terminating 3” AFF in room above.
C. All sleeves shall be firestopped. Refer to drawings and specification 16130 for specified fire-stop materials.

D. Sleeves through walls shall be EMT conduit, 4” diameter minimum, or as indicated on the drawings with bushings at both ends.

2.3 J-HOOKS

A. Manufacturers:

1. Erico-Caddy
2. B-Line

B. Horizontal cable routed exposed through ceiling space shall be supported from J-hooks.

C. J-hooks shall be a minimum of 5/8” wide and shall have a bearing surface that complies with required bend radii of the specified cables to be supported.

D. J-hooks shall have flared or folded edges to prevent damage when installing cables.

PART 3 - EXECUTION

3.1 GENERAL

A. Where cables pass through walls, the Contractor shall provide EZ path fire system through penetration to match rating of wall. The penetration shall be sized per ANSI/TIA/EIA-569.

B. The Contractor shall fire-stop all wall penetrations, including those that are not EZ path fire stop, after final cable installation, using Engineer-approved materials. Fire-stopping materials shall be installed per manufacturer's recommendations and shall maintain partition rating and integrity. All fireproofing shall be applied in a neat manner with all excess material cleaned from all walls and surfaces. Contractor shall replace and re-install all fireproofing materials removed during cable installation.

C. Contractor shall patch and repair any holes or other damage to walls or partitions and paint to match original, as applicable.

D. The Communication Cabling Contractor shall provide plastic and/or grounding bushings, as applicable, on all conduit sleeves, stubs and conduit terminations that may have been missed by the Electrical Contractor.

E. All cutting, patching and restoration to the original condition of walls, ceilings, floors, etc., shall be the responsibility of the Contractor.

F. All ceiling removal and restoration required for the execution of this work shall be the responsibility of the Contractor.

G. All horizontal sleeves and conduits that penetrate telecommunications rooms shall extend into room a minimum of 3”, without bends and 8'-0” AFF minimum, unless otherwise noted.

H. Provide EZ path fire stop sleeves where cables pass through fire rated walls.

I. Provide coring/drilling and sleeves through floors as indicated on drawings and as required. Provide fireproofing to maintain fire-rating of floor.

J. All cabling installed exposed in accessible ceiling systems shall be supported by cable tray or J-hooks.
K. All J-hooks shall be supported directly from the structure above or wall mounted, as applicable, independent of ceiling framing, electrical conduit, mechanical piping and ductwork. Provide all-thread rod with $\frac{1}{4}$" diameter or equivalent supporting means with suitable fasteners when attaching to structure or structural members. Increase size of support as required when multiple J-hooks (stacked or tree configuration) are attached to single support based on maximum loading capacity of J-hooks.

L. J-Hooks shall be spaced 48” O.C. maximum.

M. Telecommunications cabling shall be routed in conduit above hard ceilings.

N. Communications cable routing shall be coordinated with above ceiling work of other contractors to avoid conflicts and potential sources of EMI.

O. Do not route exposed communications cabling within 18” of lighting fixtures and electrical power feeders.

END OF SECTION 270110
SECTION 270150 - TELECOMMUNICATIONS CABLELING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

B. Related Sections include the following:
   1. Division 27 Section “Telecommunications General Requirements.”

1.2 REFERENCES

A. ANSI/TIA/EIA-568-B.1,2,3 - Commercial Building Telecommunications Cabling Standard

B. ANSI/NFPA 70 - National Electrical Code

C. FCC Part 68 - Connection of Terminal Equipment to the Telephone Network

D. FCC Part 15 - Radiation Limits


1.3 PROJECT CONDITIONS

A. Verify field measurements are as shown on Drawings.
B. Verify suitability of all pathways prior to cable installation.

1.4 CABLING SYSTEM PERFORMANCE

A. General:

1. Cabling system performance shall meet or exceed current industry standards and specifications contained herein.
2. The cable, connectors, jack, patch panels, work in conjunction to form the cabling system. The total system shall meet the performance criteria described below.
3. The cable and connector devices shall be certified compatible by the manufacturer of each component to meet the performance criteria described below. Submit manufacturer’s certification with submittals.
4. The referenced standards describing the performance below shall include all revisions, clarifications and bulletins to the original standard referenced as well as any standards cross-referenced.
5. The referenced standards describing the performance below shall apply to backbone cable, horizontal cabling and connecting hardware performance requirements as well as installation standards and techniques and field testing and verification of performance.

B. Enhanced Category 6 (Cat 6e) cabling shall be utilized for voice and data horizontal wiring. Provide one of the following structured cabling system products:


C. Enhanced Category 6e performance is defined by the manufacturers of the above cabling products.

1.5 CONTRACTOR QUALIFICATIONS

A. The installing contractor shall be certified by the cabling and connector manufacturer of the structured cabling system product selected from 1.4 B. (above). A letter of certification from the manufacturer shall be included in the bid submittal. No exception to this will be allowed.

1.6 SUBMITTALS

A. Product Data Sheets:

1. Submittals shall be complete and bound in 3-ring binders (or similar fashion) for Engineer's approval prior to ordering equipment.
2. The binders shall contain manufacturer's product data sheets for the specific items to be installed for this project.
3. Contractor shall highlight or otherwise identify each specific item to be installed, by catalog number, on each product data sheet. The Contractor shall indicate specific color, style, configuration, etc., and all accessories specified and required for a complete installation.

B. Samples

1. Submit 2 sets of samples of all types of cable labels to be provided in this section. Attach one set to the cable samples, and submit together for Engineer's review.
2. Submit sample of labeling scheme proposed for the project. Include all labeling scenarios such as cables, outlets, patch panels, racks, etc. Submit proposed schemes for Engineer/Owner review prior to installation.
1.7 UNIT PRICING

A. Provide separate unit pricing included with bid for each of the following:

1. A complete workstation drop of each type of outlet indicated (e.g. A1, A2, A3, etc.) of length 100 feet, including all cabling, connectors, faceplate, labeling, installation, termination and testing.

1.8 UTP CABELLING SYSTEM WARRANTY

A. General

1. The UTP voice and data cabling system shall be warranted by the manufacturer(s) of the components for a period of not less than 20 years from the time the installation is deemed complete.
2. It shall be the sole responsibility of the Contractor to register the project with the manufacturer(s) and meet all manufacturers' warranty requirements.
3. Contractor shall provide Owner with all manufacturers' warranty certificates with Record Documents.

B. Warranty Coverage

1. Product - all passive components of the cabling system shall be warranted to be free from defects in material and workmanship.
2. Performance - all passive components, as installed, shall be warranted to exceed TIA and ISO performance specifications for Permanent Link and Channel, as required, at all frequencies specified and shall meet or exceed all manufacturer's published performance data.
3. Applications - the installed Permanent Link and Channel shall be warranted to support all current applications, as well as those introduced in the future, that require the specified cabling system per TIA and ISO specifications.

C. Warranty Requirements

1. Provide a Permanent Link warranty for all voice drops. Provide a Channel warranty for all data drops.
2. Warranty shall cover repair or replacement of all defective components free of charge, including all labor performed by a manufacturer-certified installer. All replacements components shall be furnished new. No used, reconditioned, or refurbished components shall be allowed.
3. The installing contractor shall be certified by the cabling and connector manufacturers as an approved and trained installer of their equipment. Submit letter of certification from the manufacturer to the engineer at time of submittal. No exception to this will be allowed.

PART 2 - PRODUCTS

2.1 COPPER HORIZONTAL CABELLING

A. Manufacturers:


B. Description:

1. Horizontal cable shall be furnished with performance requirements for the system served (voice or data) as indicated on the drawings.
2. Enhanced Category 6e: 24 AWG, 4-pair, 100 ohm, UTP, CMR, CMP as required, with green jacket for data and yellow jacket for voice.
3. Voice jacks will terminate on wall mount 110 type termination blocks. Workstation, server, printer, etc. data jacks will terminate in their own group of patch panels installed in equipment racks. Wireless access point data jacks will terminate in their own separate group of patch panels installed in the equipment racks.

2.2 UTP JACKS AND CONNECTORS

A. Manufacturers:

1. Ortronics.

B. Modular jacks for UTP cables:

1. 8 position, 8 conductor, non-keyed, universal modular jack, snap-in type, terminated with a 110 style pc board connector, color coded for both T568A and T568B wiring
2. Designed to terminate 22-26 AWG solid and 20-26 AWG stranded conductors on insulation-displacement 110-style connectors.
3. Contacts shall be minimum 50 micron gold-plated in the contact area.
4. Rated to match the performance of the cabling system they are installed on.
5. Color coded for system served as indicated on the drawings.
6. Furnish keystones (icons) for jack identification. Keystones for voice jacks shall be white and keystones for data jacks shall be orange.

2.3 UTP PATCH PANELS

A. Manufacturers:

1. Ortronics.

B. UTP Patch Panel:

1. Patch panel shall serve as data system horizontal cross connect.
2. Patch panel shall be configured for standard 19” rack mounting.
3. High density type with 24 modular jack ports for every standard rack mount unit (1.75” high).
4. Maximum 6 port groupings of replaceable modules.
5. Terminations for the “building side” cabling on 110-style insulation pc board connectors color-coded for both T568A and T568B terminations.
6. Horizontal cable management hardware front and rear.
7. Performance shall meet the performance of the cabling system they are installed on.
8. Constructed of black anodized aluminum with adequate structural integrity so that panel will not deflect when center of panel is pushed with the hand.
9. Provisions for icons and labeling to comply with the labeling requirements in specification 17170, "Cable Plant Administration and Testing".

2.4 CROSS-CONNECT BLOCKS

A. Manufacturers:

1. Ortronics.

B. Cross-connect blocks

1. Cross connect blocks shall be used for voice connectivity backbone to horizontal cross connects.
2. Wall mount 110 type wiring blocks mounted in a modular frame design that includes the frame, blocks, vertical and horizontal wiring troughs, and designation strips.

3. Provide wire management frames between adjacent vertical sections to allow management of cross connect wiring.

4. The frames and horizontal wiring troughs shall be constructed of steel (painted white or ivory in color), the wiring blocks, connecting blocks and vertical frames shall be constructed of molded polycarbonate.

5. Blocks shall be marked black every fifth pair.

6. Locate backbone frames on the right and horizontal frames on the left.

2.5 FACE PLATES

A. Manufacturers: Same as jacks and connectors, unless otherwise noted.

B. Face plates for wall mounted workstation outlets shall allow a minimum 2 and maximum 6 positions and accept snap-in jacks, as specified.

C. Face plates for recessed outlet boxes shall be high-strength nylon, white color, single-or double-gang as required and as applicable. Face plates shall be equipped with label slots, top and bottom, and clear polycarbonate covers for each label.

D. Provide duplex mounting frames, as required, to mate and match jacks to face plates.

E. Provide stainless steel faceplates with attachment hooks for hanging telephone device for outlets indicated as wall phone outlets.

2.6 UTP PATCH CORDS

A. Manufacturers:

1. Same manufacturer as UTP connectors.

B. Description:

1. Provide 24 AWG, 4-pair, 100 Ohm, stranded, UTP patch cords of similar construction, impedance-matched, having compatible performance as copper UTP horizontal cabling and rated for (Cat 6) specifications fully warranted, as required.

2. Provide cords with stranded conductors and jacketing for greater flexibility and factory terminated and tested with a single, 8-pin modular plug at each end.

3. Patch cords shall be 10’ – 15’ in length for workstations and 3’ – 7’ in length for the telecommunications room. Verify exact lengths with Owner.

4. Provide sufficient quantity as required for cross connecting and testing and as indicated on the drawings. As a minimum, provide two (2) patch cords for each data port in a work area outlet and one (1) patch cord for each voice port, length as specified above.

PART 3 - EXECUTION

3.1 GENERAL

A. In addition to the notes contained on the Drawings, the following Contractor notes shall apply.
3.2 CABLE ROUTING

A. Route all cables and cable raceways parallel to or perpendicular to building structure.

B. All cables shall be installed as single continuous "home-run" pulls from connector block to connector block, or from patch panel in the telecommunications room to voice/data workstation outlet in the work area.

C. Cable that is run above a suspended ceiling should be supported per manufacturer's recommendations, whether in conduit, or by j-hooks.

D. All data/communication cables, not installed in conduits, shall be supported by j-hooks and shall be neatly bunched, bundled and tied together and supported from the bar joists or trusses.

E. No more than 24 voice/data cables shall be permitted per hanger.

F. The maximum spacing of cable hangers and supports shall be 48 inches. Contractor shall be responsible to replace all fire-proofing materials displaced during installation of hangers to maintain required fire rating of structure.

G. Communication cable and infrastructure shall be independently supported.

H. Do not support or tie-wrap any cables to ductwork, plumbing lines, fire suppression, electrical conduits, mechanical systems, or ceiling system.

I. Do not directly lay or route voice/data cables on ductwork, piping and plumbing systems or on top of the lay-in ceiling tile.

J. Minimum clearance distance requirements shall be observed:
   1. 5" (125 mm) from power lines of 2 KVA or less.
   2. 12" (305 mm) from high voltage lighting (including fluorescent).
   3. 39" (1 m) from power lines of 5 KVA or greater.
   4. 39" (1 m) from transformers and motors.

K. All cable must be free of tension at both ends as well as over the length of the run.

L. Cable ties and supports shall not pinch, bind, crimp or in any way deform or cause physical damage to the cable jacket, or alter the electrical characteristics of the voice/data cables.

M. Contractor shall take care to assure that during and upon completion of the installation, all cables are free of kinks, sharp bends, twists, gouges, cuts or any other physical damage which may cause physical or electrical characteristic alterations to the cables. Any of these conditions will constitute a replacement of the installed cable.

N. Contractor to observe all minimum bend radius and tension limitations, etc., as specified by the cable manufacturer when installing the cables.

O. Contractor shall supply a neatly bundled slack loops of length 10 feet for all cabling in telecommunications spaces. Provide neatly bundled slack loop of length 1 foot at workstation.

P. Provide Velcro cable ties periodically in all runs and within the telecommunications spaces provide slack loops per standards and to neatly bundle cables.
3.3 CABLE TERMINATIONS

A. The Contractor shall terminate all wiring at both ends using the T568B convention. All voice and data cables shall be terminated in accordance with ANSI/TIA/EIA 568-B installation guidelines.

B. Contractor to install all modular jack dust covers and 110 style module "stuffer" caps as per manufacturer's recommendations on all workstation outlets and patch panels.

C. All voice (phone) cables shall terminate on standard 110 type punch down blocks mounted on plywood backboard.

D. All data cables shall be terminated on rack mounted, high density, patch panels.

E. All cable terminations shall be free of stress or tension when complete.

F. Provide sufficient slack and manage cabling accordingly.

3.4 OUTLETS

A. Contractor shall coordinate the location of all outlets with the architectural furniture layouts and the Engineer and WSU C & IT.

B. Contractor to furnish and install voice, data, and video jacks in face plates for flush and surface-mounted workstation outlets.

C. Mount surface outlets securely in place in consistent locations on systems furniture. Coordinate with furniture installer.

3.5 FACE PLATES

A. Contractor shall furnish and install faceplates on wall boxes and raceway as required and as indicated on the Drawings.

B. Contractor shall provide standard faceplate with blank inserts for all outlets indicated as "future".

3.6 PATCH PANELS

A. The contractor shall provide patch panels and cable management panels in equipment racks, as required.

B. Mount patch panel starting at top of rack with cable management panel directly below panel. Alternate patch panel and cable management installation so that each patch panel has a cable management panel.

3.7 VOICE CONNECTING BLOCKS

A. Contractor shall mount 110 style-connecting blocks on plywood backboard. Provide cable management between blocks.

END OF SECTION 270150
SECTION 270170 - CABLE PLANT ADMINISTRATION AND TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

B. Related Sections include the following:
   1. Division 27 Section “Telecommunications General Requirements.”

1.2 REFERENCES
C. ANSI/TIA/EIA 568-B-1,2,3 - Commercial Building Telecommunications Cabling Standard
E. ANSI/EIA/TIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications
G. BICSI – Building Consulting Services International.

1.3 SUBMITTALS
A. Submit under provisions of Section 17010.
B. Product Data: Provide for all cable and device labeling apparatus.
C. Reports: Submit final, certified test reports in bound booklet and electronic media. Include signed and dated reports certifying the test results.
1.4 PROJECT RECORD DOCUMENTS
   A. Submit under provisions of Section 17010.
   B. Accurately record equipment layout and cable layouts in all telecommunication spaces.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Deliver, store, protect, and handle Products to site under provisions of Section 16010.
   B. Protect products from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.6 PROJECT CONDITIONS
   A. Verify that field measurements are as shown on Drawings.
   B. Verify routing and termination locations of conduits, and cable pathways prior to rough-in.

PART 2 - PRODUCTS

2.1 LABELS
   A. Manufacturers:
      1. Brady.
      2. Brother P-Touch.
      3. Equivalent by Tester manufacturer.
      4. Equivalent by UTP connectivity manufacturer.
   B. Description
      1. Machine-printed permanent glossy polyester labels for racks, cabinets, faceplates, and panels. (Brady B-422).
      C. Machine-printed, self-laminating vinyl for cabling and patch cords. (Brady B-427)

PART 3 - EXECUTION

3.1 LABELING
   A. Contractor to install all faceplate and equipment labels in accordance with manufacturer's recommendations and the specifications. All labels shall be neatly installed and shall be level with the floor and properly aligned on the faceplate.
   B. All pieces of voice and data equipment, including wires, cables, fibers and their respective terminations shall be labeled and identified in accordance with ANSI/TIA/EIA Standard 606.
   C. Labels shall meet the requirements of UL 969 as outlined in the ANSI/TIA/EIA Standard 606.
D. All horizontal and backbone subsystem copper and fiber cables shall be labeled at each end. Labeling is required at intermediate points such as pullboxes and consolidation points (where appropriate).

E. Do not install labels closer than 3" to the termination point.

F. Patch panel labels shall be printed with the associated user data jack number. Contractor shall submit a sample of patch panel label strips to the Engineer for approval prior to installation.

G. Recommended labeling scheme for voice and data jacks at both ends is [Room Number – jack number + function]. Ex: 222-V01, 222-D01, 222-V02, 222-D02, 223-V01, 223-D01, etc. Numbering scheme shall start at the top jack in the first outlet in the room starting from the north wall and proceeding clockwise. Labeling shall be consistent at each end of cabling and at workstation outlet and patch panel or connecting block.

H. All access point jacks will be terminated on their own patch panel separate from the workstation data patch panels.

I. All labels must be based on the final room numbers. Verify room numbering with Owner prior to installation of labels. Do not use room numbers that appear on construction documents without prior approval.

3.2 UTP SYSTEM TESTING

A. Upon completion of the cable installation, the Contractor shall perform complete copper cable certification tests, according to all manufacturer's requirements for warranty and all testing required by TIA/EIA, including, but not limited to:

1. Continuity checks on each cable, checking for opens and shorts.
2. Cable length (Channel and Permanent Link).
3. Correct pair polarity.
4. Correct cable labeling at both ends.

B. Tests shall be performed with connectors installed.

C. Any outlet, cable or component not satisfactorily passing tests or failing to meet quality installation standards as described in the specification, shall be repaired and/or replaced as directed by the Engineer at the Contractor's expense.

D. The Contractor shall prepare complete cable test reports for all installed cables for review and acceptance by the Engineer, WSU C & IT prior to acceptance of the cabling system.

E. Category 6e UTP cable and patch cord installations shall be fully tested and verified in accordance with TIA/EIA-568-B specifications.

F. All cable testing shall be conducted by an experienced technician using a Microtest Omni Scanner, or Agilent Technologies (HP/Scope Communications) WireScope 350, or Engineer-approved equal for certification testing.

G. The cable tester shall be calibrated to the type of cable being tested prior to beginning the cable certifications.

H. Descriptions of the proposed calibration procedure shall be submitted to the Engineer for approval prior to beginning any testing.

I. The Category 6e Horizontal Cable Certification reports shall have complete testing of Permanent Link for voice drops and Channel for data drops, at frequency increments up to 250MHz as indicated in TIA/EIA-568-B and shall include the following:
1. Cable/Faceplate Number -- matching faceplate numbers on patch panels
2. Test Date
3. Cable Length
4. Wire-Map
5. Network Tests for 100BASE-TX and 1000BASE-T
6. Attenuation
7. Near End CrossTalk (NEXT)
8. Power-sum NEXT (PS-NEXT)
9. Attenuation to Cross Talk Ratio (ACR)
10. Power-sum Attenuation to Cross Talk Ratio (PS-ACR)
11. Equal Level Far End CrossTalk (ELFEXT)
12. Power-sum Equal Level Far End CrossTalk (PS-ELFEXT)
13. Return Loss
14. Propagation Delay
15. Delay Skew
16. Signal to Noise Ratio

J. Copies of the Cable Certification report shall be provided in both hard copy and native electronic media format. A copy of the associated Cable Tester’s Data Base management software shall also be provided with the soft copy test results.

K. After the horizontal cable tests have been performed, the Contractor shall install the faceplate labels and modular jack dust covers.

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END OF TABLE OF CONTENTS
1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Removing existing vegetation.
2. Clearing and grubbing.
3. Stripping and stockpiling topsoil.
4. Removing above- and below-grade site improvements.
5. Disconnecting, capping or sealing, and removing site utilities and/or abandoning site utilities in place.
6. Temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.
D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

B. Utility Locator Service: Notify “Call Before You Dig” for area where Project is located before site clearing.

C. Do not commence site clearing operations until required temporary erosion- and sedimentation-control and plant-protection measures are in place.

D. The following practices are prohibited within protection zones:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation or other digging unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

E. Do not direct vehicle or equipment exhaust towards protection zones.

F. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

G. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #79, Alkyd Anticorrosive Metal Primer or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.

1. Use coating with a VOC content of 420 g/L (3.5 lb/gal or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide required temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place.

C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify Construction Manager not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

D. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Do not stockpile topsoil within protection zones.
2. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.
3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000
SECTI0N 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, plants and other site amenities.
2. Drainage course for concrete slabs-on-grade.
3. Excavating and backfilling trenches for utilities and pits for buried utility structures.
4. Excavating and backfilling for sedimentation and erosion control.

1.3 DEFINITIONS

1.4 SUBMITTALS

1.5 QUALITY ASSURANCE

1.6 PROJECT CONDITIONS

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

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3.1 PREPARATION

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3.4 EXCAVATION FOR UTILITY TRENCHES

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3.7 STORAGE OF SOIL MATERIALS

3.8 BACKFILL

3.9 UTILITY TRENCH BACKFILL

3.10 SOIL FILL

3.11 UTILITY TRENCH BACKFILL

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

3.13 GRADING

3.14 DRAINAGE COURSE UNDER CONCRETE SLABS ON GRADE

3.15 FIELD QUALITY CONTROL

3.16 PROTECTION

3.17 DISPOSAL OF SUPPLUS AND WASTE MATERIALS

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.

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A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, plants and other site amenities.
2. Drainage course for concrete slabs-on-grade.
3. Excavating and backfilling trenches for utilities and pits for buried utility structures.
4. Excavating and backfilling for sedimentation and erosion control.
1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698, ASTM D 1557.
C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

B. Preexcavation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Utility Locator Service: Notify "Call Before You Dig" for area where Project is located before beginning earth moving operations.

B. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

C. Do not direct vehicle or equipment exhaust towards protection zones.

D. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups and Geotechnical Engineer.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
E. Base Course/Crushed Aggregate: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

I. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; screened to be free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

J. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

K. Sand: ASTM C 33; fine aggregate.

L. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
3.3 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
   a. 24 inches outside of concrete forms other than at footings.
   b. 12 inches outside of concrete forms at footings.
   c. 6 inches outside of minimum required dimensions of concrete cast against grade.
   d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
   e. 6 inches beneath bottom of concrete slabs-on-grade.
   f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
   a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
   a. 24 inches outside of concrete forms other than at footings.
   b. 12 inches outside of concrete forms at footings.
   c. 6 inches outside of minimum required dimensions of concrete cast against grade.
   d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
   e. 6 inches beneath bottom of concrete slabs-on-grade.
   f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.4 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
1. Clearance: 12 inches each side of pipe or conduit or as indicated on drawings.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

E. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.5 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.
3.6 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.7 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete.

D. Trenches under Roadways: Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete.

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Place and compact initial backfill of [subbase material] [satisfactory soil], free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

G. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

H. Place and compact final backfill of satisfactory soil to final subgrade elevation.

I. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

J. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under walks and pavements, use satisfactory soil material.
   2. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698, ASTM D 1557:
   1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
   2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   1. Turf or Unpaved Areas: Plus or minus 1 inch.
   2. Walks: Plus or minus 1 inch.

3.14 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.
B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
   1. Place drainage course 6 inches or less in compacted thickness in a single layer.
   2. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
   3. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.15 FIELD QUALITY CONTROL

A. Special Inspections: Construction Manager will engage a qualified special inspector to perform the following special inspections:
   1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
   2. Determine that fill material and maximum lift thickness comply with requirements.
   3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.

2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.16 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.
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PART 1 -

1.1 RELATED DOCUMENTS

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

B. Materials and installation requirements are generally indicated on the plans. Materials indicated in these specifications only apply if indicated on the plans and allowed by the regulating authority. Contractor is responsible for confirming allowable materials and installation requirements with the regulating authority and including these requirements in their bid.

C. CAD files will be made available for use in construction staking. Contact the engineer regarding applicable fee and requirements for signing of the CAD File Transfer Agreement.

1.2 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:

1. Fence footings
2. Concrete filled bollards
3. Mechanical unit pads

B. All materials, equipment and construction for concrete pavements and seatwalls shall be in accordance with the current version of the Michigan department of Transportation Standard Specifications for Construction.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, expansive hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

1.4 SUBMITTALS

A. Design Mixes: For each concrete pavement mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

B. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1. Cementitious materials and aggregates.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Bonding agent or adhesive.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

1. Manufacturer must be certified according to the National Ready Mix Concrete Association's Plant Certification Program.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.

E. ACI Publications:


2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.

G. No substitutions will be permitted without written approval of the University Landscape architect. The Landscape contractor shall remove rejected materials from the site.

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."

1. Before submitting design mixes, review concrete pavement mix design and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with concrete pavement to attend, including the following:
   a. Contractor’s superintendent.
   b. Independent testing agency responsible for concrete design mixes.
   c. Ready-mix concrete producer.
   d. Concrete subcontractor.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

   1. Use flexible or curved forms for curves of a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.

B. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

2.3 CONCRETE MATERIALS

A. General: Use the same brand and type of cementitious material from the same manufacturer throughout the Project.

B. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

   1. Portland Cement: ASTM C 150, Type I. Supplement with the following:
      a. Fly Ash: ASTM C 618, Class F or C.
      b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

3. Fly Ash: ASTM C 618, Class F or C.

C. Aggregate: ASTM C 33, uniformly graded, from a single source, with coarse aggregate as follows:
   1. Aggregate under Pad: MDOT 21AA.
   2. Aggregate around Pad: MDOT 6AA, ASTM #57.
   3. Sand: MDOT 2NS.

D. Water: ASTM C 94.

2.4 ADMIXTURES


B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Retarding Admixture: ASTM C 494/C 494M, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Water: Potable.

2.6 CONCRETE MIXES

A. Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

B. Prepare design mixes, proportioned according to ACI 301, for normal-weight concrete determined by either laboratory trial mix or field test data bases, as follows:
   1. Compressive Strength (28 Days):
      b. Footing: 3000 psi 470#/CY cement.
   2. Slump: 4 inches.
a. Slump Limit for Concrete Containing High-Range Water-Reducing Admixture: Not more than 8 inches after adding admixture to plant- or site-verified, 2- to 3-inch slump.

C. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the trial batch method.

D. Proportion mixes to provide concrete with the following properties:
   1. Compressive Strength (28 Days): 4000 psi for all work
   2. Maximum Water-Cementitious Materials Ratio: 0.50.
   3. Slump Limit: 4 inches max and 1.5 inches min. as determined by the slump cone test specified in ASTM C-143.
   4. Air entrained with a total air content of not less than 4 percent but not more than 7 percent.
   5. Cement content shall be a min. of 6 sacks per cubic yard.

E. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals and as follows:
   1. Fly Ash: 25 percent.

2.7 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94.

2.9 RELATED MATERIALS


B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:
   1. Type II, non-load bearing, for bonding freshly mixed concrete to hardened concrete.
   2. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
   3. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

D. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
PART 3 - EXECUTION

3.1 PREPARATION

A. Proof-roll prepared subbase or base surface to check for unstable areas and verify need for additional compaction. Proceed with pavement only after nonconforming conditions have been corrected and subbase or base is ready to receive pavement.

B. Remove loose material from compacted subbase or base surface immediately before placing concrete.

3.2 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Chamfer exterior corners and edges of permanently exposed concrete as indicated on drawings.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.

1. Apply epoxy repair coating to uncoated or damaged surfaces of epoxy-coated reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

D. Comply with requirements and with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.
E. Do not add water to concrete during delivery, at Project site, or during placement.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 301.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

H. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer, or use bonding agent (at no additional cost) if approved by Architect or the University of Michigan.

I. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments.

J. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.

2. Do not use frozen materials or materials containing ice or snow.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.

K. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, reinforcement steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.6 CONCRETE FINISHING
A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.

B. Float Finish for flat concrete: Begin the second floating operation when bleed-water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, and fill low spots. Refloat surface immediately to uniform granular texture.

1. Flat concrete: Medium-to-Fine-Textured Broom Finish. Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer’s written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer’s written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.8 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch.


3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/4 inch.

4. Joint Spacing: 3 inches.

5. Contraction Joint Depth: Plus 1/4 inch, no minus.


3.9 FIELD QUALITY CONTROL
A. Testing Agency: THE UNIVERSITY OF MICHIGAN will engage a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.

B. Testing Services: Testing shall be performed according to the following requirements:

1. Sampling Fresh Concrete: Representative samples of fresh concrete shall be obtained according to ASTM C 172, except modified for slump to comply with ASTM C 94.

2. Slump: ASTM C 143; one test at point of placement for each compressive-strength test, but not less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.

3. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each set of compressive-strength specimens.

4. Compression Test Specimens: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.

5. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.

6. When frequency of testing will provide fewer than five compressive-strength tests for a given class of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

7. When total quantity of a given class of concrete is less than 50 cu. yd., the University of Michigan may waive compressive-strength testing if adequate evidence of satisfactory strength is provided.

8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.

9. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive compressive-strength test results equal or exceed specified compressive strength and no individual compressive-strength test result falls below specified compressive strength by more than 500 psi.

C. Test results shall be reported in writing to Architect, the University of Michigan, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the University of Michigan but will not be used as the sole basis for approval or rejection.

E. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by The University of Michigan. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.
3.10 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.

B. Drill test cores where directed by the University of Michigan when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

3.11 CLEAN UP

A. Concrete work washout cannot be discharged into storm drains, catch basins or the sanitary sewer system.

B. Contractor shall utilize proper disposal and washout practices in designated areas or off site.

**END OF SECTION**
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Expansion joints within concrete pavement.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.

B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than that allowed by joint sealant manufacturer for application indicated.

C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range for this characteristic.

2.2 COLD-APPLIED JOINT SEALANTS

A. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.

2.3 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rod for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depths and prevent bottom-side adhesion of sealant.

2.4 PRIMERS

A. Primers: Product recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION
3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint sealant manufacturer's written installation instructions applicable to products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of backer materials.
2. Do not stretch, twist, puncture, or tear backer materials.
3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.

D. Install sealants by proven techniques to comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses provided for each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealants from surfaces adjacent to joint.
2. Use tooling agents that are approved in writing by joint sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint sealant manufacturer's written instructions, unless otherwise indicated.

G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.
3.4 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

END OF SECTION 321373
SECTION 323119 – ORNAMENTAL METAL FENCES

GENERAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Ornamental Metal Fences
2. Ornamental Metal Pedestrian Gate
3. Exit Devices

1.3 PERFORMANCE REQUIREMENTS FOR ORNAMENTAL METAL

A. Structural Performance of Ornamental metal: Provide ornamental metal complying with requirements of ASTM E 985 for structural performance, based on testing performed according to ASTM E 894 and ASTM E 935.
B. Thermal Movements: Provide ornamental metal that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

D. Comply with Section concerning “Hot Dip Galvanizing”.

1.4 SUBMITTALS

A. Product Data: For each product used in ornamental metal, including finishing materials and methods.

1. Include Product Data for grout and anchoring cement.

B. Shop Drawings: Show fabrication and installation of ornamental metal. Include plans, elevations, component details, and attachments to other Work. Indicate materials and profiles of each ornamental metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

1. Include setting drawings, templates, and directions for installing anchor bolts and other anchorages.

C. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Arrange for installation of ornamental metal specified in this Section by the same firm that fabricated it.

B. Fabricator Qualifications: A firm experienced in producing ornamental metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. The manufacturer shall supply a total ornamental aluminum fencing system. The system shall include all components (i.e., pickets, posts, rails, gates and hardware) required.
D. Welding Standards: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store ornamental metal inside a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

1.7 PROJECT CONDITIONS

A. Field Measurements: Where ornamental metal is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Ornamental metal:
   a. Known Source: Ameristar Echelon Plus ‘Classic’.
   b. Or approved substitute.

2.2 METALS

A. General: Provide metals free from surface blemishes where exposed to view in finished unit. Exposed-to-view surfaces exhibiting pitting, seam marks, roller marks, stains, discolorations, or other imperfections on finished units are not acceptable.

B. Steel and Iron: Provide steel and iron in form indicated to comply with the following requirements:

1. Tubing: Cold formed, ASTM A 500.
2. Steel Plate, Shapes, and Bars: ASTM A 36.
5. Malleable-Iron Castings: ASTM A 47, grade as recommended by fabricator for type of use indicated.

C. Aluminum material for fence framework (i.e., tubular pickets, rails and posts) shall conform to the requirements of ASTM B221. The aluminum extrusions for posts and rails shall be Alloy and Temper Designation 6005-T5. The aluminum extrusions for pickets shall be Alloy and Temper Designation 6063-T5.

D. Pickets shall be 3/4" square x .045" thick. Horizontal rails shall be 1-1/4" x 1-7/16" Forerunner™ channel with .060" thick top & internal web wall, and .090" thick side walls and shall be punched to allow picket to pass through the top of the rail. The Forerunner™ rail shall be constructed with an internal web insert providing a raceway for the pickets to be retained with a 1/8" retaining rod. The number of rails shall vary with the style, height and strength as determined by manufacturer. Fence posts and gate posts shall meet the minimum size requirements of Table 1.

E. Accessories: Aluminum castings shall be used for all post caps, scrolls, finials, and other miscellaneous hardware. Hinges and latches shall be fabricated from aluminum, stainless steel or composite materials.

F. Etching Cleaner for Galvanized Metal: Complying with MPI#25

G. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

H. Polyurethane Topcoat: Complying with MPI#72 and compatible with undercoat. Color gloss black.

2.3 MISCELLANEOUS MATERIALS

A. Welding Electrodes and Filler Metal: Type and alloy of filler metal and electrodes as recommended by producer of metal to be welded, complying with applicable AWS specifications, and as required for color match, strength, and compatibility in fabricated items.

B. Fasteners: Use fasteners of same basic metal as fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.

1. Provide concealed fasteners for interconnecting ornamental metal components and for attaching them to other work unless exposed fasteners are unavoidable or are the standard fastening method.

2.4 FABRICATION, GENERAL
A. Form ornamental metal to required shapes and sizes, with true curves, lines, and angles. Provide components in sizes and profiles indicated, but not less than that needed to comply with requirements indicated for structural performance.

B. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Drill and tap for required fasteners, unless otherwise indicated.

C. Comply with AWS for recommended practices in shop welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of all flux, and dress all exposed and contact surfaces.

D. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form joints exposed to weather to exclude water penetration.

E. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

F. Fabricate and assemble materials per manufacturer's specifications.

2.5 FABRICATING FENCING

A. Nonwelded Connections: Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

B. Welded Connections: Fabricate ornamental metal for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
5. Provide welded connections for ferrous ornamental metal.

C. Form changes in direction of railing members as follows:

1. By changing direction at post.

D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain profile of member
throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces of handrail and railing components.

E. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect handrail and railing members to other work, unless otherwise indicated.

1. Furnish inserts and other anchorage devices for connecting ornamental metal to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by ornamental metal. Coordinate anchorage devices with supporting structure.

2.6 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.7 IRON AND STEEL FINISHES

A. Galvanizing: Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A 123.

1. Hot-dip galvanize iron and steel hardware indicated to be galvanized to comply with ASTM A 153.

B. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. Finishes shall be per manufacturer’s specifications.

2.8 EXIT DEVICES

A. Surface mount exit bar kit, suitable for exterior uses: reversible exit bar, 24" tall mounting plate, adjustable receiver bracket, lock box with keyed cylinder and two keys.

1. Known Source:
   DAC Industries Model # D-6045-S48
PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fencing and gates per manufacturer’s specifications.

B. Provide anchorage devices and fasteners where necessary for securing ornamental metal to in-place construction.

C. Perform cutting, drilling, and fitting required to install ornamental metal. Set products accurately in location, alignment, and elevation; measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

D. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, with uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of ornamental metal, restore finishes to eliminate any evidence of such corrective work.

E. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

F. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.

G. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.

   1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.

H. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding, for appearance and quality of welds, and for methods used in correcting welding work. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Grind exposed welded joints smooth and restore finish to match finish of adjacent surfaces.

3.2 INSTALLING ORNAMENTAL FENCING

A. Adjust posts and railings before anchoring to ensure alignment at abutting joints.

B. Concrete anchored posts in concrete footings: set W6x15 posts true and level in concrete footing to match details on structural drawings.

C. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to
railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of ornamental metal.

D. Welded Connections: Use fully welded joints for permanently connecting railing components by welding. Cope or butt components to provide 100 percent contact or use fittings designed for this purpose.

3.3 CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.4 PROTECTION

A. Protect finishes of ornamental metal from damage during construction period with temporary protective coverings approved by ornamental metal fabricator. Remove protective covering at the time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 323119
SECTION 329300 – EXTERIOR PLANTS

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following:

EXTERIOR PLANTS
SECTION 329300 - 1
1. Shrubs.
2. Sod.

1.3 DEFINITIONS

A. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

E. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

F. Substantial Completion: The work or designated portion thereof is complete in accordance with the contract documents so the owner can occupy or use the work or designated portion thereof for its intended use subject only to the completion of the details of construction, decoration and mechanical adjustment which in the aggregate are minor in character.

1.4 SUBMITTALS

A. Samples for Verification: For each of the following:
   1. Edging materials and accessories, of manufacturer's standard size, to verify color selected.

B. Product label: For sod.

C. Product Certificates: For each type of manufactured product, signed by product manufacturer, and complying with the following:
   1. Manufacturer's certified analysis for standard products.
   2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when exterior planting is in progress.

B. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."

1. Selection of exterior plants purchased under allowances will be made by Architect, who will tag plants at their place of growth before they are prepared for transplanting.

C. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches (150 mm) above ground for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.

D. Observation: Architect may observe trees and shrubs either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver exterior plants freshly dug.

B. Do not prune trees and shrubs before delivery, except as approved by Architect. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery.

C. Handle planting stock by root ball.

D. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants trees in shade, protect from weather and mechanical damage, and keep roots moist.
1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
2. Water root systems of exterior plants stored on-site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

E. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding."

1.7 COORDINATION

A. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

B. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns, unless otherwise acceptable to Architect.

1. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

1.8 WARRANTY

A. Special Warranty: Warrant the following exterior plants, for the warranty period indicated, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by Owner, or incidents that are beyond Contractor's control.

1. Warranty Period for Trees and Shrubs: One year from date of Substantial Completion.
2. Warranty Period for Ground Cover and Plants: Four months from date of Substantial Completion.
3. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season.
4. Replace exterior plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.

1.9 MAINTENANCE

A. Trees and Shrubs: Maintain for the following maintenance period by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, tightening and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees and shrubs free of insects and disease. Restore or replace damaged tree wrappings.

1. Maintenance Period: 12 months from date of Substantial Completion.
B. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Sodded Lawns: 60 days from date of Substantial Completion.
2. Seeded Lawns: 90 days from date of Substantial Completion.
   a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.

C. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.

1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.

D. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches (100 mm).

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water lawn at a minimum rate of 1 inch (25 mm) per week.

E. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 30 percent of grass height. Remove no more than 30 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow grass 2 inches (38 to 50 mm) high.

F. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

   Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to lawn area

PART 2 - PRODUCTS

2.1 TREE AND SHRUB MATERIAL
A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Grade: Provide trees and shrubs of sizes and grades complying with ANSI Z60.1 for type of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Label each tree and shrub with securely attached, waterproof tag bearing legible designation of botanical and common name.

D. Label at least one tree and one shrub of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.

E. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.2 EVERGREENS

A. Form and Size: Normal-quality, well-balanced, coniferous evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.

1. Evergreen shrub shall be Thuja occidentalis ‘Emerald green’ aka ‘Smaragd’, planted 22”, balled and burlaped or container, 4.0’ ht. min.

2.3 TURFGRASS SOD

A. Turfgrass Sod: Number 1 Quality/Premium Bluegrass blend, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with TPI's "Specifications for Turfgrass Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable sod, grown on topsoil, of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

2.4 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7.4 percent organic material minimum, free of stones 1 inch or larger in any dimension, and other extraneous materials harmful to plant growth.

1. Topsoil Source: Import topsoil from off site sources as necessary. Obtain topsoil from naturally well-drained sites where topsoil occurs at least 4” deep; do not obtain from bogs and marshes.
2.5 FERTILIZER

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

2.6 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Ground or double shredded bark.

2.7 LANDSCAPE EDGINGS

A. Steel Edging: Standard commercial-steel edging, rolled edge, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes as manufactured by Border Line or approved equal.

1. Edging Size: 1/8 inch wide by 4 inches min. deep.
2. Stakes: Tapered steel, a minimum of 15 inches long.
3. Accessories: Standard tapered ends, corners, and splicers.
5. Paint Color: Black.

Known source: Border Concepts, Inc (704) 541-5509

2.8 PLANTING SOIL MIX

A. Planting Soil Mix: Four parts top soil to one part peat moss and two pounds commercial fertilizers for each cubic yard of mixture.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple exterior plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before planting. Make minor adjustments as required.

3.3 PLANTING BED ESTABLISHMENT

A. Loosen subgrade of planting beds to a minimum depth of 12 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply fertilizer directly to subgrade before loosening.
2. Thoroughly blend planting soil mix off-site before spreading.
   
a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.

3. Spread planting soil mix to depth indicated but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
   
a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil mix.

B. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

3.4 TREE AND SHRUB EXCAVATION

A. Pits and Trenches: Excavate circular pits with sides sloped inward. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.
1. Excavate approximately three times as wide as ball diameter for [balled and
   burlapped] stock.
2. If drain tile is shown or required under planted areas, excavate to top of porous
   backfill over tile.

B. Subsoil removed from excavations may be used as backfill.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental
to trees or shrubs are encountered in excavations.
   1. Hardpan Layer: Drill 6-inch- diameter holes into free-draining strata or to a
      depth of 10 feet, whichever is less, and backfill with free-draining material.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or
   retention in tree or shrub pits.

E. Fill excavations with water and allow to percolate away before positioning trees and
   shrubs.

3.5 TREE AND SHRUB PLANTING

A. Set balled and burlapped stock plumb and in center of pit or trench with top of root ball
   flush with adjacent finish grades.
   1. Remove burlap and wire baskets from tops of root balls and partially from sides,
      but do not remove from under root balls. Remove pallets, if any, before setting.
      Do not use planting stock if root ball is cracked or broken before or during
      planting operation.
   2. Place planting soil mix around root ball in layers, tamping to settle mix and
      eliminate voids and air pockets. When pit is approximately one-half backfilled,
      water thoroughly before placing remainder of backfill. Repeat watering until no
      more water is absorbed. Water again after placing and tamping final layer of
      planting soil mix.

B. Organic Mulching: Apply average thickness of organic mulch to depth indicated
   extending 12 inches beyond edge of planting pit or trench. Do not place mulch within 3
   inches trunks or stems.

3.6 TREE AND SHRUB PRUNING

A. Prune, thin, and shape trees and shrubs according to standard horticultural practice.
   Prune trees to retain required height and spread. Unless otherwise indicated by
   Architect, do not cut tree leaders; remove only injured or dead branches from flowering
   trees. Prune shrubs to retain natural character. Shrub sizes indicated are sizes after
   pruning.
3.7 SOD INSTALLATION

A. Sodding:

1. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

2. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
   a. Lay sod across angle of slopes exceeding 1:3.
   b. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

3. Saturate sod with fine water spray within two hours of planting. During first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.8 PLANTING BED MULCHING

A. Mulch backfilled surfaces of planting beds and other areas indicated.

1. Organic Mulch: Apply organic mulch to depth indicated, and finish level with adjacent finish grades. Do not place mulch against plant stems.

3.9 MAINTENANCE

A. The contractor shall maintain new installed turfgrass areas, including watering, spot weeding, mowing, applications of herbicides, fungicides, insecticides, and re-sodding until a full, uniform stand of grass free of weed, undesirable grass species, disease, and insects is achieved and accepted by the Owner.

1. Water to maintain adequate surface soil moisture for proper seed germination.
2. Repair, re-work, and/or re-seed all respective areas that have washed out, or eroded.
3. Set mower blades at a minimum height of 2". Not more than 30% of the grass leaf shall be removed at the initial or subsequent mowing. Mow all areas before turf reaches a height of 3".

B EDGING INSTALLATION
A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.

3.10 CLEANUP AND PROTECTION

A. During exterior planting, keep adjacent pavings and construction clean and work area in an orderly condition.

B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.

C. Any soil, peat or similar material which has been brought onto paved areas by hauling operations or otherwise shall be removed promptly. Upon completion of planting, all excess soil, stones, and debris shall be removed from the site or disposed of as directed by the Owner. All planting areas shall be prepared for final inspection.

3.11 DISPOSAL

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

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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.

B. Related Sections include the following:

1. Division 02 Section "Selective Demolition" for demolition of existing fuel distribution and storage system components.
2. Division 20 Section "Mechanical General Requirements."
3. Division 20 Section "Basic Mechanical Materials and Methods."
4. Division 23 Section "Fuel Oil Piping" for fuel oil piping and specialties inside the building.

1.2 DEFINITIONS

A. Fuel: Includes fuel oil.
B. Fuel Oil: Includes diesel fuel oil for diesel engines.

C. The following are industry abbreviations for storage tanks:
   1. AST: Aboveground storage tank.
   2. FRP: Glass-fiber-reinforced plastic.
   3. UST: Underground storage tank.

D. The following are industry abbreviations for plastic piping materials:
   1. PE: Polyethylene plastic.
   2. PTFE: Polytetrafluoroethylene plastic.
   5. TFE: Tetrafluoroethylene plastic.

E. STI: Steel Tank Institute.

1.3 PIPING SYSTEMS DESCRIPTION

A. Aboveground, Fuel Piping and Vent Piping: Use the following piping materials for each size range:
   1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
   2. NPS 2-1/2 and larger: Steel pipe, steel welding fittings, and welded joints.

B. Underground, Fuel Piping: Use the following piping materials. Size indicated is carrier-pipe size.
   1. NPS 1-1/2 and Smaller: Flexible double-contained piping.
   2. NPS 2 and Larger: Rigid double-contained piping.

C. Underground, Fuel Tank, Fill Piping: Use the following piping materials. Size indicated is carrier-pipe size.
   1. All Sizes: Rigid double-contained piping and bonded joints.

D. Underground Gage Piping: Use any of the following piping materials for each size range:
   1. NPS 2 and Smaller: Copper tube, copper fittings, and brazed joints.
   2. NPS 2-1/2 to NPS 4: Copper tube, copper fittings, and brazed joints.

E. Valve Applications: Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Fuel Oil Shutoff Duty: Use gate or ball valves.

1.4 PERFORMANCE REQUIREMENTS

A. General: Use flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system’s pressure rating in aboveground and containment sump applications, unless otherwise indicated.

B. Minimum working-pressure ratings for piping are the following, unless otherwise indicated:
2. Double-Contained Piping:
   b. Secondary-Containment Conduit: 5 psig.


1.5 SUBMITTALS

A. Product Data: For the following:
   1. Piping.
   2. Valves.
   3. Fuel storage tank piping specialties.
   4. Leak-detection and -monitoring systems.

B. Brazing certificates.

C. Welding certificates.

D. Material Certificates: For each fuel storage tank, signed by manufacturers.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For fuel storage tank pumps and leak-detection and -monitoring systems to include in operation and maintenance manuals.

G. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of fuel storage tanks and are based on specific units indicated. Refer to Division 01 Section "Product Requirements."

B. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.


F. Comply with NFPA 30, "Flammable and Combustible Liquids Code," for design, construction, installation, testing, and inspection of fuel distribution systems.

G. Comply with requirements of the EPA and state and local environmental-protection authorities having jurisdiction. Include recording of fuel storage tanks and monitoring of tanks and piping.
1.7 DELIVERY, STORAGE, AND HANDLING

A. Lift and support fuel storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.

B. Prepare fuel storage tanks and accessories for shipping as follows:

1. Ensure that units are dry and internally protected against rust and corrosion.
2. Protect fuel storage tank accessories and piping connections against damage.

C. Store plastic pipes protected from direct sunlight. Support pipes to prevent sagging and bending.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Fuel Oil Service: Do not interrupt fuel oil service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fuel oil supply according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of fuel oil service.
2. Do not proceed with interruption of fuel oil service without Owner's written permission.

1.9 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel storage tanks that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following when used for storage of fuel at temperatures not exceeding 150 deg F:
   a. Structural failure including cracking, breakup, and collapse.
   b. Corrosion failure including external and internal corrosion of steel tanks.

2. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2.2 Piping Materials

A. Refer to Part 1 "Piping Systems Description" Article for applications of pipes, tubes, fittings, valves, and joining materials.

2.3 Piping, Tubes, and Fittings

A. Steel Pipe: ASTM A 53/A 53M, Schedule 40, Type S or E, Grade A or B, black.
   1. Steel Welding Fittings: ASTM A 234/A 234M, seamless or welded; ASME B16.9, butt-welding type or ASME B16.11, socket-welding type.
   2. Steel Threaded Fittings: ASME B16.11, with threads according to ASME B1.20.1.

B. Rigid Nonmetallic Piping: Fiberglass piping for underground applications. Include transition, bulkhead, termination, or other end fittings as required.
   1. Manufacturers:
      a. Ameron International; Fiberglass Pipe Group.
      b. Smith Fibercast; a Varco Company; Red Thread.
   2. RTRP: ASTM D 2996 or ASTM D 2997, and complying with UL 971.
      a. RTRP NPS 2 and NPS 3: 150-psig minimum working-pressure rating.
      b. RTRP NPS 4 and NPS 6: 125-psig minimum working-pressure rating. UL requirement for NPS 6 is waived.
      c. RTRFs: ASTM D 2996 or ASTM D 2997, complying with UL 971, and made by RTRP manufacturer.
      d. Bonding Adhesive: Manufacturer's standard, suitable for fuel piping application.

C. Flexible Double-Contained Piping: UL 971, flexible, nonmetallic, carrier pipe with flexible, nonmetallic, secondary-containment pipe, for underground applications. Include bulkhead, termination, or other end fittings as required.
   1. Manufacturers:
      a. Advanced Polymer Technology, Inc. (APT).
      b. Innovative Petroleum Products LLC (IPP).
      c. PetroTechnik Group; UPP Pipework.

D. Rigid Double-Contained Piping: Factory manufactured type. Field fabricated systems will not be allowed. System consisting of carrier pipe, containment pipe, carrier pipe supports, special fittings, and end seals. System prefabricated and supplied by single manufacturer.
   1. Manufacturers:
      a. Insul-Tek Piping Systems, Inc.; ENVIRO-TEK.
      b. Ipex Inc.; Guardian CustomGuard.
      c. Rovanco Piping Systems, Inc.
   2. Carrier Pipe and Fittings: Steel pipe and welding fittings as specified in Paragraph "Steel Pipe."
3. Isolation Valves: UL Valves as specified in Article “Valves.”

4. Inner Pipe Supports: Nonmetallic construction, designed to allow free air and fluid movement within containment pipe, and spaced to carry weight of carrier pipe full of fluid while allowing carrier pipe to expand and contract.

5. Containment Pipe: Filament-wound fiberglass reinforced epoxy pipe with integral epoxy liner and exterior coating with minimum wall thickness of 80 mils as specified in Paragraph “Rigid Nonmetallic Piping.”

6. Containment Pipe Fittings: Factory prefabricated of same materials as containment pipe, and capable of withstanding 75 psig pressure test. Refer to Paragraph “Rigid Nonmetallic Piping.”

7. End Seals: Equip terminal ends of system with end seals manufactured of same material and to same standards as containment pipe fittings.


E. Copper Tube: ASTM B 88, Type L; water tube; drawn temper.

2. Copper Unions: MSS SP-123, cast-copper alloy, hexagonal-body stock with ball-and-socket metal-to-metal seating surfaces and solder-joint or threaded ends.
3. Brazing Filler Metals: AWS A5.8, BAg-1 (silver classification).

F. Flexible Nonmetallic Piping: UL 971, plastic pipe and fittings for underground applications. Include bulkhead, termination, or other end fittings as required.

1. Manufacturers:
   a. Ameron International; Fiberglass Pipe Group.
   b. Containment Technologies Corp.
   c. Dayco Industrial Products, Inc.
   d. Environ Products Inc.
   e. OPW Fueling Components.
   f. S. Bravo Systems, Inc.
   g. Western Fiberglass, Inc.

G. Transition Couplings:

1. Aboveground, Fuel Piping: Manufactured coupling or fitting or companion flanges same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
2. Underground, Fuel Piping: Sleeve-type coupling or manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

H. Flexible Connectors: UL-listed, flexible piping 96 inches or less in length.

1. Metallic Connectors: For connection to aboveground, fuel tanks.
   a. Manufacturers:
      1) FLEX-ING, Inc.
      2) Hose Master, Inc.
      3) Jackson Industries.
      4) Teleflex Fluid Systems, Inc.
      5) Titeflex Corporation.

2. Nonmetallic Connectors: For connection to underground piping or underground sumps.
   a. Manufacturers:
I. Flexible Metal Hoses: UL 536, with 100-psig minimum pressure rating.
   1. Manufacturers:
      a. American Flexible Hose Co., Inc.

J. Flexible Pipe Connectors: Flexible metal hose.
   1. Manufacturers:
      a. Anamet Inc.
      b. Flex-Hose Co., Inc.
      c. Flexcraft Industries.
      d. Flex-Pression Ltd.
      e. Hyspan Precision Products, Inc.
      f. Mercer Rubber Company.
      g. Metraflex, Inc.
      h. Proco Products, Inc.
      i. Unaflex Inc.

2. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   a. Working-Pressure Rating: 200 psig minimum.
   b. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
   c. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

   a. Working-Pressure Rating: 200 psig minimum.
   b. End Connections NPS 2 and Smaller: Threaded stainless-steel pipe nipple.
   c. End Connections NPS 2-1/2 and Larger: Flanged stainless-steel nipple.

2.4 JOINING MATERIALS

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for joining materials not in this Section.

2.5 VALVES

A. Bronze Gate Valves: MSS SP-80, Type 2, Class 200. Include ends threaded according to ASME B1.20.1. Valves with solder ends may be furnished for use with copper tube.

B. Bronze Ball Valves: MSS SP-110; 3-piece bolted-body; 400-psig- minimum, WOG, nonshock, working-pressure rating. Include full-port, cast-bronze, chrome-plated bronze ball; PTFE seats; lever handle; and threaded ends according to ASME B1.20.1. Valves with solder ends may be furnished for use with copper tube.

C. Bronze Check Valves: MSS SP-80, Type 3, Class 200. Include ends threaded according to ASME B1.20.1. Valves with solder ends may be furnished for use with copper tube.
D. Bronze Vertical Ball Check Valves: ASTM B 61 or ASTM B 62, 2-piece construction; and 400-psig WOG, nonshock, working-pressure rating. Include integral bronze seats, replaceable stainless-steel ball, and threaded ends according to ASME B1.20.1.

E. Cast-Iron Gate Valves: MSS SP-70, Type I, Class 250. Include OT construction, all-bronze trim, and flanged ends.

F. Steel Ball Valves: MSS SP-72; full-port, chrome-plated steel ball; TFE seats; and flanged ends.

G. Cast-Iron Check Valves: MSS SP-71, Type I, Class 250. Include flanged ends.

H. UL Valves: UL 842, listed for fuel oil service.

I. Special-Purpose, General-Duty Valves: Valves made in shape or configuration for specific fuel oil service and complying with requirements of NFPA 30.

2.6 FUEL STORAGE TANK PIPING SPECIALTIES

A. Manufacturers:
   1. EBW, Inc.
   2. EMCO Wheaton DTM, Inc.
   3. Environ Products Inc.
   6. OPW Fueling Components.
   7. Petroleum Containment Composites.
   8. Preferred Utilities Manufacturing Corp.
   9. Smith Fibercast; a Varco Company.
   10. Universal Valve Company.

B. Fitting Materials: Cast-iron, malleable-iron, brass, or corrosion-resistant metal; suitable for service.

C. Spill-Containment Remote Fill Boxes: Free standing, with lockable door, 10 gallon capacity and 1" drain with locking ball valve, quick disconnect, check and ball valve and hand pump. Provide box with 4 leg stand for free standing.

D. Pipe Adapters and Extensions: Compatible with piping and fittings.

E. Suction Strainers and Check Valves: Bronze or corrosion-resistant metal components.

2.7 LEAK-DETECTION AND -MONITORING SYSTEMS

A. Manufacturers:
   1. Amprodux, Inc.
   2. Caldwell Systems.
   3. Containment Solutions, Inc.
   4. EBW, Inc.
   5. Gems Sensors Inc.
   7. In-Situ, Inc.
8. Intelligent Controls, Inc.
10. MSA International; Instrument Div.
11. Pneumercator Inc.
12. Raychem Corp.
13. Tuthill Corporation; Tuthill Transfer Systems; Emco Electronics Div.

B. Description: Calibrated, leak-detection and monitoring system complying with UL 1238 with probes and other sensors and remote alarm panel for fuel piping. Include fittings and devices required for testing.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Install piping free of sags and bends.
B. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
C. Install fittings for changes in direction and branch connections.
D. Install rigid, underground, double-contained fill and vent piping at uniform slope downward toward fuel storage tank sump.
E. Install flexible, double-contained, fuel pipe at minimum slope of 1 percent downward toward fuel storage tank sump.
F. Assemble and install bulkhead fittings for pipe penetrations through storage tank sump sidewalls. Follow fitting manufacturer's written instructions and use components required for liquid-tight joints.
G. Install reductions in pipe sizes using eccentric reducer fittings. Install fitting with level side down.
H. Install flexible connectors at piping connections to UST.
I. Install flexible pipe connectors at piping connections to ASTs and vibration-producing equipment. Use according to the following applications:
   2. Copper Tubing: Bronze-hose, flexible connectors.
J. Install double-contained piping according to manufacturer's written instructions for assembly, joining, trench preparation, and installation.
K. Install and terminate double-contained piping at fuel storage tank containment sumps and at building.
3.3 VALVE INSTALLATION

A. Install valves in accessible locations. Protect valves from physical damage, and install metal tag attached with metal chain indicating fuel piping systems.

3.4 JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.

D. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

E. Ground equipment according to Division 26 Section "Grounding and Bonding."

F. Connect wiring according to Division 26 Section "Conductors and Cables."

G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 CONCRETE BASES

A. Construct concrete equipment bases according to equipment manufacturer's setting templates for anchor-bolt and tie locations. Use 3000 psi, 28-day, compressive-strength concrete.

B. Refer to Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

3.7 LEAK-DETECTION AND -MONITORING SYSTEM INSTALLATION

A. Install leak-detection and -monitoring systems according to manufacturer's written instructions. Install alarm panel inside building where indicated.


3.8 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on each AST and on equipment exposed in sumps and manholes.

1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
B. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for equipment nameplates and signs.

C. Warning Tapes: Arrange for installation of continuous underground detectable warning tape during backfilling of trenches.
   1. Piping: Over underground, fuel distribution piping.
   2. Fuel Storage Tanks: Over edges of each UST.

D. Refer to Division 20 Section "Mechanical Identification" for warning tapes.

3.9 FIELD PAINTING OF ABOVEGROUND PIPING
A. Paint exposed metal piping, valves, and piping specialties except units with factory-applied paint or protective coating.

B. Steel Piping: Prepare surface of aboveground steel piping and apply painting systems according to specifications in Division 09 Section "High-Performance Coatings" for severe environment semigloss finish for ferrous metal.

C. Copper Tubing: Prepare surface of aboveground copper tubing and apply painting systems according to specifications in Division 09 Section "High-Performance Coatings" for severe environment semigloss finish for nonferrous metal.

3.10 FIELD QUALITY CONTROL
A. Perform field tests on underground piping and USTs before backfilling.

B. Perform the following field tests and inspections and prepare test reports:
   1. Test fuel piping according to NFPA 30, "Piping Systems" Chapter on testing or NFPA 31, "Piping, Pumps, and Valves" Chapter on tests of piping.
      a. Hydrostatically test carrier piping to 1-1/2 times system pressure.
      b. Pneumatically test containment jacket at maximum 5 psig (35 kPa).
   2. Test leak-detection and -monitoring systems for accuracy by manually operating sensors and checking against alarm panel indication.

C. Remove and replace units and retest as specified above.

3.11 ADJUSTING
A. Adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.12 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain leak-detection and -monitoring systems.

END OF SECTION 33 5213