SECTION 01 1100

SUMMARY OF WORK

PART 1 - GENERAL

1.1 ENGINEER

A. Throughout the Bidding and Contract Documents, General Requirements (Division 01), and technical sections, all references to the Engineer or to the Architect shall mean James Posey Associates, Inc.

1.2 SECTION INCLUDES

A. Brief project description.

B. Contractor use of site and premises.

C. Owner occupancy.

1.3 DEFINITIONS

A. Project correction period: A period after Substantial Completion of the work during which the Contractor shall correct every part of the work found to be not in accordance with the requirements of the contract documents, promptly after receipt of written notice.

1.4 BRIEF PROJECT DESCRIPTION

A. Remove existing 30-kW 277/480-volt outdoor onsite liquid propane emergency generator manufactured by Kohler Power Systems, located in the service yard adjacent to the main electrical room, and associated automatic transfer switch. Replace with new larger natural-gas generator that can accommodate additional building loads, and new "life safety" automatic transfer switch ATS-1. Under Alternate 1, provide new "standby" automatic transfer switch ATS-2 and new electrical equipment (277/480-volt standby Panel S1, 30-kVA transformer, and 120/208-volt standby Panel SR1) to serve existing equipment, which includes boilers, heating water pumps, automatic temperature control (ATC) panel, and kitchen refrigeration equipment.

1.5 CONTRACTOR USE OF SITE AND PREMISES

A. Access to site: Limited to areas of work indicated on drawings and to paved areas.

B. Emergency building exits during construction: Keep existing exits clear.

C. Construction operations: Limited areas noted on Drawings.

D. Time restrictions for performing interior and exterior Work: See “Instruction to Bidders” for restrictions for on-site work hours.

E. Utility Outages and Shutdown: Shall be arranged with Owner in writing no less than 10 days in advance.

1.6 OWNER OCCUPANCY

A. The Owner will occupy the site and premises during entire period of construction for the conduct of normal operations.

B. Cooperate with Owner to minimize conflict, and to facilitate Owner's operations.

C. Schedule the work to accommodate this requirement.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 01 1200

ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Coordinate work of trades and schedule elements of alterations and renovation work by procedures and methods to expedite completion of the Work.

B. In addition to demolition specified in Division 02, and other sections and that specifically shown, cut, move or remove items as necessary to provide access or to allow alterations and new work to proceed. Include such items as:

1. Repair or removal of hazardous or unsanitary conditions.
2. Removal of abandoned items and items serving no useful purpose, such as abandoned piping, conduit and wiring.
3. Removal of unsuitable or extraneous materials not marked for salvage, such as abandoned furnishings and equipment, and debris such as rotted wood, rusted metals and deteriorated concrete.
4. Cleaning of surfaces and removal of surface finishes as needed to install new work and finishes.

C. Patch, repair and refinish existing items to remain, to the specified condition for each material, with a workmanlike transition to adjacent new items of construction.

D. Coordinate work to assure that required means of egress are open and clearly identified during the work. If temporary structures should be required to maintain egress, obtain required permits and provide structures as part of the work of this Contract.

1.2 RELATED SECTIONS

A. Partial Owner occupancy: Section 01 1000.

B. Cutting and patching: Section 01 7329.

C. Construction schedules: Section 01 3300.

D. Use of existing utilities: Section 01 5000.

E. Cleaning during construction: Section 01 7700.

1.3 ALTERATIONS, CUTTING AND PROTECTION

A. Assign the work of moving, removal, cutting and patching, to trades qualified to perform the work in a manner to cause least damage to each type of work, and provide means of returning surfaces to appearance of new work.

B. Perform cutting and removal work to remove minimum necessary, and in a manner to avoid damage to adjacent work.

1. Cut finish surfaces such as masonry, tile, plaster or metals, by methods to terminate surfaces in a straight line at a natural point of division.

C. Perform cutting and patching as specified in Section 01 7329.

D. Protect existing finishes, equipment, and adjacent work which are scheduled to remain, from damage.

1. Protect existing and new work from weather and extremes of temperature.

a. Maintain existing interior work above 60 degrees F.
b. Provide weather protection, waterproofing, heat and humidity control as needed to prevent damage to remaining existing work and to new work.

E. Provide temporary enclosures to separate work areas from existing building and from areas occupied by Owner, and to provide weather protection.

PART 2 - PRODUCTS

2.1 PRODUCTS FOR PATCHING, EXTENDING AND MATCHING

A. Provide same products or types of construction as that in existing structure, as needed to patch, extend or match existing work.

1. Generally Contract Documents will not define products or standards of workmanship present in existing construction; determine products by inspection and any necessary testing and workmanship by use of the existing as a sample of comparison.

B. Presence of a product, finish, or type of construction, requires that patching, extending or matching shall be performed as necessary to make Work complete and consistent to identical standards of quality.

PART 3 - EXECUTION

3.1 SPECIAL TECHNIQUES

A. Patch and extend existing work using skilled mechanics that are capable of matching existing quality of workmanship. Quality of patches or extended work shall be not less than that specified for new work.

3.2 ADJUSTMENTS

A. Where partitions are removed, patch floors, walls, and ceilings, with finish materials to match existing.

1. Where removal of partitions results in adjacent spaces becoming one, rework walls, floors and ceiling to provide smooth planes without breaks, steps, or bulkheads.
2. Where planes change, request instructions from Engineer as to method of making transition.

3.3 DAMAGED SURFACES

A. Patch and replace any portion of an existing finished surface which is found to be damaged, lifted, or discolored, or shows other imperfections, with matching material.

1. Provide adequate support of substrate prior to patching the finish.
2. Refinish patched portions of painted or coated surfaces in a manner to produce uniform color and texture over entire surface.
3. When existing surface finish cannot be matched, refinish entire surface to nearest intersections, using the same finish used in comparable new work. Obtain approval before beginning the work.

3.4 TRANSITION FROM EXISTING TO NEW WORK

A. When new work abuts or finishes flush with existing work, make a smooth transition. Patched work shall match existing adjacent work in texture and appearance so that the patch or transition is invisible at a distance of five feet.

1. When finished surfaces are cut in such a way that a smooth transition with new work is not possible, terminate existing surface in a neat manner along a straight line at a natural line of division, and provide trim appropriate to finished surface. Obtain approval of proposed trim before beginning the work.

3.5 CLEANING

A. Perform periodic and final cleaning as specified in Section 01 7700.

1. Clean Owner-occupied areas daily.
2. Clean spillage, overspray, and heavy collection of dust in Owner-occupied areas immediately.

B. At completion of work of each trade, clean area and make surfaces ready for work of successive trades.

C. At completion of alterations work in each area, provide final cleaning and return space to a condition suitable for use by Owner.

END OF SECTION

SECTION 01 2300

ALTERNATES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Submittal procedures.

B. Documentation of changes to contract sum and contract time.

1.2 RELATED SECTIONS

A. Work schedule affected by alternates: Section 01 1000.

B. Product options and substitutions: Section 01 6000.

C. Technical Sections Affected by Alternates: See the description of each Alternate.

1.3 REQUIREMENTS

A. Submit Alternates with full description of the proposed Alternate and the effect on adjacent or related components.

B. Indicate variation of Bid Price for Alternates described below and list in Bid Form Document or any supplement to it, which requests a difference in Bid Price by adding to or deducting from the base bid price.

C. Coordinate related work and modify surrounding work to integrate the Work of each Alternate.

D. Provide each selected alternate complete with all changes in associated work as required for complete, operational installation, in conformance with general requirements.

1.4 SELECTION AND AWARD OF ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at Owner's option. Accepted Alternates will be identified in the Owner-Contractor Agreement.

B. Bid will be evaluated on base bid price. After determination of lowest bidder, consideration will be given to Alternates and Bid Price adjustments.

1.5 SCHEDULE OF ALTERNATES

A. Alternate No. 1: Generator standby equipment.

1. Provide electrical equipment, feeders, and branch circuits for connecting existing equipment to generator "standby" power system. Existing equipment includes boilers, heating water pumps, automatic temperature control (ATC) panel, and kitchen refrigeration equipment. Provide "standby" automatic transfer switch ATS-2 and associated electrical equipment, which includes enclosed switches, circuit breaker in existing switchboard, 277/480-volt standby Panel S1, 30-kVA transformer, and 120/208-volt standby Panel SR1. Replace existing combination starters serving heating water distribution pumps with variable frequency drives.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 APPLICATION

A. Immediately after execution of the Owner-Contractor Agreement, in which accepted alternates will be listed, inform all subcontractors, suppliers, and staff assigned to the project, of the accepted alternates.

B. Provide all parties involved with complete information, including, but not limited to, drawings, general requirements, and technical specifications, defining the accepted alternates.

C. Coordinate all changes in the Work, caused by the Owner's selection or rejection of Alternates, as specified in Section 01 3100, Coordination.

END OF SECTION

SECTION 01 3100

COORDINATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Administrative and supervisory requirements for coordinating construction.

B. Procedures for review of documents and coordination of construction activity, including preparation of coordination drawings.

C. Coordination with Owner's requirements.

D. Coordination of work of various trades, suppliers, and subcontractors.

1.2 COORDINATION PROCEDURES

A. In accordance with requirements of the General Conditions, before starting each portion of the work, study and compare the various drawings and other contract documents relative to that portion of the work, as well as other information and field measurements and drawings.

B. Examples of items which may require particular field adjustment and coordination include, but are not limited to:

1. Reflected ceiling plans, which require coordination with mechanical and electrical equipment installed in and above ceilings.
2. Specifications and drawings for equipment and furnishings which require connections to and coordination with associated mechanical and electrical systems and devices.
3. Installation of systems typically shown on contract drawings as diagrams and therefore subject to field adjustment.

    a. Areas where two or more such systems are required to be installed in limited space.

4. Areas subject to several simultaneously applied requirements of mechanical, electrical, and building codes.

C. Immediately report as required by the General Conditions and by procedural and administrative specifications:

1. If, during the coordination review or later during the progress of the work, errors, inconsistencies, or omissions are discovered.
2. If a situation should develop which prevents the proper installation of any equipment or item, or compliance with the contract documents.

D. Coordinate scheduling, submittals and work of the various sections of Specifications to assure efficient, timely, and orderly sequence of installation of construction elements. Provide for accommodating items to be installed later. Coordinate work so that each trade will have completed installations prior to construction which could obstruct their work.

E. Dimensions: Coordinate sizing of various components to assure proper fit and location. Verify dimensions of existing work and of new construction and equipment.

F. Drawings: Various products and systems have been indicated schematically or diagrammatically.

Coordinate actual layout and dimensions, and prevent interference between components or trades.

G. Substitution or Change: Determine and coordinate the effects. Upon approval of substitution or Change in the Work, accommodate all the consequent ramifications and costs.

H. Sequence: Coordinate to provide normal progression of the Work in a timely manner without delays. Determine long-lead items and the requirements for items on which each sequence is dependent.

I. Individual Inspection: Every subcontractor or trade is responsible for reviewing contract documents, and inspecting surfaces, substrates and areas related to the execution of their work.

J. Coordinate trades to insure that proper clearances and access are provided for items which require operation and maintenance.

K. Work under this contract is to be done during regular working hours. Cooperate with the Owner in setting up the schedule of work during the entire course of the project so as not to interfere with normal operations of Owner.

1. All passageways and means of egress from the building shall be kept open during normal hours except where special arrangements are made in advance with Owner and authorities having jurisdiction.
2. Do not schedule work within the existing building unless a custodian is on duty.
3. Do not shut down domestic water, heating, air conditioning, electric, fire alarm, or waste systems, or Owner's equipment without consent of the Owner. Coordinate and schedule shutdowns with the Owner, giving the maximum notice time possible with a minimum of three working days in advance.
4. Fire alarm system shall always be in operation when Contractor's personnel leave the project.

1.3 COORDINATION MEETINGS

A. In addition to progress meetings specified in Section 01 3119, hold coordination meetings and preinstallation conferences with personnel and subcontractors to assure coordination of work.

1.4 COORDINATION OF SUBMITTALS

A. Schedule and coordinate submittals. See requirements of the Section specifying submittal procedures.

B. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, equipment.

C. Coordinate requests for substitutions to assure compatibility of space, of operating elements and effect on work of other sections.

1.5 COORDINATION SUBMITTALS

A. Coordination drawings: Prepare coordination drawings where careful and detailed coordination is needed, as required for situations described in "Coordination Procedures" above, and where required in other sections of specifications.

1. Show relationships of components shown on separate shop drawings.
2. Show proposed field coordination of systems shown schematically or diagrammatically on contract drawings.

3. Indicate installation sequences.

1.6 COORDINATION OF SPACE

A. Coordinate use of Project space and sequence of installation of mechanical and electrical work which is indicated diagrammatically on drawings. Follow route shown for pipes, ducts and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Use space efficiently to provide access for other installations, for maintenance, and for repairs.

B. In finished areas conceal pipes, ducts, and wiring in the construction. Coordinate locations of fixtures and outlets with finish elements.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Review of Work: Prior to the commencement of Work of each section of the specifications, carefully examine previously executed work performed under other sections or by other trades, which might affect execution of work of a section.

B. Acceptance: Commencement of work of a Section will indicate acceptance by the Contractor of previously executed surfaces, substrates and areas of work. The commencement indicates that previous work has been inspected and meets the Contractor's requirements for warranty.

3.2 FIELD QUALITY CONTROL

A. A competent superintendent shall be on the premises at all times to check, lay out, coordinate, and superintend the installation of work. Superintendent shall establish grades and lines relative to the work before starting, and be responsible for their accuracy.

B. Coordinate completion and clean-up of work of separate sections in preparation for Substantial Completion.

C. Coordinate access to site by various trades and subcontractors for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

D. Assemble and coordinate closeout submittals specified in Section 01 7700.

END OF SECTION

SECTION 01 3119

PROJECT MEETINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Preconstruction conference

B. Progress meetings.

1.2 RELATED SECTIONS

A. Coordination: Section 01 3100

PART 2 - PRODUCTS

Not used

PART 3 - EXECUTION

3.1 PRECONSTRUCTION CONFERENCE

A. Owner will conduct conference for execution of Owner-Contractor Agreement.

B. Owner will conduct conference for clarification of Owner and Contractor responsibilities in use of site and review of administration procedures.

3.2 PROGRESS MEETINGS

A. Progress meetings shall be held at the job site no less than two weeks apart, and also when and if the Contractor or Engineer finds them necessary or advantageous to progress of work.

B. Contractor, those subcontractors and those material suppliers concerned with current progress or with the scheduling of future progress, Engineer and Owner shall each be represented at these meetings by persons familiar with the details of work and authorized to conclude matters relating to work progress.

C. Contractor shall conduct each progress meeting and prepare agenda of meeting with a copy for each attendee. Contractor shall keep accurate minutes of Progress Meetings, wording of which shall be approved by Engineer and shall promptly within two days distribute a sufficient number of copies to all parties.

D. Contractor shall provide tables and chairs for meetings and a set of drawings and specifications shall be available for use.

END OF SECTION

SECTION 01 3300

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. Submittal procedures.

B. Manufacturer and subcontractor list.

C. Product data.

D. Shop drawings.

E. Manufacturers' instructions.

F. Schedule of values.

G. Manufacturers' certificates.

H. Project schedules.

1.2 RELATED SECTIONS

A. Section 01 4500, Quality Control: Manufacturers' field services and reports.

B. Section 01 7700, Closeout Procedures: Operation and maintenance manuals; certificates and special warranties; closeout submittals.

1.3 DEFINITIONS

A. Coordination drawings show the relationship and integration of different construction elements that require careful coordination during fabrication or installation to fit in the space provided or to function as intended.

1. Preparation of coordination drawings is specified in Division 01 Section “Coordination” and may include components previously shown in detail on Shop Drawings or Product Data.

1.4 SUBMITTAL PROCEDURES

A. Transmit each submittal with a form or letter of transmittal acceptable to the Engineer.

B. Sequentially number the transmittal forms. Resubmittals to have original number with an alphabetic suffix.

C. Identify Project, Contractor, Subcontractor or supplier; pertinent Drawing sheet and detail number(s), and specification Section number, and paragraph, as appropriate. Identify specific service or location for which the item is to be used.

D. 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.

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

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

G. Provide space for Contractor and Engineer review stamps.

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

I. Contractor's failure to make submittals in time for review and resubmittals shall not be allowed as a reason for extending contract time.

J. Product data and shop drawings will not be reviewed until the manufacturer and subcontractor list has been accepted. Do not order, fabricate, or install any item until it has been reviewed and accepted.

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

1.5 MANUFACTURER AND SUBCONTRACTOR LIST

A. Within 7 days after date of Owner-Contractor Agreement, submit complete list of manufacturers and subcontractors proposed for use, with name of manufacturer, trade name, and model number of each product. A partial or incomplete list will not be accepted.

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

1.6 PRODUCT DATA

A. Submit submittal in electronic format to the Engineer and Owner.

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

C. The approval of a Shop Drawing or Product Data does not guarantee the measurements or the building conditions or that the Shop Drawings or Product Data have been checked to see that item submitted properly fits the building conditions. Approval shall not relieve the Contractor of the responsibility for furnishing material and performing work as required by the specifications and contract drawings; or the responsibility for verifying correctness of dimensions and quantities, and proper coordination of details and interface among trades.

D. All exclusively electrical items furnished as associated items with mechanical items but not specifically described in the mechanical item submission, shall be submitted as a separate Shop Drawing but shall be clearly marked as associated with the mechanical item by specification paragraph.

E. After review, distribute in accordance with Article on Procedures above and provide copies for Record Documents described in Section 01 7700, Closeout Procedures.

1.7 SHOP DRAWINGS

A. Submit in electronic PDF format.

B. Available space for equipment is indicated by the size of equipment shown on the drawings. Suppliers shall ascertain that their equipment will fit the available space. Include with shop drawings of equipment, drawings showing necessary deviations and changes required in materials and appurtenances made necessary by the units proposed to be furnished. Contractor shall be responsible for required changes without any additional cost.

C. After review, distribute in accordance with Article on Procedures above and for Record Documents described in Section 01 7700, Closeout Procedures.

1.8 MANUFACTURER'S INSTRUCTIONS

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

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

1.9 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of Schedule of Values with preparation of the Contractor’s Construction Schedule.

1. Correlate line items in the Schedule of Values with other required administrative schedules and forms, including:

a. Contractor’s Construction Schedule.
b. Application for Payment forms, including Continuation Sheets.
c. List of subcontractors.
d. Schedule of alternates.
e. List of products.
f. List of principal suppliers and fabricators.
g. Schedule of submittals.

2. Submit the Schedule of Values at the earliest possible date but no later than 7 days before the date scheduled for submittal of the initial Applications for Payment.

B. Format and content: Use the Project Manual table of contents as a guide to establish the format for the Schedule of Values. Provide at least one line item for each Specification Section.

1. Identification: Include the following project identification on the Schedule of Values:

a. Project name and location.
b. Name of the Engineer.
c. Project number.
d. Contractor’s name and address.
e. Date of submittal.

2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:

    a. Related specification section or division.
    b. Description of work.
    c. Name of subcontractor.
    d. Name of manufacturer or fabricator.
    e. Name of supplier.
    f. Change Orders (numbers) that affect value.
    g. Dollar value.
    h. Percentage of Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

3. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Break principal subcontract amounts down into several line items.
4. Round amounts to nearest whole dollar; the total shall equal the Contract Sum.
5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment, purchased or fabricated and stored, but not yet installed.

    a. Differentiate between items stored on-site and items stored off-site. Include requirements for insurance and bonded warehousing, if required.

6. Provide separate line items on the Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the work.
7. Margins of cost: Show line items for indirect costs and margins on actual costs only when such items are listed individually in Applications for Payment. Each item in the Schedule of Values and Applications for Payment shall be complete. Include the total cost and proportionate share of general overhead and profit margin for each item.

    a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at the Contractor's option.

C. Schedule updating: Update and resubmit the Schedule of Values prior to the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.10 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 whether material or product conforms to or exceeds 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.

1.11 CONSTRUCTION PROGRESS SCHEDULES

A. Submit initial progress schedule in duplicate within 20 days after date of Owner-Contractor Agreement 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 computer generated network analysis diagram using the critical path method, generally as outlined in Associated General Contractors of America (AGC) publication "The Use of CPM in Construction - A Manual for General Contractors and the Construction Industry".

E. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, and duration.

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

G. Indicate submittal dates required for shop drawings, product data, samples, and product delivery dates, including those furnished by Owner and under Allowances.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not used

END OF SECTION

SECTION 01 4100

REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. As a convenience to users of the contract documents, listings of organizations and their common acronyms or abbreviations which are referred to in the documents or which are among the authorities having jurisdiction.

B. Description of submittals required for conformance to regulatory requirements.

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. “Approved”: When used to convey Architect’s action on Contractor’s submittals, applications, and requires, “approved” is limited to Architect’s duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 SUBMITTALS

A. Secure certificates of approval from specified or other approved testing agencies, inspection agencies, and authorities having jurisdiction. Certificates shall cover all work, including, but not limited to, plumbing, ductwork, fire protection, and electrical. Submit certificates of approval prior to final acceptance of the work.

B. Obtain, including the expediting of all necessary signatures and paperwork, permits, fees, and inspections required by city, county, state, or federal authorities having jurisdiction, and utility connections or extension charges. Pay for all certificates, permits, fees, inspections and

connections. Include these costs in Applications for Payment only after copies of the certificates, permits, receipts, or reports have been transmitted to the Owner.

C. Before starting construction, obtain necessary forms, completely fill them out, and file to obtain the permit and register the burners and boilers with the Maryland Department of the Environment, Bureau of Air Quality Control, local office as required by State regulations.

1.4 QUALITY ASSURANCE

A. When these specifications call for materials or construction of a better quality or larger sizes than required by the codes and standards of the regulatory authorities or industry organizations, the provisions of the specifications shall take precedence.

B. Provide without extra charge, additional materials and labor which may be required for compliance with these codes and standards even though the work is not mentioned in these specifications or shown on the contract drawings.

C. Materials, equipment or workmanship specified by reference to number, symbol, or title of any industry or government agency standard shall comply with the applicable provisions of such standard, except as limited to type, class, or grade, or modified in contract specifications. Standards referred to in the specifications, except as modified, shall have full force and effect as though printed in detail in specifications.

D. Regulatory authorities: The work covered under these specifications shall be performed in accordance with the applicable requirements of the authorities having jurisdiction. The applicable edition of a regulatory code is as defined by the authority. Where standards are referred to, comply with standards and revisions in effect as of the date of the contract documents. The applicable regulatory authorities include, but are not limited to:

1. The Plumbing, Mechanical, Electrical, Building, Boiler and Pressure Vessel, Fire, and Safety Codes of the State and County or City in which the work is being performed.
2. The State Department of Health.
3. The National Electric Code (NEC, NFPA 70).
4. The ASME Boiler Code.
5. The National Fire Protection Association (NFPA).
6. Insurance Service Office of Maryland.
7. International Building Code (IBC).
8. International Energy Conservation, Fire, Fuel Gas, Mechanical, and Plumbing Codes (ICC).
9. Washington Suburban Sanitary Commission (WSSC).

E. Trade associations and standards: The following abbreviations and acronyms, when referred to in the contract documents, mean the organizations identified below. Names and addresses are subject to change and are believed, but not assured, to be correct as of the date of the contract documents.

AA	Aluminum Association 900 19th St., NW, Suite 300 Washington, DC 20006 www.aluminum.org	(202) 862-5100
AABC	Associated Air Balance Council 1518 K St., NW, Suite 503 Washington, DC 20005 www.aabchq.com	(202) 737-0202

AAMA	American Architectural Manufacturers Association 1827 Walden Office Sq., Suite 104 Schaumburg, IL 60173-4268 www.aamanet.org	(847) 303-5664
AAN	American Association of Nurserymen (See ANLA)	
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol St., NW, Suite 249 Washington, DC 20001 www.aashto.org	(202) 624-5800
ABMA	American Boiler Manufacturers Association 950 North Glebe Rd., Suite 160 Arlington, VA 22203-1824 www.abma.com	(703) 522-7350
ACI	American Concrete Institute P.O. Box 9094 Farmington Hills, MI 48333-9094 www.aci-int.org	(248) 848-3700
ACIL	ACIL: The Association of Independent Scientific, Engineering, and Testing Firms 1629 K St., NW, Suite 400 Washington, DC 20006 www.acil.org	(202) 887-5872
ACPA	American Concrete Pipe Association 222 West Las Colinas Blvd., Suite 641 Irving, TX 75039-5423 www.concrete-pipe.org	(972) 506-7216
ADC	Air Diffusion Council 11 South LaSalle St., Suite 1400 Chicago, IL 60603	(312) 201-0101
AEIC	Association of Edison Illuminating Companies 600 N. 18th St. P.O. Box 2641 Birmingham, AL 35291-0992	(205) 250-2530
AFPA	American Forest and Paper Association (Formerly: National Forest Products Association) 1111 19th St., NW, Suite 800 Washington, DC 20036	(800) 878-8878 (202) 463-2700
AGA	American Gas Association 1515 Wilson Blvd. Arlington, VA 22209 www.aga.com	(703) 841-8400

AGMA	American Gear Manufacturers Association (AGMA) 1500 King Street, Suite 201 Alexandria, VA 22314-2730	(703) 684-0211
	Order Publications From:	
	Global Engineering Documents 15 Inverness Lane East Englewood, CO 80112	(800) 854-7179
AISC	American Institute of Steel Construction One East Wacker Dr., Suite 3100 Chicago, IL 60601-2001	(800) 644-2400 (312) 670-2400
AISI	American Iron and Steel Institute 1101 17th St., NW Washington, DC 20036-4700 www.steel.org	(202) 452-7100
AMCA	Air Movement and Control Association International, Inc. 30 W. University Dr. Arlington Heights, IL 60004-1893 www.amca.org	(847) 394-0150
ANSI	American National Standards Institute 11 West 42nd St., 13th Floor New York, NY 10036-8002 www.ansi.org	(212) 642-4900
APA	Architectural Precast Association P.O. Box 08669 Fort Myers, FL 33908-0669	(941) 454-6989
API	American Petroleum Institute 1220 L St., NW, Suite 900 Washington, DC 20005-8029	(202) 682-8000
AREA	American Railway Engineering Association 50 F Street, N.W., Suite 5200 Washington, D.C. 20001	(202) 639-2190
ARI	Air-Conditioning and Refrigeration Institute 4301 Fairfax Dr., Suite 425 Arlington, VA 22203 www.ari.org	(703) 524-8800
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers 1791 Tullie Circle, NE Atlanta, GA 30329-2305 www.ashrae.org	(800) 527-4723 (404) 636-8400
ASME	American Society of Mechanical Engineers 345 East 47th St. New York, NY 10017-2392	(800) 434-2763 (212) 705-7722

	www.asme.org	
ASPE	American Society of Plumbing Engineers 8614 W. Catalpa Ave., Ste 1007-1009 Chicago, IL 60656-116	(805) 495-7120
ASSE	American Society of Sanitary Engineering 28901 Clemens Rd. Westlake, OH 44145 www.asse-plumbing.org	(216) 835-3040
ASTM	American Society for Testing and Materials 100 Barr Harbor Dr. West Conshohocken, PA 19428-2959 www.astm.org	(610) 832-9500
AWI	Architectural Woodwork Institute 1952 Isaac Newton Sq. Reston, VA 20190 www.awinet.org	(703) 733-0600
AWS	American Welding Society 550 NW LeJeune Rd. Miami, FL 33126 www.amweld.org	(800) 443-9353 (305) 443-9353
AWWA	American Water Works Association 6666 W. Quincy Ave. Denver, CO 80235 www.awwa.org	(800) 926-7337 (303) 794-7711
BIA	Brick Institute of America 11490 Commerce Park Dr. Reston, VA 22091-1525 www.bia.org	(703) 620-0010
CAGI	Compressed Air and Gas Institute c/o Thomas Associates, Inc. 1300 Sumner Ave. Cleveland, OH 44115-2851 www.taol.com/cagi	(216) 241-7333
CBM	Certified Ballast Manufacturers Association 1422 Euclid Ave., Suite 402 Cleveland, OH 44115-2094	(216) 241-0711
CDA	Copper Development Association, Inc. 260 Madison Ave., 16th Floor New York, NY 10016-2401 www.copper.org	(800) 232-3282 (212) 251-7200
CISPI	Cast Iron Soil Pipe Institute 5959 Shallowford Rd., Suite 419 Chattanooga, TN 37421	(423) 892-0137

CTI	Cooling Tower Institute P.O. Box 73383 Houston, TX 77273	(281) 583-4087
DEMA	Diesel Engine Manufacturers Association (DEMA) 2130 Keith Building, Cleveland, OH 44115	
EEI	Edison Electric Institute (EEI) 90 Park Avenue New York, NY 10016	
EIA	Electronic Industries Association 2500 Wilson Blvd. Arlington, VA 22201	(703) 907-7500
ETL	ETL Testing Laboratories, Inc. (Now part of ITS)	
FGMA	Flat Glass Marketing Association (See GANA)	
FM	Factory Mutual System 1151 Boston-Providence Tnpk. P.O. Box 9102 Norwood, MA 02062-9102 www.factorymutual.com	(781) 762-4300
FTI	Facing Tile Institute c/o Stark Ceramics P.O. Box 8880 Canton, OH 44711	(330) 488-1211
HI	Hydraulic Institute 9 Sylvan Way Parsippany, NJ 07054-3802	(201) 267-9700
IEEE	Institute of Electrical and Electronics Engineers 345 E. 47th St. New York, NY 10017-2394 www.ieee.org	(800) 678-4333 (212) 705-7900
IRI	Industrial Risk Insurers P.O. Box 5010 85 Woodland St. Hartford, CT 06102-5010	(860) 520-7300
ITS	Intertek Testing Services (Formerly: Inchcape Testing Services) P.O. Box 2040 3933 US Route 11 Cortland, NY 13045-7902 www.itsglobal.com	(800) 345-3851 (607) 753-6711

LPI	Lightning Protection Institute 3335 N. Arlington Heights Rd., Suite E Arlington Heights, IL 60004-7700	(800) 488-6864 (847) 577-7200
MIA	Marble Institute of America 30 Eden Alley, Suite 301 Columbus, OH 43215 www.marble-institute.com	(614) 228-6194
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry 127 Park St., NE Vienna, VA 22180-4602	(703) 281-6613
NAAMM	National Association of Architectural Metal Manufacturers 8 South Michigan Ave., Suite 1000 Chicago, IL 60603 www.gss.net/naamm	(312) 456-5590
NAIMA	North American Insulation Manufacturers Association (Formerly: Thermal Insulation Manufacturers Association) 44 Canal Center Plaza, Suite 310 Alexandria, VA 22314 www.naima.org	(703) 684-0084
NCRPM	National Council on Radiation Protection and Measurements 7910 Woodmont Ave., Suite 800 Bethesda, MD 20814-3095 www.ncrp.com	(800) 229-2652 (301) 657-2652
NEBB	National Environmental Balancing Bureau 8575 Grovemont Circle Gaithersburg, MD 20877-4121	(301) 977-3698
NEMA	National Electrical Manufacturers Association 1300 N 17th St., Suite 1847 Rosslyn, VA 22209 www.nema.org	(703) 841-3200
NETA	InterNational Electrical Testing Association P.O. Box 687 106 Stone St. Morrison, CO 80465-1526 www.electricnet.com/neta	(303) 697-8441
NFPA	National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02269-9101 www.nfpa.org	(800) 344-3555 (617) 770-3000

NRCA	National Roofing Contractors Association O'Hare International Center 10255 W. Higgins Rd., Suite 600 Rosemont, IL 60018-5607 www.roofonline.org	(800) 323-9545 (847) 299-9070
NSF	NSF International (Formerly: National Sanitation Foundation) P.O. Box 130140 Ann Arbor, MI 48113-0140 www.nsf.org	(313) 769-8010
PDI	Plumbing and Drainage Institute 45 Bristol Dr., Suite 101 South Easton, MA 02375	(800) 589-8956 (508) 230-3516
PEI	Porcelain Enamel Institute 4004 Hillsboro Pike, Suite 224-B Nashville, TN 37215 www.porcelainenamel.com	(615) 385-5357
PPI	Plastic Pipe Institute (The Society of the Plastics Industry, Inc.) 1801 K St., NW, Suite 600L Washington, DC 20006 www.plasticpipe.org	(202) 974-5306
RFCI	Resilient Floor Covering Institute 966 Hungerford Dr., Suite 12-B Rockville, MD 20850-1714	(301) 340-8580
RMA	Rubber Manufacturers Association 1400 K St., NW, Suite 900 Washington, DC 20005 www.rma.org	(800) 220-7620 (202) 682-4800
SJI	Steel Joist Institute 3127 10th Ave., North Ext. Myrtle Beach, SC 29577-6760	(803) 626-1995
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association, Inc. 4201 Lafayette Center Dr. P.O. Box 221230 Chantilly, VA 20151-1209 www.smacna.org	(703) 803-2980
SSPC	Steel Structures Painting Council 40 24th St., 6th Floor Pittsburgh, PA 15222-4643	(412) 281-2331
SSPMA	Sump and Sewage Pump Manufacturers Association P.O. Box 647 Northbrook, IL 60065-0647	(847) 559-9233

STI	Steel Tank Institute 570 Oakwood Rd. Lake Zurich, IL 60047-1559	(847) 438-8265
TCA	Tile Council of America 100 Clemson Research Blvd. Anderson, SC 29625	(864) 646-8453
TIMA	Thermal Insulation Manufacturers Association (See NAIMA)	
UL	Underwriters Laboratories, Inc. 333 Pfingsten Rd. Northbrook, IL 60062 www.ul.com	(800) 704-4050 (847) 272-8800

F. Federal Government Agencies: Names and titles of Federal Government standards- or specification-producing agencies are often abbreviated. The following abbreviations and acronyms referred to in the Contract Documents indicate names of standards- or specification-producing agencies of the Federal Government. Names and addresses are subject to change and are believed, but are not assured, to be accurate and up-to-date as of the date of the Contract Documents.

CFR	Code of Federal Regulations (Available from the Government Printing Office) Washington, DC 20401 (Material is usually published first in the "Federal Register.") www.access.gpo.gov	(202) 512-0000
EPA	Environmental Protection Agency 401 M St., SW Washington, DC 20460	(202) 260-2090
FCC	Federal Communications Commission 1919 M St., NW Washington, DC 20554	(202) 418-0126
FS	Federal Specification Unit (Available from GSA) 470 East L'Enfant Plaza, SW, Suite 8100 Washington, DC 20407	(202) 619-8925
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor) 200 Constitution Ave., NW Washington, DC 20210	(202) 219-8148

1.5 OTHER REFERENCES

A. International Code Council (ICC)
500 New Jersey Avenue, NW, 6th Floor
Washington, DC 20001

B. Maryland Occupational Safety and Health Act (MOSHA)
State of Maryland Department of Health and Mental Hygiene

201 W. Preston Street, Baltimore, MD 21201

C. Standardized Plant Names, Published by J. Horace McFarland, Harrisburg, PA, for the American Joint Committee on Horticultural Nomenclature.

D. Applicable State, City and County Standard Details and Design Manuals for Water Mains, Sanitary Standards, and Storm Details.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

SECTION 01 4500

QUALITY CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Quality assurance and control of installation.

B. References.

C. Inspection and testing laboratory services.

D. Tests of mechanical and electrical systems and equipment.

E. Manufacturers' field services and reports.

1.2 RELATED SECTIONS

A. Submittals: Section 01 3300.

B. Requirements for material and product quality: Section 01 6000.

1.3 REFERENCES

A. Conform to reference standard by date of issue current on date of Contract Documents.

B. Obtain copies of standards when required by Contract Documents.

C. Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

D. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.4 QUALITY ASSURANCE

A. The Specifications and Drawings are intended to define the minimum requirements, as to quality of materials, construction, finish and overall workmanship.

B. In case of discrepancies between the specifications and drawings, the specifications should be followed as to the general methods and principles and the drawings followed as to sizes, capacities and specifics for corresponding parts. If sizes are omitted, the Engineer will determine sizes to be used.

C. In all cases of doubt, uncertainty or conflict as to the true meaning of the specifications or drawings it is the responsibility of the Contractor to notify the Engineer and obtain a decision as to the intent, before initiating any work which may be affected by this decision.

1.5 SPECIALIST

A. The term “specialist” as used in the specification shall mean an individual or firm of established reputation (or, if newly organized, whose personnel have previously established a reputation in the same field,) which is regularly engaged in, and which maintains a regular force of workers skilled in either (as applicable) manufacturing or fabricating items required by the contract, installing items required by the contract, or otherwise performing work required by the Contract. Where the contract specification requires installation by a specialist, the term shall also be deemed to mean either the manufacturer of the item, an individual or firm licensed by the manufacturer, or an individual or firm who will perform the work under the manufacturer’s direct supervision.

B. Specialist shall submit a list of a minimum of three projects of similar type, size and duty, which have been performed for not less than five years.

C. List shall include project name, address, name and phone number of Owner’s Representative, project size and type.

1.6 CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, Products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply fully with manufacturers’ instructions, including each step in sequence.

C. Should manufacturers’ instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform work by persons qualified to produce workmanship of specified quality.

F. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTS

A. Furnish all labor, specialties, equipment, services, and appurtenances required for the tests, and pay any other expenses incurred, including necessary changes to the systems as required to produce the specified results.

B. Conduct all tests before any equipment is connected that would be subject to damage from the test pressure and voltage.

C. Notify all parties whose presence is necessary for the test. Notify Engineer at least two days prior to the actual test.

D. Perform specific tests on the systems and equipment installed as work of Division 23 for HVAC;

and Division 26 for Electrical; and specified in technical sections.

E. Tests shall be performed in accordance with the requirements of the applicable codes and as herein specified. The entire installation shall be proven complete and in readiness for regular and satisfactory use.

F. Equipment, materials and workmanship found at fault during tests shall be replaced, repaired or made good to satisfaction of the Engineer, and test repeated.

3.2 INSPECTION AND TESTING LABORATORY SERVICES

A. Contractor shall employ and pay for services of an independent testing laboratory to perform specified inspection and testing.

B. The independent firm will perform inspections, tests, and other services specified in individual Specification Sections and as required by the Engineer.

C. Reports will be submitted by the independent firm to the Engineer and Owner, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

D. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage and assistance as requested.

1. Notify Engineer and independent firm 24 hours prior to expected time for operations requiring services.
2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.

E. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the Engineer. Payment for retesting will be charged to the Contractor by the Testing Laboratory.

3.3 MANUFACTURERS' FIELD SERVICES AND REPORTS

A. Submit qualifications of observer to Engineer 30 days in advance of required observations. Observer subject to approval of Engineer and Owner.

B. When specified in individual specification Sections, require material or Product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance of equipment as applicable, and to initiate instructions when necessary.

C. Individuals to report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

D. Submit report in duplicate within 30 days of observation to Engineer for review.

END OF SECTION

SECTION 01 5000

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities: Electricity, ventilation, telephone service, water, and sanitary facilities.

B. Temporary Controls: Barriers, fencing, and protection of the Work.

C. Construction Facilities: Access roads, parking, and progress cleaning.

1.2 RELATED SECTIONS

A. Project Meetings: Section 01 3119.

B. Project Closeout: Section 01 7700.

PART 2 - PRODUCTS

2.1 Products shall comply with applicable sections of Division 2 through 33 and shall be commercial grade.

PART 3 - EXECUTION

3.1 TEMPORARY ELECTRICITY

A. Connect to existing power service. Power consumption for construction shall not disrupt Owner's continuous service.

B. Owner will pay cost of energy used. Exercise measures to conserve energy.

C. Permanent convenience receptacles may be utilized during construction.

3.2 TEMPORARY VENTILATION

A. Use existing ventilation equipment. Extend and supplement equipment with temporary fan units as required to maintain clean air for construction operations.

B. Prevent dust or fumes from construction work from entering building ventilation systems.

3.3 TELEPHONE SERVICE

A. Provide, maintain and pay for telephone service to field office at time of project mobilization.

3.4 TEMPORARY WATER SERVICE

A. Connect to existing water source for construction operations.

B. Owner will pay cost of water used. Exercise measures to conserve water.

3.5 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Existing facilities shall not be used.

3.6 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas to allow for Owner's use of site, and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

B. Provide access, staging, and protection as necessary for proper handling of work.

C. Provide protection for plant life designated to remain. Replace damaged plant life.

D. Protect non-owned vehicular traffic, stored materials, site and structures from damage.

3.7 FENCING

A. Construction: Commercial grade chain link fence.

B. Provide 6 foot high fence around construction site; equip with vehicular gates with locks.

3.8 PROTECTION OF INSTALLED WORK

A. Protect installed Work and provide special protection where specified in individual specification Sections.

B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to minimize damage.

C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

E. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

F. Prohibit traffic from landscaped areas.

G. Each trade and subcontractor is responsible for preventing damage and soiling of work performed by other trades or subcontractors. Each trade and subcontractor is responsible for providing temporary protection of its own work.

1. Protect Work from spills, splatters, dippings, adhesives, bitumens, mortars, paints, plasters, welding or burning.
2. Protect finished Work from damage, defacement, staining, or scratching.
3. Protect finish Work from cleaning agents, or grinding and finishing equipment.
4. Protect adjacent and finished Work from damage, using tape, masking, covers or coatings and protective enclosures.
5. Coordinate installations and temporarily remove items to avoid damage from finishing Work.

H. Repair damage and soiling to the complete satisfaction of the Engineer; replace any materials or Work damaged to such an extent that they cannot be restored to their original condition, at no addition to the Contract Sum.

3.9 FIRE PROTECTION

A. As a minimum, provide hand-carried, portable, UL-rated extinguishers with each work crew working inside the building.

B. Select extinguishers in accordance with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

3.10 SCAFFOLDING, TARPAULINS

A. Wood Scaffolding: Do not use wood scaffolding, except for deck planking. All supporting members shall be of metal.

B. Tarpaulins: Certified flame retardant in accordance with NFPA 701.

3.11 SAFETY

A. Safety requirements of the Maryland Occupational Safety Authority supersede the following safety suggestions and shall govern all work on this project.

1. Contact Owner's representative before starting any work.
2. Make sure all objects attached to walls or ceilings are securely fastened.
3. Do not work overhead of Owner's personnel.
4. When cutting or chipping concrete, protect against spalling below and against flying chips.
5. Do not block doors with ladders; if blocking is necessary, place a "Caution" sign on other side of door.
6. Keep the work area clear of debris or other items over which people might trip.

3.12 HEAVY EQUIPMENT

A. Provide, either through own organization or through Subcontractors, all construction cranes, and other rigging, concrete lifts, chutes, and the like required for completion of work.

B. All such construction shall be carried out in conformance with local codes and subject to the approval of Engineer. Do not locate or move cranes, chutes or other heavy equipment in such a manner as to damage or strain the framework of any building. Contractor shall be responsible for the integrity of the site and shall replace any and all construction damaged by the use of equipment.

C. Contractor and its Subcontractors shall be entirely responsible for the proper handling and safety of all equipment used.

3.13 SECURITY

A. Provide security and facilities to protect Work, and existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.

B. Coordinate with Owner's security program.

3.14 ACCESS ROADS

A. Construct and maintain temporary roads accessing public thoroughfares to serve construction area.

B. Extend and relocate as Work progress requires. Provide detours necessary for unimpeded traffic flow.

C. Provide and maintain access to fire hydrants, free of obstructions.

D. Existing on-site roads may be used for construction traffic.

E. Use of sidewalks or roads outside the property lines shall be with permission and approval of the authorities having jurisdiction.

3.15 PARKING

A. When site space is not adequate, provide additional off-site parking.

3.16 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Remove waste materials, debris, and rubbish from site daily and dispose off-site.

3.17 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary above grade or buried utilities, equipment, facilities, materials, prior to Substantial Completion inspection.

B. Remove underground installations to a minimum depth of 2 feet.

C. Clean and repair damage caused by installation or use of temporary work.

D. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

END OF SECTION

SECTION 01 6000

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Products.

B. Product Options.

C. Substitutions.

D. Delivery, Storage, and Handling.

1.2 PRODUCTS

A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.

B. Labeling and Testing Electrical Components and Equipment: As specified in Mechanical and Electrical Basic Materials and Methods.

C. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

D. Provide interchangeable components of the same manufacturer, for similar components.

E. All products and materials shall be of the specified level of quality, suitable for the conditions and expected performance of the project, and of standard manufacture.

F. All equipment, construction and installation must meet requirements of Local, State and Federal Governing Codes.

G. Singular Number: In cases where material, a device, or part of the equipment is referred to in the singular number in the specifications, it is intended that such reference shall apply to as many items of material, devices, or parts of the equipment as are required to complete the installation as shown on the drawings or required for proper operation of the system.

1.3 PRODUCT OPTIONS

A. General: Where Contractor is permitted to use a product other than the specific item and model named as the basis of design, Contractor is responsible for all coordination and additional costs as specified in article 1.5 for substitutions.

B. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.

C. Products specified by naming one or more manufacturers, or model name or catalog reference number: Products specified establish a standard of quality, options to be included, and performance.

1. Where other acceptable manufacturers are named, Contractor may provide products only of those manufacturers, which meet the specifications.
2. Where specification permits “equal” products, without naming other acceptable manufacturers, Contractor may use products of any manufacturer, which meet the specifications.

D. Products Specified by Naming One Manufacturer or particular product, with no provision for other options: No options or substitutions allowed.

1.4 SUBSTITUTIONS

A. Engineer will consider requests for Substitutions only within 30 days after date of Owner-Contractor Agreement.

B. Instructions to Bidders specify time restrictions for submitting requests for Substitutions during the bidding period, in accordance with requirements specified in this Section.

C. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.

D. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

E. A request constitutes a representation that the Contractor:

1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
2. Will provide the same warranty for the Substitution as for the specified product.
3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
4. Waives claims for additional costs or time extension which may subsequently become apparent.
5. Will reimburse Owner for review or redesign services associated with re-approval by authorities.

F. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

1.5 DELIVERY, STORAGE AND HANDLING

A. Transport and handle products in accordance with manufacturer’s instructions.

B. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

D. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.

E. For exterior storage of fabricated products, place on sloped supports, above ground.

F. Provide off-site storage and protection when site does not permit on-site storage or protection.

G. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.

H. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

I. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

J. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.

K. Ship equipment in sections of suitable size for entering the building. Make all necessary arrangements for bringing equipment into the building and installing it in its ultimate location.

L. Deliver all package products to the job site in manufacturer's unopened, original, standard containers with grade seals unbroken and labels intact.

M. All materials received on the site shall be clean or be cleaned upon arrival.

N. Consult the Engineer before placing building materials or supplies on the building structure, so as not to overload the structure.

O. Laterally brace stacks and piles of materials.

P. Metals shall be free of mud, ice, frost, rust or foreign materials which will damage the finish.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. All materials and equipment shall be installed and completed in a first class and workmanlike manner and in accordance with the best modern methods, practice and manufacturer's instructions. Any work which does not present an orderly and neat or workmanlike appearance shall be removed and replaced when so directed in writing by the Engineer.

END OF SECTION

SECTION 01 7329

CUTTING AND PATCHING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Requirements and limitations for cutting and patching of Work.

1.2 RELATED SECTIONS

A. Work by Owner or by separate contractors: Section 01 1000

B. Submittal procedures: Section 01 3300.

C. Product options and substitutions: Section 01 6000.

D. Individual product specification sections:

1. Cutting and patching incidental to work of the Section.
2. Advance notification to other Sections of openings required in work of those Sections.
3. Limitations on cutting structural members.

1.3 SUBMITTALS

A. Submit written request in advance of cutting or alteration which affects:

1. Structural integrity of any element of Project.
2. Integrity of fire rating of any fire-rated assembly.
3. Integrity of weather-exposed or moisture-resistant element.
4. Efficiency, maintenance, or safety of any operational element.
5. Visual qualities of sight exposed elements.
6. Work of Owner or separate contractor.

B. Include in request:

1. Identification of Project.
2. Location and description of affected work.
3. Necessity for cutting or alteration.
4. Description of proposed work, and products to be used.
5. Alternatives to cutting and patching.
6. Effect on work of Owner or separate contractor.
7. Written permission of affected separate contractor.
8. Date and time work will be executed.

C. Submit evidence of Specialist’s experience.

1.4 PROJECT CONDITIONS

A. If, in the course of the work, workers encounter a material they suspect to be asbestos, to contain lead or PCBs, or to present some other hazard:

1. Promptly notify the Owner and Engineer in writing.
2. Do not perform any work which would disturb the suspected material until written instructions have been received.

B. Drawings showing utilities in concealed locations are based on the best information available but are not represented as being precisely correct. Work of the contract includes digging, cutting, drilling, using nondestructive methods, and other methods of locating concealed utilities in the field.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Primary products: Those required for original installation. Comply with contract requirements.

B. Product substitution: For any proposed change in materials, submit request for substitution as required in Section 01 6000.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect existing conditions prior to commencing Work, including elements subject to damage or movement during cutting and patching.

B. After uncovering existing work, inspect conditions affecting performance of work.

C. Report unsatisfactory or questionable conditions to Engineer in writing; do not proceed with work until Engineer has provided further instructions.

D. Beginning of cutting or patching means acceptance of existing conditions.

3.2 PREPARATION

A. Provide temporary supports to ensure structural integrity of the Work. Provide devices and methods to protect other portions of Project from damage.

B. Provide protection from elements for areas which may be exposed by uncovering work.

3.3 CUTTING AND PATCHING

A. Execute cutting, fitting, and patching to complete work.

B. Fit products together, to integrate with other work.

C. Uncover work to install ill-timed work.

D. Remove and replace defective or non-conforming work.

E. Provide openings in the work for penetration of mechanical and electrical work.

3.4 PERFORMANCE

A. Execute work by methods to avoid damage to other work, and which will provide appropriate surfaces to receive patching and finishing.

B. Where possible, employ original installer to perform cutting and patching for weather exposed and moisture resistant elements, and sight-exposed surfaces.

C. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval. Neatly cut holes and slots to size required, with minimum disturbance to adjacent work; cut holes in concrete slabs for pipes and conduit with core drills of proper sizes. Openings shall be covered temporarily when not in use and patched as soon as work is installed.

1. Do not cut or core drill floor slab until reinforcing steel in the area to be cut has been located, and penetration has been designed so that it will not damage reinforcing.
2. Method for location: Non-destructive testing using a calibrated metal detector (R-meter type).

D. Restore work with new products in accordance with requirements of Contract Documents.

E. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

F. Where patching fire-rated assemblies, restore each assembly with materials and methods to maintain its fire rating.

G. At penetrations of fire-rated walls, partitions, ceilings, or floors, completely seal voids with firestopping material in accordance with Section 07 8000, to full thickness of the penetrated element.

H. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

END OF SECTION

SECTION 01 7700

CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 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.

1.2 RELATED SECTIONS

A. Submittals: Section 01 3300.

B. Cleaning: Section 01 5000.

C. Special project warranties: Individual technical sections, Divisions 02-33.

1.3 SUBMITTALS

A. Closeout Procedures:

1. 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.
2. Provide submittals to Engineer that is required by governing or other authorities.
3. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

    a. Owner will occupy all of the building as specified in Section 01 1000.

B. Project Record Documents:

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

    a. Contract Drawings.
    b. Specifications.
    c. Addenda.
    d. Change Orders and other Modifications to the Contract.
    e. Reviewed shop drawings, product data, and samples.

2. Maintain Record Documents separate from documents used for construction.
3. Record information concurrent with construction progress.
4. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:

    a. Manufacturer's name and product model and number.
    b. Product substitutions or alternates utilized.
    c. Changes made by Addenda and Modifications.

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

    a. Measured depths of foundations in relation to finish first floor datum.
    b. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
    c. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
    d. Field changes of dimension and detail.
    e. Details not on original Contract Drawings.

6. Submit documents to Engineer with final Application for Payment.

C. Operation and Maintenance Data:

1. Submit three sets.
2. Lubrication Charts: Prepare lubrication charts for each piece of mechanical equipment that requires grease or oil, including the following:

    a. Types of lubricants required.
    b. Locations of lubrication points.
    c. Frequency of lubrication.
    d. Provide one extra set of lubrication charts mounted in plastic covers, besides those required in Operating and Maintenance Manuals.

3. Binders: Three-ring binders with vinyl-covered hard covers. Provide large enough binders, and sufficient quantity, that the required contents can be easily turned, removed, and reinserted.
4. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", and title of project. Print on spine of binder "O & M INSTRUCTIONS". If more than one binder is required, print covers and spines with volume numbers. Include in the front of every binder an index to all binders.
5. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
6. Contents: Prepare a Table of Contents for each volume, with each Product or system description identified, typed on white paper.
7. Part 1: Directory, listing names, addresses, and telephone numbers of Civil, Structural, Mechanical, and Electrical Engineers; Contractor; Subcontractors; and major equipment suppliers.
8. Part 2: Operation and maintenance instructions, arranged by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:

a. Significant design criteria, including pump and fan curves and similar performance charts.
b. List of equipment, including operating weights.
c. Parts list for each component, including recommended spare parts list.
d. Operating instructions.
e. Maintenance instructions for equipment and systems.
f. Maintenance instructions for finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.
g. Valve charts, including locations of flow fittings.

9. Part 3: Project documents and certificates, including the following:

a. Shop drawings and product data.
b. Photocopies of certificates.
c. Photocopies of warranties, guarantees, and bonds.
d. Test Reports: Copies of the results of all tests required under all sections of specifications.

10. Submit one copy of completed volumes in final form 15 days prior to final inspection. This copy will be returned after final inspection, with Engineer comments. Revise content of documents as required prior to final submittal.
11. Submit final volumes revised, within ten days after final inspection.

1.4 WARRANTIES

A. All work and equipment provided as work of the Contract shall be fully warranted under the general project warranty. In addition, provide added special warranties as specified in individual sections.

B. During the correction period, the Contractor shall promptly correct any work found to be defective, or otherwise not in accordance with the requirements of the Contract Documents, on receipt of written notice from the Owner. Except as otherwise required in General Conditions, the correction period is two years after the date of substantial completion of the work. Work requiring correction shall promptly be repaired or completely replaced at no addition to the Contract Sum.

C. When use of the permanent equipment has been permitted for temporary heating or ventilation of the building, the warranty and correction periods shall nevertheless begin at the time of substantial completion, unless another date of acceptance has been agreed to in writing by the Owner.

D. Special warranties are warranties required by individual specification sections, incidental product warranties, manufacturers' standard warranties, installer or subcontractor service agreements, and other individual warranties in addition to the general project warranty.

E. Provide duplicate notarized copies.

F. Execute and assemble documents from Subcontractors, suppliers, and manufacturers.

G. Submit to Owner prior to final Application for Payment.

H. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.

1.5 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 by Owner; obtain receipt prior to final payment.

PART 2 - PRODUCTS

Not used

PART 3 - EXECUTION

3.1 ADJUSTING

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

3.2 LUBRICATION

A. Bearings of equipment shall be provided with adequate facilities for lubrication. Oiling devices, fittings, and appurtenances shall be accessible. Lubricate all bearings upon completion of work prior to start-up of the equipment. Lubricants shall be as specified by equipment manufacturers.

3.3 FINAL CLEANING

A. Execute final cleaning prior to final inspection.

B. Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.

C. Clean equipment and fixtures to a sanitary condition.

D. Clean site; sweep paved areas, rake clean landscaped surfaces.

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

3.4 OPERATING INSTRUCTIONS

A. Provide operating instructions as specified in Sections 23 0500 and 26 0500.

END OF SECTION

SECTION 02 4119

SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Demolition and removal of selected portions of a building or structure.
2. Demolition and removal of selected site elements.
3. Repair procedures for selective demolition operations.

B. Related sections include the following:

1. Cutting and Patching for cutting and patching procedures for selective demolition operations Division 01.
2. Demolishing, cutting, patching, or relocating mechanical items: Division 23.
3. Demolishing, cutting, patching, or relocating electrical items: Division 26.

1.2 REFERENCES

A. ANSI A10.6: Safety Requirements for Demolition.

B. NFPA 241: Safeguarding Construction, Alteration, and Demolition Operations.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and salvage: Detach items from existing construction and deliver them to Owner.

C. Remove and reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

D. Existing to remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner’s property, demolished materials shall become Contractor’s property and shall be removed from Project site.

1.5 SUBMITTALS

A. 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.

B. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.

C. Landfill records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous or regulated wastes.

1.6 QUALITY ASSURANCE

A. Demolition firm qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this project.

B. Regulatory requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Standards: Comply with ANSI A10.6 and NFPA 241.

1.7 PROJECT CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.

B. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.

1. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.

C. Owner assumes no responsibility for condition of areas to be selectively demolished.

1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

D. Hazardous materials: It is not expected that hazardous materials will be encountered in the work.

1. Hazardous materials will be removed by Owner before start of the work.
2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site will not be permitted.

F. Utility service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

G. Maintain fire-protection facilities in service during selective demolition operations.

1.8 WARRANTY

A. Existing warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1. If possible, retain original Installer or fabricator to patch the exposed Work listed below that is damaged during selective demolition. If it is impossible to engage a Specialist as specified in Section 01 4500, Quality Control.

PART 2 - PRODUCTS

2.1 REPAIR MATERIALS

A. Use repair materials identical to existing materials.

1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
2. Use materials whose installed performance equal or surpasses that of existing materials.

B. Comply with material and installation requirements specified in individual specification sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Engineer.

D. Perform surveys as the work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES

A. Existing utilities: Maintain services indicated to remain and protect them against damage during selective demolition operations.

B. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.

1. Provide at least 72 hours' notice to Owner if shutdown of service is required during changeover.

C. Utility requirements: Refer to Divisions 23 and 26 Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.3 PREPARATION

A. Dangerous materials: Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with selective demolition operations.

B. Site access and temporary controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Maintain streets and walkways, erect temporary protection, and protect existing site improvements as required in Section 01 5000, Temporary Facilities and Controls.

2. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.

3.4 POLLUTION CONTROLS

A. Dust control: Use temporary enclosures, and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations.

1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
2. Wet mop floors to eliminate trackable dirt and wipe down walls and doors of demolition enclosure. Vacuum carpeted areas.

B. Disposal: Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

C. Cleaning: Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.5 SELECTIVE DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove large objects and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly.
10. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.

B. Existing facilities: Comply with building manager’s requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.

C. Existing Items to remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

D. Concrete: Demolish in small sections. Cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain, using power-driven saw. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated for selective demolition. Neatly trim openings to dimensions indicated.

E. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

F. Concrete slabs-on-grade: Saw-cut perimeter of area to be demolished, then break up and remove.

3.6 PATCHING AND REPAIRS

A. General: Promptly repair damage to adjacent construction caused by selective demolition operations.

B. Patching: Comply with Section 01 7329, Cutting and Patching.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner’s property and legally dispose of them.

END OF SECTION

SECTION 03 3000

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies cast-in place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.

1.2 SUBMITTALS

A. Submit name and qualifications of proposed testing agency.

B. Product data for proprietary materials and items:

1. Reinforcement and forming accessories
2. Admixtures
3. Patching compounds
4. Joint systems
5. Curing compounds

C. Shop drawings: Fabrication, bending, and placement of concrete reinforcement. Comply with ACI SP-66 (88), "ACI Detailing Manual," showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

D. Laboratory test reports for concrete materials and mix design test.

E. Materials certificates in lieu of materials laboratory test reports when permitted by Engineer. Materials certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

1.3 QUALITY ASSURANCE

A. Codes and standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:

1. ACI 318, "Building Code Requirements for Reinforced Concrete."
2. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice."

B. Concrete testing service: Engage a testing laboratory acceptable to Engineer to perform material evaluation tests and to design concrete mixes.

C. Materials and installed work may require testing and retesting at any time during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractor's expense.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for exposed finish concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.

1. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

B. Forms for unexposed finish concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.

C. Form coatings: Provide commercial formulation form-coating compounds with a maximum VOC of 350 mg/l that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

D. Form ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units that will leave no metal closer than 1.5 inches to exposed surface.

1. Provide ties that, when removed, will leave holes not larger than 1-inch diameter in concrete surface.

2.2 REINFORCING MATERIALS

A. Reinforcing bars: ASTM A 615, Grade 60, deformed.

B. Steel wire: ASTM A 82, plain, cold-drawn steel.

C. Welded wire fabric: ASTM A 185, welded steel wire fabric. Where size is not indicated, provide 6 x 6 inch mesh, W1.4 x W1.4 gage.

D. Supports for reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire-bar-type supports complying with CRSI specifications.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

2.3 CONCRETE MATERIALS

A. Portland cement: ASTM C 150, Type I. Use one brand of cement throughout project unless otherwise acceptable to Engineer.

B. Normal weight aggregates: ASTM C 33 and as herein specified. Provide aggregates from a single source for exposed concrete.

1. For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-causing deleterious substances.
2. Local aggregates not complying with ASTM C 33 but that special tests or actual service have shown to produce concrete of adequate strength and durability may be used when acceptable to Engineer.

C. Water: Drinkable.

D. Admixtures, general: Provide admixtures for concrete that contain no more than 0.1 percent chloride ions.

E. Air-entraining admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures. Subject to compliance with requirements, provide one of the following:

1. "Air-Tite," Cormix.
2. "Air-Mix" or "Perma-Air," Euclid Chemical Co.
3. "Darex AEA" or "Daravair," W.R. Grace & Co.
4. "MB-VR" or "Micro-Air," Master Builders, Inc.
5. "Sealtight AEA," W.R. Meadows, Inc.
6. "Sika AER," Sika Corp.

F. Water-reducing admixture: ASTM C 494, Type A. Subject to compliance with requirements, provide one of the following:

1. "Chemtard," ChemMasters Corp.
2. "PSI N," Cormix.
3. "Eucon WR-75," Euclid Chemical Co.
4. "WRDA," W.R. Grace & Co.
5. "Pozzolith Normal" or "Polyheed," Master Builders, Inc.
6. "Prokrete-N," Prokrete Industries.
7. "Plastocrete 161," Sika Corp.

G. High-range water-reducing admixture (super plasticizer): ASTM C 494, Type F or Type G. Subject to compliance with requirements, provide one of the following:

1. "Super P," Anti-Hydro Co., Inc.
2. "PSI Super," Cormix.
3. "Eucon 37," Euclid Chemical Co.
4. "WRDA 19" or "Daracem," W.R. Grace & Co.
5. "Rheobuild," Master Builders, Inc.
6. "PSP," Prokrete Industries.
7. "Sikament 300," Sika Corp.

H. Water-reducing, accelerating admixture: ASTM C 494, Type E. Subject to compliance with requirements, provide one of the following:

1. "Q-Set," Conspec Marketing & Manufacturing Co.
2. "Gilco Accelerator," Cormix.
3. "Accelguard 80," Euclid Chemical Co.
4. "Daraset," W.R. Grace & Co.
5. "Pozzutec 20," Master Builders, Inc.

I. Water-reducing, retarding admixture: ASTM C 494, Type D. Subject to compliance with requirements, provide one of the following:

1. "PSI-R Plus," Cormix.
2. "Eucon Retarder 75," Euclid Chemical Co.
3. "Daratard-17," W.R. Grace & Co.
4. "Pozzolith R," Master Builders, Inc.
5. "Protard," Prokrete Industries.
6. "Plastiment," Sika Corporation.

2.4 RELATED MATERIALS

A. Absorptive cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

B. Moisture-retaining cover: One of the following, complying with ASTM C 171.

1. Waterproof paper.
2. Polyethylene film.
3. Polyethylene-coated burlap.

C. Liquid membrane-forming curing compound: Liquid-type membrane- forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.055 gr./sq. cm. when applied at 200 sq. ft./gal. Subject to compliance with requirements, provide one of the following:

1. "A-H 3 Way Sealer," Anti-Hydro Co., Inc.
2. "Spartan-Cote," The Burke Co.
3. "Conspec #1," Conspec Marketing & Mfg. Co.
4. "Hardtop," Cormix.
5. "Day-Chem Cure and Seal," Dayton Superior Corp.
6. "Eucocure," Euclid Chemical Co.
7. "Horn Clear Seal," A.C. Horn, Inc.
8. "L&M Cure," L & M Construction Chemicals, Inc.
9. "Masterkure," Master Builders, Inc.
10. "CS-309," W.R. Meadows, Inc.
11. "LR-151," Prokrete Industries.
12. "Kure-N-Seal," Sonneborn-Rexnord.
13. "Stontop CS2," Stonhard, Inc.

D. Evaporation control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss. Subject to compliance with requirements, provide one of the following:

1. "Eucobar," Euclid Chemical Co.
2. "E-Con," L&M Construction Chemicals, Inc.
3. "Confilm," Master Builders, Inc.

E. Bonding compound: Polyvinyl acetate or acrylic base. Subject to compliance with requirements, provide one of the following:

1. Polyvinyl acetate (interior only):

a. "Superior Concrete Bonder," Dayton Superior Corp.
b. "Euco Weld," Euclid Chemical Co.
c. "Weld-Crete," Larsen Products Corp.
d. "Everweld," L&M Construction Chemicals, Inc.

2. Acrylic or styrene butadiene:

a. "Acrylic Bondcrete," The Burke Co.
b. "Strongbond," Conspec Marketing and Mfg. Co.
c. "Day-Chem Ad Bond," Dayton Superior Corp.
d. "SBR Latex," Euclid Chemical Co.
e. "Daraweld C," W.R. Grace & Co.
f. "Hornweld," A.C. Horn, Inc.
g. "Everbond," L & M Construction Chemicals, Inc.
h. "Acryl-Set," Master Builders Inc.
i. "Intralok," W.R. Meadows, Inc.
j. "Sonocrete," Sonneborn-Rexnord.
k. "Stonlock LB2," Stonhard, Inc.

F. Epoxy adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material "Type," "Grade," and "Class" to suit project requirements. Subject to compliance with requirements, provide one of the following:

1. "Burke Epoxy M.V.," The Burke Co.
2. "Spec-Bond 100," Conspec Marketing and Mfg. Co.
3. "Euco Epoxy System #452 or #620," Euclid Chemical Co.
4. "Epoxtite Binder 2390," A.C. Horn, Inc.
5. "Epabond," L&M Construction Chemicals, Inc.
6. "Concresive 1001," Master Builders, Inc.
7. "Sikadur 32 Hi-Mod," Sika Corp.

2.5 PROPORTIONING AND DESIGN OF MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to Engineer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.

B. Submit written reports of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until proposed mix designs have been reviewed by Engineer.

C. Design mixes to provide normal weight concrete with the following properties, as indicated on drawings and schedules:

1. 4500-psi, 28-day compressive strength; W/C ratio, 0.58 maximum (non-air-entrained), 0.46 maximum (air-entrained).

D. Adjustment to concrete mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted and accepted before using in work.

2.6 ADMIXTURES

A. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete as required for placement and workability.

B. Use nonchloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).

C. Use high-range water-reducing admixture (HRWR) in pumped concrete, concrete for industrial slabs, architectural concrete, parking structure slabs, concrete required to be watertight, and concrete with water/cement ratios below 0.50.

D. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1.5 percent within following limits:

1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:

    a. 4.5 percent (moderate exposure); 5.5 percent (severe exposure) 1.5-inch max. aggregate.
    b. 4.5 percent (moderate exposure); 6.0 percent (severe exposure) 1-inch max. aggregate.
    c. 5.0 percent (moderate exposure); 6.0 percent (severe exposure) 0.75-inch max. aggregate.
    d. 5.5 percent (moderate exposure); 7.0 percent (severe exposure) 0.5-inch max. aggregate.

2. Other concrete (not exposed to freezing, thawing, or hydraulic pressure) or to receive a surface hardener: 2 percent to 4 percent air.

E. Use admixtures for water reduction and set control in strict compliance with manufacturer's directions.

F. Slump limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

1. Ramps, slabs, and sloping surfaces: Not more than 3 inches.
2. Reinforced foundation systems: Not less than 1 inch and not more than 3 inches.
3. Concrete containing HRWR admixture (superplasticizer): Not more than 8 inches after addition of HRWR to site-verified 2-inch to 3-inch slump concrete.
4. Other concrete: Not more than 4 inches.

2.7 CONCRETE MIXING

A. Job-site mixing: Mix materials for concrete in appropriate drum-type batch machine mixer. For mixers of one cu. yd. or smaller capacity, continue mixing at least 1.5 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than one cu. yd., increase minimum 1.5 minutes of mixing time by 15 seconds for each additional cu. yd. or fraction thereof.

1. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

B. Ready-mix concrete: Comply with requirements of ASTM C 94, and as specified. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1.5 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate the installation of joint materials with placement of forms and reinforcing steel.

3.2 FORMS

A. General: Design, erect, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances complying with ACI 347.

B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.

D. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

E. Chamfer exposed corners and edges using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

F. Provisions for other trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

G. Cleaning and tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms and bracing before concrete placement as required to prevent mortar leaks and maintain proper alignment.

3.3 PLACING REINFORCEMENT

A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as herein specified.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved.

D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire fabric in as long lengths 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.

3.4 JOINTS

A. Construction joints: Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to Engineer.

B. Provide keyways at least 1.5 inches deep in construction joints in walls and slabs and between walls and footings. Accepted bulkheads designed for this purpose may be used for slabs.

C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as otherwise indicated. Do not continue reinforcement through sides of strip placements.

D. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.

E. Isolation joints in slabs-on-ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

1. Joint filler and sealant materials are specified in Division 07 Sections of these specifications.

F. Contraction (control) joints in slabs-on-ground: Construct contraction joints in slabs-on-ground to form panels of patterns as shown. Use saw cuts 0.125 inch wide by 0.25 slab depth or inserts 0.25 inch wide by 0.25 of slab depth, unless otherwise indicated.

1. Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
2. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
3. If joint pattern not shown, provide joints not exceeding 15 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).

4. Joint sealant material is specified in Division 7 Sections of these specifications.

3.5 INSTALLATION OF EMBEDDED ITEMS

A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached thereto.

B. Forms for slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to obtain required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.6 PREPARATION OF FORM SURFACES

A. General: Coat contact surfaces of forms with an approved, nonresidual, form-coating compound before reinforcement is placed.

B. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

C. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

3.7 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work.

B. General: Comply with ACI 304, "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete," and as herein specified.

C. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete to avoid segregation at its final location.

D. Placing concrete in forms: Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

E. Placing concrete slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.

1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
3. Maintain reinforcing in proper position during concrete placement.

F. Cold-weather placing: Comply with provisions of ACI 306 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 (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

G. Hot-weather placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F (32 deg C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.
2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
3. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, when acceptable to Engineer.

3.8 FINISH OF FORMED SURFACES

A. Rough form finish: For formed concrete surfaces not exposed to view in the finish work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 0.25 inch in height rubbed down or chipped off.

B. Smooth form finish: For formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

C. Related unformed surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces occurring 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.

3.9 MONOLITHIC SLAB FINISHES

A. Float finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and as otherwise indicated.

1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to tolerances of Ff 20 - Fl 17. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

B. Trowel finish: Apply trowel finish to monolithic slab surfaces to be exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system.

1. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of Ff 20 - Fl 17. Grind smooth surface defects that would telegraph through applied floor covering system.

C. Trowel and fine broom finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.

D. Nonslip broom finish: Apply nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.10 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply in accordance with manufacturer's instructions after screeding and bull floating, but before power floating and troweling.

B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.

C. Curing methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.

1. Moisture curing:

a. Keep concrete surface continuously wet by covering with water.
b. Use continuous water-fog spray.

c. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4-inch lap over adjacent absorptive covers.

2. Moisture-cover curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing and sealing compound: Apply specified curing and sealing compound to exposed interior slabs and to exterior slabs, walks, and curbs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

a. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.

D. Curing formed surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

E. Curing unformed surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces, by application of appropriate curing method.

1. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.

3.11 REMOVAL OF FORMS

A. General: Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days and until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

C. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

3.12 REUSE OF FORMS

A. Clean and repair surfaces of forms to be reused in work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces except as acceptable to Architect.

3.13 MISCELLANEOUS CONCRETE ITEMS

A. Filling in: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment bases and foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

D. Reinforced masonry: Provide concrete grout for reinforced masonry lintels and bond beams where indicated on drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.

3.14 CONCRETE SURFACE REPAIRS

A. Patching defective areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Architect.

1. Cut out honeycomb, rock pockets, voids over 0.25 inch in any dimension, and holes left by tie rods and bolts, down to solid concrete but in no case to a depth of less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar before bonding compound has dried.
2. For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

B. Repair of formed surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry-pack mortar, or precast cement cone plugs secured in place with bonding agent.

1. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

C. Repair of unformed surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having required slope.

1. Repair finished unformed surfaces that contain defects that affect durability of concrete. Surface defects, as such, include crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
3. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with patching compound. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Architect.
4. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 0.75-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

D. Perform structural repairs with prior approval of Engineer for method and procedure, using specified epoxy adhesive and mortar.

E. Repair methods not specified above may be used, subject to acceptance by Engineer.

3.15 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. General: Employ a testing laboratory to perform tests and to submit test reports. Include the following tests:

B. Sampling fresh concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.

1. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
2. Air content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231 pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
3. Concrete temperature: Test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and each time a set of compression test specimens is made.
4. Compression test specimen: ASTM C 31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cure test specimens are required.
5. Compressive strength tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yds. plus additional sets for each 50 cu. yds. more than the first 25 cu. yds. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

    a. When frequency of testing will provide fewer than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
    b. When total quantity of a given class of concrete is less than 50 cu. yds., Engineer may waive strength test if adequate evidence of satisfactory strength is provided.

c. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
d. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.

C. Report test results in writing to Engineer, Ready-Mix Producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

D. Nondestructive testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

E. Additional tests: Make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.

END OF SECTION

SECTION 07 8400

FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Through-penetration firestopping in fire-rated construction.

B. Through-penetration smoke-stopping in smoke partitions.

1.2 RELATED SECTIONS

A. Conduit: Section 26 0533.

1.3 REFERENCES

A. Underwriters Laboratories

1. UL Fire Resistance Directory
2. UL 1479: Through Penetration Firestops.

B. American Society for Testing and Materials Standards:

1. ASTM E 814: Standard Test Method for Fire Tests of Through-Penetration Firestops.

1.4 DEFINITIONS

A. Assembly: Particular arrangement of materials specific to given type of construction described in referenced documents.

B. Barriers: Time-rated fire walls, smoke barrier walls, time-rated ceiling/floor assemblies and structural floors.

C. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gasses and smoke.

D. Penetration: Opening or foreign materials passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.

E. Sleeve: Metal fabrication or pipe section extending through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other sections and may or may not be required.

F. System: Specific products and applications, classified and numbered by the rating agency to close specific barrier penetrations.

1.5 SYSTEM DESCRIPTION

A. Design requirements:

1. Fire-rated construction: Maintain barrier and structural floor fire resistant ratings including resistance to cold smoke at all penetrations.

2. Smoke barrier construction: Maintain barrier and structural floor resistance to cold smoke at all penetrations.

1.6 SUBMITTALS

A. Product data: Manufacturer's specifications and technical data including the following:

1. Detailed specification of construction and fabrication.
2. Manufacturer's installation instructions.

B. Shop drawings: Submit firestop assemblies and devices for all openings and through penetrations in fire-rated construction. Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, plus the following specific requirements.

1. Details of each proposed assembly identifying intended products and applicable rating agency classification.
2. Manufacturer or manufacturer's representative shall provide qualified engineering judgments and drawings relating to conditions where rated assemblies do not exist.

C. Quality control submittals:

1. Statement of qualifications.

D. Certifications: Letters or forms showing acceptance by local authorities for systems without acceptance by a rating agency.

1.7 QUALITY ASSURANCE

A. Products and assemblies shall be tested and labeled by an independent, nationally recognized testing and labeling authority.

B. Installer's qualification: Firm experienced in installation or application of systems similar in complexity to those required for this project, plus the following:

1. Acceptable to or licensed by manufacturer, state, or local authority where applicable.
2. At least 2 years' experience with systems.
3. Successfully completed at least 5 projects of comparable scale, using these systems.

C. Local and state regulatory requirements: Obtain acceptance for proposed assemblies not conforming to specific rating agency classifications or rated assemblies.

D. Materials shall have been tested to provide fire rating at least equal to that of the construction in which they are to be installed.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:

1. Deliver products in original unopened packaging with legible manufacturer's identification.
2. Coordinate delivery with scheduled installation date, allow minimum storage at site.

B. Storage and protection: Store materials in a clean, dry, ventilated location. Protect from soiling, abuse, moisture and freezing when required. Follow manufacturer's instructions.

1.9 PROJECT CONDITIONS

A. Existing conditions:

1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.

B. Environmental requirements:

1. Furnish adequate ventilation if using solvent.
2. Furnish forced-air ventilation during installation if required by manufacturer.
3. Keep flammable materials away from sparks or flame.
4. Provide masking and drop cloths to prevent contamination of adjacent surfaces by firestopping materials.
5. Comply with manufacturing recommendations for temperature and humidity conditions before, during and after installation of firestopping.

1.10 WARRANTY

A. General project warranty and correction period, as required in general conditions and Division 01, requires repair or replacement of materials or systems which fail in joint adhesion, co-adhesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers and products: Those listed in the UL Fire Resistance Directory for the UL System involved, or rated for the application by Warnock Hersey or by another acceptable rating agency.

2.2 THROUGH-PENETRATION FIRESTOPPING OF FIRE-RATED CONSTRUCTION

A. Provide systems or devices listed and labeled by a rating agency, and conforming to the construction type, penetrant type, annular space requirements and fire rating involved in each separate instance. The system shall be symmetrical for wall applications. Systems or devices shall be asbestos-free.

1. Additional requirements: Withstand the passage of cold smoke either as an inherent property of the system, or by the use of a separate product included as a part of the rated system or device, and designed to perform this function.

2.3 SMOKE-STOPPING AT SMOKE PARTITIONS

A. Through-penetration smoke-stopping: Any system complying with the requirements for through-penetration firestopping in fire-rated construction is acceptable, provided that the system includes the specified smoke seal or will provide a smoke seal. The length of time of the fire resistance may be disregarded.

2.4 ACCESSORIES

A. Fill, void or cavity materials and forming materials: Classified for firestopping use, or included in a rated firestopping assembly, by a rating agency.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Verify barrier penetrations are properly sized and in suitable condition for application of materials.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean surfaces to be in contact with penetration seal materials, of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.

3.3 INSTALLATION

A. Provide firestop devices or assemblies for every opening and penetration in floors or fire-rated construction.

B. Install penetration seal materials in accordance with printed instructions of the rating agency and in accordance with manufacturer's instruction.

C. Ensure an effective smoke barrier in each sealed penetration. Install smoke stopping as specified for firestopping.

D. Protect materials from damage on surfaces subject to traffic.

E. Where large openings are created in walls or floors to permit installation of pipes, conduits, cables, or other items, close unused portions of opening with firestopping material tested for the application.

F. Where rated walls are constructed with horizontally continuous air space, double-width masonry, or double-stud frame construction, provide vertical, 12-inch-wide fiber dams for full thickness and height of air cavity at maximum 15 foot intervals.

3.4 FIELD QUALITY CONTROL

A. Examine penetration seals to ensure proper installation before concealing or enclosing them.

B. Keep areas of work accessible until inspection and acceptance by applicable authorities.

C. Before substantial completion, patch and repair firestopping cut or penetrated by other construction work.

3.5 ADJUSTING AND CLEANING

A. Clean up spills of liquid components.

B. Neatly cut and trim materials as required.

C. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

END OF SECTION

SECTION 23 1123

NATURAL-GAS PIPING

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Piping, specialties, and accessories for natural-gas systems.

1.14 RELATED SECTIONS

A. Grounding: Section 26 0526.

1.30 SUBMITTALS

A. General: Comply with Division 01.

B. Product data: Pipe, valves, fittings and accessories.

C. Certifications:

1. Test and approval of gas piping installation by the authorities having jurisdiction.

D. Test reports: Field test results for fuel gas piping system as specified in Part 3 below.

1.40 QUALITY ASSURANCE

A. UL label and local testing (if required): As specified in Section 23 0500, Common Work Results for HVAC.

B. Flexible stainless-steel gas piping shall be stored in an area that will not expose it to damage or outdoor elements.

C. Pipe shall be certified by the manufacturer to meet referenced standards and shall bear a label, directly on the pipe, indicating compliance.

1.42 REGULATORY REQUIREMENTS

A. Installation of gas piping shall meet requirements of the authority having jurisdiction, the gas supplier for gas service, and NFPA 54.

B. Upon completion of the work, the piping shall be tested as required by inspection authorities having jurisdiction.

PART 2 - PRODUCTS

2.20 PIPE AND FITTINGS

A. Aboveground pipe: Black steel, ASTM A 53, Grade B, Type E (electric resistance welded).

B. Steel pipe fittings:

1. Threaded: Pipe systems 1.5 inches and smaller (when welding fittings are not permitted), malleable iron or black steel, ASME B16.3 Class 150, with pipe joint compound approved for gas service or PTFE tape.

2. Welding: Pipe systems 2 inches and larger, steel, ASME B16.9 Class 150 buttwelding, or ASME B16.5 flanges and flanged welding fittings.

2.21 GAS VALVES

A. NPS 2 (DN 50) and smaller: Ball valve equal to Conbraco Industries "Apollo 80" Series, Watts 6000 Series or equal by ASCO; UL approved and listed for natural and LP gas service.

1. Material: Bronze.
2. Rating: 400 psi WOG nonshock.
3. Connections: Threaded.

B. NPS 2.5 (DN 65) through 4 (100): Eccentric plug valve equal to Key Port Valve Fig. 425, UL approved and listed for natural and LP gas service, with resilient plug seal recommended by manufacturer for gas service.

1. Material: Cast iron.
2. Rating: 170 psi WOG nonshock.
3. Connections: Flanged.

C. Gas regulators (and relief valves): Fisher Controls spring-adjustable diaphragm type, 10 psi inlet, of size and capacity as shown on the drawings or equal by Sensus, Maxitrol, or American Meter Division of the Singer Company.

1. Maxitrol Model 325-7AL is not acceptable.

2.23 ACCESSORIES

A. Gas flexible connections: Coated stainless-steel gas flexible connector, equal to Dormont "Flared Series," one-piece construction of annealed austenitic stainless steel with chemical corrosion resistant coating; RoHS compliant fittings of plated steel or brass. Maximum working pressure of 15 psig.

PART 3 - EXECUTION

3.20 INSTALLATION

A. Install piping as indicated on the drawings, in accordance with the regulations of the local authority and local gas company, and in accordance with installation and testing requirements of this section.

B. Remove burrs resulting from cutting pipe or from any other operation.

C. Threaded connections:

1. Cut threads full and clean.
2. Apply specified pipe jointing compound or tape on male threads only.

D. Thoroughly clean pipe and fittings before they are installed, and keep them clean until the acceptance of the completed work. Cap or plug the ends of the lines so as to prevent earth and other debris from entering during construction.

E. Take branches from horizontal runs from side or top of such runs. A tee shall be placed at the bottoms of risers in gas piping. Bottom of tee shall be provided with a six-inch-long nipple and cap the same size as riser. When riser is concealed, the cap shall project through wall to be

accessible and shall be properly marked with engraved plastic nameplate, "DANGER, GAS, CLEANOUT". Red background with white letters.

F. Purge gas lines to equipment when the gas is turned on from the gas supply.

G. Install valves at the house side of each meter and specialties readily accessible for operation and maintenance, with ample clearance for turning wheel handles or operators.

H. Install valves at each connection to equipment, accessible and adjacent to the equipment. Install valves in branch lines as indicated on drawings.

I. Install a jumper wire across the stainless-steel flex connector. Refer to Section 26 0526, Grounding and Bonding, for installation details.

J. All above ground gas piping 1.5-inch and smaller shall be assembled with threaded fittings, piping 2 inches and larger shall be welded.

K. All above ground rigid gas piping and fittings shall be primed and painted OSHA yellow. Do not paint flexible piping.

3.61 PIPING TESTS

A. Notify Owner at least one day prior to the actual test.

B. Test before pipes are concealed or insulated. Test the piping in sections as the work progresses, so as not to delay progress of the building construction. Furnish pumps and gages required for testing.

C. Conduct piping tests before connecting equipment that would be subject to damage from the test pressure. Replace piping or fittings found defective with new material.

D. Bracing and supporting: Adequately brace and support piping during the test, so that no movement, displacement, or damage results from the application of the test pressure.

E. Test the piping systems for not less than four hours to fulfill the conditions in the Piping Systems Test Schedule at the end of this section.

F. Documentation of tests: Prepare a test report for each portion of piping tested, identified by service, material, location, and pipe size. Subject four copies of test documentation for distribution. Include these items:

1. Date of test.
2. Starting and completion times.
3. Initial test pressure.
4. Final test pressure.
5. Problems or leaks detected.
6. Corrective actions taken.
7. Record of successful completion of testing.
8. Name, title, and signature of person conducting test.

3.90 SCHEDULES

A. Piping Systems Test Schedule:

SYSTEM	TEST PRESSURE PSIG (kPa)	ALLOWABLE DROP	MEDIUM
Fuel gas	100 (690)	None	*Air

*If pressure drops, locate leaks with soap and water solution.

END OF SECTION

SECTION 26 0500

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements applicable to work of more than one section of Division 26.

B. Testing wiring systems.

1.2 RELATED SECTIONS

A. Operation and Maintenance Manuals: Section 01 7700.

1.3 DEFINITIONS

A. Project correction period: A period after Substantial Completion of the work during which the Contractor shall correct every part of the work found to be not in accordance with the requirements of the contract documents, promptly after receipt of written notice.

B. Qualified testing agency: A Nationally Recognized Testing Laboratory (NRTL), a National Voluntary Laboratory Accreditation Program (NVLAP), or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 548; and with additional qualifications specified in individual sections; and where required by authorities having jurisdiction, that is acceptable to authorities.

1.4 DESIGN REQUIREMENTS

A. The drawings and system performances have been designed on the basis of using the particular manufacturers' products specified and scheduled on the drawings.

B. Products of other manufacturers that are listed under the article "Acceptable Manufacturers," or permitted as "equal," are permitted provided:

1. Product shall meet the specifications.
2. Contractor shall make, without addition to the contract sum, all adjustments for deviations so that the final installation is complete and functions as the design basis product is intended.

C. Do not propose products with dimensions or other characteristics different from the design basis product that make their use impractical or cause functional fit, access, or connection problems.

D. The contract drawings are generally diagrammatic, and do not indicate all fittings or offsets in conduit or all pull boxes, access panels, or other specialties required.

1. Install conduit exposed to view parallel with the lines of the building and as close to walls, columns, and ceilings as may be practical, maintaining adequate clearance for access at parts requiring servicing.
2. Install conduit a sufficient distance from other work to permit a clearance of not less than 0.5 inch (15 mm) between its finished covering and adjacent work.
3. No conduit shall be run below the head of a window or door.
4. Pull boxes and other appurtenances which require operation or maintenance shall be easily accessible. Do not cut or form handholes for operation or maintenance of appliances through walls or ceilings.

1.5 SUBMITTALS

A. Test reports: Show that tests specified in Part 3 below demonstrate the specified results.

1.6 QUALITY ASSURANCE

A. Provide materials and perform work in accordance with the electrical, building, fire, and safety codes and regulations of the state, county, or city in which the work is performed.

B. Electrical control panels, equipment, materials and devices provided or installed as work of Division 26 shall bear UL label, or, if UL label is not available, the item shall be tested and labeled by a qualified testing agency, acceptable to authorities having jurisdiction, and in accordance with NFPA 70. Provide testing, if required, without addition to the contract sum.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Electrical equipment backing panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated in accordance with AWPA C27, in thickness indicated, not less than 0.5 inch (13 mm) nominal.

1. One side finished.

B. Wood-preservative-treated lumber: Treated by pressure process, AWPA C2, with chemicals acceptable to authorities having jurisdiction, and marked with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. Application: Treat items indicated on the drawings, and the following:

a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, or waterproofing.
b. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.
c. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
d. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
e. Wood floor plates that are installed over concrete slabs-on-grade.

C. Aircraft cable: 0.25-inch (6-mm) steel wire rope, galvanized, construction 7 by 19 strands, minimum 7000 lbs (31138 N) breaking strength.

2.2 DATE-SENSITIVE EQUIPMENT

A. Date-sensitive equipment: Systems, equipment, or components which use or process date and time data in order to perform their functions.

B. Each item of date-sensitive equipment used in the project shall be warranted by the manufacturer to properly function and correctly use or process all time-related data for all dates and times which occur during a reasonable life expectancy of the equipment.

PART 3 - EXECUTION

3.1 INSTALLATION OF PRODUCTS AND EQUIPMENT

A. Manufacturers' instructions: Except as modified by drawings or specifications, install products and equipment in accordance with manufacturers' instructions and recommendations applicable to the project conditions.

1. Immediately notify Engineer if a difference or discrepancy is found between manufacturers' instructions and the drawings or specifications.

B. Install plywood backing panels with finished face exposed.

3.2 TESTS

A. During the progress of the work and after completion, test the branch circuits and distribution system, and the low-voltage alarm and signal systems.

B. Results of the tests shall show that the wiring meets the requirements of this specification. Should any test indicate defect in materials or workmanship, immediately repair, or replace with new, the faulty installation, and retest the affected portions of the work.

C. Furnish equipment and instruments necessary for testing.

D. Tests shall demonstrate the following:

1. Lighting, power, and control circuits are continuous and free from short circuits.
2. Circuits are free from unspecified grounds.
3. The resistance to ground of each non-grounded circuit is not less than one megohm.
4. Circuits are properly connected in accordance with the applicable wiring diagrams.
5. Circuits are operable. Demonstration shall include functioning of each control not less than ten times, and continuous operation of each lighting and power circuit for not less than 0.5 hour.

E. Test circuit breakers larger than 100 amps at full voltage.

F. Make voltage built-up tests with a voltage sufficient to determine that no short circuits exist.

G. Immediately repair defects and retest until systems are operating correctly.

H. Submit test reports.

3.3 OPERATING INSTRUCTIONS

A. Furnish the necessary technicians, skilled workers, and helpers to operate the electrical systems and equipment of the entire project for one 8-hour day.

B. Where specified in technical sections, provide longer periods required for specialized equipment.

C. Instruct the Owner or designated personnel in operation, maintenance, lubrication, and adjustment of systems and equipment.

D. The Operating and Maintenance Manual shall be available at the time of the instructions for use by instructors and Owner personnel.

E. Schedule the general and specialized instruction periods for a time agreed upon by the Owner and Engineer.

END OF SECTION

SECTION 26 0504

ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Extent and location of demolition are shown on the drawings.

1.2 RELATED SECTIONS

A. Demolition: Division 02.

1.3 QUALITY ASSURANCE

A. Demolition shall be carried out as expeditiously as possible, in accordance with accepted practice and applicable building code provisions.

1.4 PROJECT CONDITIONS

A. If, in the course of the work, workers unexpectedly encounter a material not identified for special removal but which they suspect to be asbestos, to contain lead or PCBs, or to present some other hazard:

1. Promptly notify the Owner and Engineer in writing.
2. Do not perform any work which would disturb the suspected material until written instructions have been received.

B. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

C. Locate, identify, and protect mechanical and electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect existing building and equipment that is to remain, particularly to prevent entry of either dust or water. Ensure weathertightness at all times. Keep materials on hand to patch and maintain protection.

3.2 DEMOLITION

A. Comply with demolition and disposal requirements of Division 02.

B. Perform removal work neatly with the least possible disturbance to the building.

C. Provide temporary barriers, danger signals, and appurtenances for protection of personnel and equipment during removal operations.

D. Demolish, remove, demount, and disconnect inactive and obsolete conduit, fittings and specialties, equipment, and fixtures.

1. Conduit and ducts embedded in floors, walls, and ceilings may be abandoned in place if they do not interfere with new installations. Cut back to at least one inch below finished surface.
2. Remove materials above accessible ceilings.
3. Disconnect and cap items to remain behind finished surfaces.
4. Patch and repair surface materials as required in Section 01 7329, Cutting and Patching.

E. Remove the anchors, bolts, and fasteners associated with conduit and equipment to be removed.

3.3 DISPOSAL

A. Dispose of equipment and materials removed, and rubbish and waste material, as work progresses. Do not allow demolition debris to accumulate on site. Remove products of demolition from the building daily.

END OF SECTION

SECTION 26 0519

WIRES AND CABLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wire and cable rated 600-volts and less.

B. Type MC, Type NM, and Type AC-HCF cables are not permitted.

1.2 RELATED SECTIONS

A. Underground ducts: Division 33.

B. Conduits: Section 26 0533.

1.3 REFERENCES

A. ANSI/NEMA WC 70 – Power Cables rated 2000 Volts or Less for Distribution of Electrical Energy.

B. ASTM B3 – Standard Specification for Soft or Annealed Copper Wire.

C. ASTM B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors.

D. UL 44 – Standard for Thermoset-Insulated Wires and Cables.

E. UL 83 – Standard for Thermoplastic-Insulated Wires and Cables.

F. Additional UL Standards as indicated.

1.4 SUBMITTALS

A. Product data:

1. Each type of wire and cable, including accessories.
2. Include copies of UL certifications showing compliance with requirements in “Quality Assurance” below.

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. Products and installation shall comply with NFPA 70 and other applicable national, state, and local electrical codes.

1.6 DELIVERY, STORAGE, AND HANDLING

A. General requirements: Deliver, store, and handle wire and cable in accordance with the manufacturer’s instructions.

1. Wire and cable shall be packaged in a manner that protects them during ordinary handling and shipping. Ship from manufacturer with ends temporarily sealed against moisture.
2. Protect wire and cable during storage (both onsite and offsite).

    a. Store in a clean and dry location. Elevate from surfaces where water can accumulate, and cover cable rolls to protect against weather.

3. Handle wire and cable as recommended by the manufacturer. Do not pull from the center or periphery of the cable reel.
4. Damaged wire and cable shall be removed from the project site.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE (600-Volts Max.)

A. Conductors: UL listed and NEMA WC 70 compliant; Copper, 98 percent conductivity, suitable for 600-volt duty; rated 90-degree Celsius temperature for wet/dry applications; solid bare annealed copper for No. 10 and smaller complying with ASTM B 3, and stranded for No. 8 and larger complying with ASTM B 8.

B. Conductor insulation:

1. Type THHN/THWN-2: Comply with UL 83; PVC insulation, nylon jacket.

C. Conductor identification: Markings along outer braid denoting conductor size, voltage classification, type of insulation, and manufacturer's trade name, and color code. Identification shall extend to branch circuits and outlets. Use the color coding system tabulated below throughout the building's network of feeders and circuits, unless otherwise required by the authority having jurisdiction.

1. Colors on conductors No. 10 and smaller, or No. 6 and smaller for grounded and grounding conductors: Solid colored insulation.
2. Colors on conductors No. 8 and larger, or No. 4 and larger grounded and grounding conductors: Colored tape wrapped a minimum of 6 inches (150 mm) on either end of conductor.

COLOR CODE				
VOLTAGE	NEUTRAL	PHASE		
		A	B	C
120-V, 2-wire	White	Black, Red, or Blue, depending on phase		
208/120-V wye, 3-phase, 4-wire	White	Black	Red	Blue
277-V, 2-wire	Gray	Brown, Orange, or Yellow, depending on phase		
480/277-V wye, 3-phase, 4-wire	Gray	Brown	Orange	Yellow
480-V delta, 3-phase, 3-wire		Brown	Orange	Yellow

D. Wires used solely for grounding purposes shall be green, where insulated.

E. Control wiring shall be coded with colors different from those used to designate phase wires.

2.2 WIRING ACCESSORIES

A. Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service where installed.

B. Twist-on wire connectors (dry locations): Color-keyed, Ideal Industries, Inc., Wingnut®, 3M Company "Scotchlok", or equal by King Innovation.

C. Twist-on wire connectors (damp and wet locations): Ideal Industries, Inc., UnderGround®, models 60, 64, or 66 as appropriate; King Innovation DryConn®; or equal by 3M Company. Connectors shall be listed under UL 486D.

D. Compression connectors: Color-keyed, 3M Company "Scotchlok"™ compressor connectors, "10000" series for copper conductors, or equal by Thomas & Betts (Blackburn) or Ilsco.

E. Compression connectors (damp and wet locations): Protect the connector's with a waterproof system, UL-listed for direct burial and 600 volts: 3M Company 8420 series, Thomas & Betts Model DBSK82, or equal by Ilsco.

F. Compression taps: Series CT-2 tap with CT-2C cover, or Series 54710 color-keyed compression taps, Burndy Corporation "Versitap" or equal by OZ/Gedney.

G. Power distribution blocks: Equal to Hubbell Burndy “U-Blok.”

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Provide wire and cable indicated in accordance with national, state, and local electrical codes.

B. Conceal wire and cable in new construction and in locations with finished walls, ceilings, and floors unless otherwise noted on drawings.

C. Wire and cable serving systems over 100-volts shall be installed in raceways, except where otherwise noted on drawings.

D. Wire and cable serving systems rated below 100-volts shall be installed in raceways, except where otherwise noted in individual specification sections. Refer to paragraph “INSTALLING CABLE RATED BELOW 100-VOLTS” below for additional information.

3.2 INSTALLING INTERIOR WIRING

A. Sizes: Minimum sizes shall be as follows, unless a larger size is indicated on the drawings.

1. 120-volt branch circuits:

a. Homerun from first outlet to panel: No. 12 when run is 50 feet (15,000 mm) or less; No. 10 when run is between 50 feet (15,000 mm) and 100 feet (30,000 mm); No. 8 when run is more than 100 feet (30,000 mm).
b. First outlet to other outlets: No. 12.

2. Exit light and emergency lighting circuits: No. 10. Do not install in raceways, outlet boxes, or other locations with non-emergency wiring systems.
3. Other systems (over 100-volts): Minimum No. 12 unless specified or shown on drawings to be smaller.

B. Wiring methods and locations: Wires and cables shall be installed based on the following requirements, unless otherwise noted.

1. Feeders, exposed: Type THHN/THWN-2, single conductors in raceway.
2. Feeders, concealed in ceilings, walls, partitions, and crawlspaces: Type THHN/THWN-2, single conductors in raceway.
3. Feeders, concealed in concrete and below slab-on-grade: Type THHN/THWN-2, single conductors in raceway.
4. Feeders, underground: Type THHN/THWN-2, single conductors in raceway.
5. Branch circuits, concealed in ceilings, walls, and partitions:

   a. Unless otherwise indicated, utilize Type THHN/THWN-2, single conductors in raceway.

6. Branch circuits, exposed: Type THHN/THWN-2, single conductors in raceway.
7. Branch circuits, concealed in concrete and below slab-on-grade: Type THHN/THWN-2, single conductors in raceway.
8. Branch circuits, underground: Type THHN/THWN-2, single conductors in raceway.
9. All other applications: Provide Type THHN/THWN-2, single conductors in raceway.

C. Splicing shall be done in outlet boxes and junction boxes and not in conduit.

1. Conductors No. 8 and larger: Terminated, spliced and taped, wherever practical, with compression connectors or solderless connectors. Use tools recommended by the manufacturer.
2. Splices in conductors No. 10 and smaller, including lighting fixtures: Made with wire connectors.
3. Taps in conductors No. 6 and larger: Made with compression taps or power distribution blocks.

D. Wiring in high ambient temperature areas shall be of types required by NFPA 70 including over boilers and breechings.

E. Wires shall be neatly shaped in panels, troughs, boxes, and appurtenances.

3.3 COORDINATION WITH DEVICES AND EQUIPMENT

A. Where conductor size or parallel conductors shown on drawings connect to terminals on devices or equipment which is not sized for the connection:

1. Provide a junction box as near the equipment as possible, but no more than 10 feet (3 m) away. Obtain approval of location before installing.
2. Provide conductor(s) sized to the ampacity of the equipment, from equipment to junction box.
3. In the junction box, splice the conductors from the equipment to the conductors of sizes, or parallel conductors, shown on the drawings.

3.4 INSTALLING EXTERIOR WIRING

A. Sizes: Minimum sizes shall be as follows, unless a larger size is indicated on the drawings.

1. 600-volt branch circuits: Copper, No. 10 minimum.

2. Exterior lighting circuits: Copper, No. 10 minimum, with an extra No. 10 (minimum) bare copper ground conductor.

B. Splicing shall be done in outlet boxes and junction boxes and not in conduit. Treat these boxes as wet locations.

1. Conductors No. 8 and larger: Terminated, spliced and taped, wherever practical, with compression connectors. Use tools recommended by the manufacturer.
2. Splices in conductors No. 10 and smaller, including lighting fixtures: Made with wire connectors.
3. Taps in conductors No. 6 and larger: Made with compression taps or power distribution blocks.

3.5 INSTALLING CABLE RATED BELOW 100-VOLTS

A. Install in raceway, unless otherwise indicated in individual specification sections.

B. Where individual specification sections allow cable to be installed either in raceway or on J-hooks, install as follows:

1. Wiring method:

a. Wiring in walls, above inaccessible ceilings, where exposed in finished spaces, exposed on walls, and wherever it may not be accessible or may be subject to physical damage: Install cables in raceway.
b. Wiring exposed in ceilings of unfinished spaces: Install cables in raceway.
c. Wiring concealed above accessible suspended ceilings: Install cables on J-hooks.
d. Wiring within enclosures, consoles, cabinets, desks, and counters: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and/or distribution spools.

2. Conceal raceway and cables, except in unfinished spaces, and in open ceiling spaces and raceways on existing walls.
3. Cable not in raceways:

a. Do not install in hangers used for pipes, electric conduits, or ceiling hangers, nor support it in any way by attachments to pipes, conduits, or ceiling hangers.
b. Install without damaging conductors, shield, or jacket. Cables shall not run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
c. Install away from potential EMI sources, including electrical power lines and equipment.
d. Install parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.

4. Cable support with J-hooks:

a. Install J-hooks at intervals not exceeding 60 inches.
b. Secure cables on J-hooks with cable ties. Avoid cinching cables.

5. Each cable run shall contain an ‘S’ loop or other means to accommodate expansion or contraction.

C. For cable installed in conduit, comply with requirements for raceways and boxes specified in Section 26 0533, Conduits, and Section 26 0534, Boxes.

1. Provide separate conduit systems for each low-voltage system.

2. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

    a. Pull cables simultaneously if more than one is being installed in same raceway.
    b. Use pulling compound or lubricant, if necessary. Use compounds that will not damage conductor or insulation.
    c. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage cables or raceway.

D. Avoid installing near hot utilities, which might adversely affect system performance or result in damage to the cable. If cable must be placed close to such utilities, keep it separate and protect with insulation.

E. Cable bends shall have a radius not less than the value recommended by the cable manufacturer.

F. Tag cables connected to electronic equipment, to show function and the location of other end. Securely fasten labels to the cable.

END OF SECTION

SECTION 26 0521

WIRING CONNECTIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Power and control wiring for equipment.

1.2 RELATED SECTIONS

A. Equipment: Installed items requiring electricity, specified in other sections or shown on drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Conduits, wires and cables, devices, and accessories as specified in other sections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide power wiring from the motor starters to each motor and its manual controlling device.

1. Make flexible or liquid tight connections as specified in Section 26 0533, Conduits.

B. Certain equipment, as indicated, will be furnished with control panels and auxiliary control components. Mount the panels, furnish and install source wiring and disconnects, and completely connect controls and motors.

C. Provide source wiring, connections, and disconnects for existing pumps.

D. Provide power and control wiring for emergency generator, controllers, remote control .

END OF SECTION

SECTION 26 0526

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Grounding and bonding electrical systems and equipment.

1.2 RELATED SECTIONS

A. Gas flexible pipe connector: Section 23 1123.

1.3 REFERENCES

A. IEEE STD 142

B. NFPA 70

C. ASTM F467 and F468

D. UL 467

1.4 DEFINITIONS

A. Area served by a separately-derived system: The area within the building that contains any part of a circuit of the system.

1.5 SUBMITTALS

A. Product data: Ground rods and connections.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Ground conductor, unless specifically noted otherwise, shall be copper, 98 percent conductivity, solid for No. 10 AWG and smaller and stranded for No. 8 AWG and larger.

B. Ground rods: Copper bonded steel, 0.75 inch diameter by 10 feet long, one end pointed and the other end tinned, equal to the product of Erico International Corporation.

C. Mechanical type ground connectors:

1. Connectors: IEEE 837 and UL 467 compliant, equal to FCI Burndy G Series, listed for use for specific types, sizes, and combinations of conductors and connected items.
2. Nuts, bolts, and washers: Silicon bronze alloy type B per ASTM F467 and F468.

D. Exothermic type ground connections: Exothermic welding systems shall be equal to “Cadweld,” manufactured by Erico International Corporation.

E. Lugs: Lugs shall be two- or four-hole, equal to Burndy Hylug series.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Provide the complete grounding of conduit systems, electrical equipment, conductor and equipment enclosures, motors, transformers, and neutral conductors in accordance with applicable codes. Grounded phase and neutral conductors shall be continuously identified. Continuity of metal raceways shall be insured by double locknuts.

B. Furnish and install main grounds for secondary electrical service to cold water main in accordance with NEC requirement. In addition to the cold water ground, provide ground rods as indicated or as required by NEC and applicable codes.

C. Install copper grounding jumpers of 3/0 copper cable around each main water valve in the building. Install copper grounding jumpers around conduit expansion fittings. Jumpers shall be of adequate current carrying capacity corresponding to size of conduit.

D. Ground system connections which are beneath the floor and in a concealed or inaccessible location shall be brazed or welded. Brazing and welding shall be “CADWELD.”

E. Separately-derived 120/208-volt three phase wye electrical systems originating in transformers shall be grounded at the transformer neutral terminal:

1. The grounding electrode for the system shall be whichever one of the following that is closest to the transformer:

    a. Building’s grounding electrode.
    b. Steel structural member of the building conforming to NEC requirements for grounding electrodes.
    c. First five feet of the water service piping to the building.

F. Separately-derived three phase wye electrical systems originating in generators shall be grounded at the generator neutral terminal:

1. The grounding electrode for the outdoor generator shall be a ground rod.
2. The grounding electrode for the indoor generator shall be whichever one of the following that is closest to the generator:

    a. Building’s grounding electrode.
    b. Steel structural member of the building conforming to NEC requirements for grounding electrodes.
    c. First five feet of the water service piping to the building.

G. Bonding separately-derived systems:

1. Each metal water piping system, not used as the electrical system’s grounding electrode, in the area served by the electrical system shall be bonded to the electrical system’s neutral by a system bonding jumper.
2. If exposed structural metal is not used as the grounding electrode for the system, bond exposed structural metal in the area served by the electrical system to the system’s neutral by a system bonding jumper.
3. If a metal water piping system in the area served by the electrical system is bonded to exposed structural metal by a NEC-compliant bonding jumper, then only one of the two (piping or structure metal) need to be bonded to the electrical system’s neutral.

H. Bonding straps and jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to equipment mounted on vibration isolation hangers and supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connections for outdoor locations; if a disconnect-type connection is required, use a bolted clamp secured with a minimum of two bolts and lock washers.

3.2 EQUIPMENT GROUNDING AND BONDING

A. Provide insulated equipment grounding conductors to all feeders and branch circuits.

B. Gas piping:

1. Comply with NFPA 54.
2. Provide bonding jumpers for each length of corrugated stainless-steel tubing (CSST).

a. Jumpers shall be No. 6 AWG or the same size as the equipment grounding conductor serving the equipment served by the CSST, whichever is larger.
b. Install in accordance with CSST manufacturers' instructions and NFPA 54.

END OF SECTION

SECTION 26 0528

EQUIPMENT FOUNDATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Outdoor equipment foundations.

1.2 RELATED SECTIONS

A. Generators: Section 26 3213.

1.3 SUBMITTALS

A. Product data: Concrete mix, grout, reinforcement, and accessories.

B. Certifications: Test report showing strength of concrete.

PART 2 - PRODUCTS

2.1 CONCRETE

A. Concrete: 4,500 psi (31.0 MPa) compressive strength at 28 days.

2.2 GROUT

A. Non-shrink grout: Premixed, consisting of non-metallic aggregate, cement, water-reducing and plasticizing agents; capable of developing minimum compressive strength of 7,000 psi in 28 days.

1. Five Star Products, Inc. “Five-Star Grout”
2. L&M Construction Chemicals, Inc. “Crystex”
3. Sonneborn “Sonogrout”

2.3 METAL REINFORCEMENT

A. Reinforcing bars: Deformed steel bars in accordance with ASTM A615, Grade 60, clean and free from loose rust, scale, or other coatings that will reduce bond.

B. Welded wire fabric reinforcing: ASTM A 185 No. 6 steel wire spot-welded at intersections and of size 6 by 6 inch mesh.

C. Metal accessories: Include spacers, chairs, bolsters, ties, and other devices necessary for properly placing, spacing, supporting and fastening reinforcement in place.

PART 3 - EXECUTION

3.1 INSTALLING OUTDOOR EQUIPMENT FOUNDATIONS

A. Provide equipment foundations of size and thickness indicated.

B. Place reinforcement accurately in position shown, securely fasten, and support to prevent displacement before or during pouring. Clean, bend, place, and splice reinforcement in

accordance with approved shop drawings. Lap ends and sides of mesh reinforcement in slabs not less than one mesh.

1. Coverage of main reinforcing shall be as follows: Slabs, 0.75 inch (19 mm); concrete poured against earth, 3 inches (75 mm); other locations, 2 inches (50 mm).

C. Properly align, level, and grout equipment.

END OF SECTION

SECTION 26 0533

CONDUITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conduit and accessories, aboveground and below ground where not in duct banks.

1.2 RELATED SECTIONS

A. Exterior duct banks: Division 33.

B. Firestopping: Division 07.

C. Boxes: Section 26 0534.

D. Trenching: Division 31.

1.3 DEFINITIONS

A. FMC: Flexible metal conduit.

B. LFMC: Liquid-tight flexible metal conduit.

1.4 SUBMITTALS

A. Product data:

1. Each type of conduit included in the work, and related fittings.
2. Accessory materials.
3. Hangers and fasteners.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

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

B. Steel conduit and tubing:

1. AFC Cable Systems, Inc. (FMC and LFMC)
2. Allied Tube & Conduit; a Tyco International Ltd-Co.
3. O-Z/Gedney, Unit of General Signal
4. Wheatland Tube Co.

C. Steel conduit fittings:

1. Appleton Electric Co.
2. Cooper Crouse-Hinds.
3. Hubbell, Inc.; Killark Electric Manufacturing Co.
4. O-Z/Gedney; Unit of General Signal.
5. Spring City Electrical Manufacturing Co.
6. Thomas & Betts Corporation

7. Wheatland Tube Co.

D. Nonmetallic conduit, tubing and fittings:

1. Allied Tube & Conduit; a Tyco International Ltd. Co.
2. Arnco Corp.
3. Beck Manufacturing
4. CANTEX Inc.
5. Certainteed Corp.; Pipe and Plastics Group
6. Lamson & Sessions; Carlon Electrical Products

E. Wiring troughs and fittings:

1. Hoffman Engineering Co.
2. Lamson & Sessions, Carlon Electrical Products
3. Square D Schneider Electric

F. Conduit hangers and supports:

1. Thomas & Betts “Kindorf”
2. Tyco Power-Strut
3. Unistrut Diversified Products

G. Fasteners:

1. Caddy Fasteners by Erico Products Inc
2. ITW Ramset “Red Head”
3. Wej-It Fastening Systems

2.2 CONDUIT AND FITTINGS

A. Galvanized steel conduit: Hot-dip galvanized with threads galvanized after cutting, one of the following:

1. Intermediate steel conduit (IMC) conforming to UL 1242 and ANSI C80.6.

B. Steel conduit fittings: Cast malleable iron fittings with smooth finish and full threaded hubs. Include steel or malleable iron locknuts, bushings, and other fittings.

1. Insulating bushings: Equal to Thomas & Betts Series 22.
2. Hub fittings with recessed sealing ring and nylon insulated throat equal to Thomas & Betts Series 370.
3. Fittings for exposed locations: Conduit outlet bodies, zinc or cadmium plated.

C. Electrical metallic tubing (EMT): Hot-dip galvanized or sherardized thin-wall steel conduit conforming to UL 797 and ANSI C80.3.

D. Connectors and couplings for EMT: Concrete- or rain-tight, compression or set screw type, made of zinc- or chromium-plated steel. Connectors shall have nylon insulating throats.

1. Compression connector equal to Thomas & Betts No. 5223.
2. Compression coupling equal to Thomas & Betts No. 5220.
3. Set screw connector equal to Steel City No. TC722A.
4. Set screw coupling equal to Steel City No. TK122A.

E. Flexible metal conduit (Type FMC): Made of sheet metal strip, interlocked construction, conforming to UL 1.

F. Liquidtight flexible metal conduit (Type LFMC) shall conform to UL 360.

G. Connectors for flexible metal conduit: Equal to angle wedge “Tite-Bite” with nylon insulated throat, Thomas & Betts Series 3110 and 3130.

H. Liquidtight type connectors: UL 14814A. Fittings: With nylon insulated throat, equal to Thomas & Betts Series 5331.

I. Plastic conduit: Polyvinyl chloride (PVC) Schedule 40, rated for use with 90-degree conductors, for exposed, underground, and encased applications, complying with NEMA Specification TC-2 and UL 651.

J. Wiring troughs: Steel wiring trough with hinged cover, UL listed as wireways and auxiliary gutters, equal to Square D “Square-Duct.”

1. Cover: Opening complete width and length of trough;
2. Finish: Baked enamel.

K. Fittings for wiring troughs: Made with removable covers to permit installation of a complete system with access to wires throughout the system, UL listed with the troughs. Connections: Threaded screws at every connector.

L. Weatherproof expansion fittings: With bonding jumpers, equal to O-Z/Gedney types AX and TX.

2.3 SLEEVES FOR RACEWAYS

A. Steel pipe sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

1. Sleeves for exterior walls: Anchor flange welded to perimeter.

B. Sleeves for rectangular openings: Galvanized sheet steel of length to suit application. Minimum thickness:

1. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm): 0.052 inch (1.3 mm).
2. For sleeve cross-section rectangle perimeter equal to or more than 50 inches (1270 mm) and 1 or more sides equal to or more than 16 inches (400 mm): 0.138 inch (3.5 mm).

C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07.

2.4 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annual space between sleeve and conduit.

1. Sealing elements: EPDM or NBR 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: Stainless steel. Include two for each sealing element.
3. Connecting bolts and nuts: Stainless-steel of length required to secure plates to sealing elements. Include one for each sealing element.

2.5 ACCESSORY MATERIALS

A. Pull rope: Polypropylene, thickness, tensile strength, and work load selected to meet project load requirements.

B. Caps and plugs: Equal to Thomas & Betts Series 1470.

C. Lubricant: Equal to Ideal Industries, Inc. “Yellow 77”. UL approved.

D. Bituminous protective coating: Coal tar based, self-priming on steel, applied in a wet film thickness at least 22.0 mils (559 microns) per coat.

E. Rust inhibitive paint: Alkyd based, equal to Benjamin Moore Super Spec HP D.T.M. Alkyd Low Lustre P23; white, black, or bronzetone; applied in a wet film thickness of at least 2.9 mils.

2.6 CONDUIT HANGERS

A. Adjustable hangers: Equal to Kindorf C-711 lay-in hanger or C-710 Clevis hanger.

B. Trapeze hangers: Constructed of channels with Kindorf C-105 notched steel straps.

C. Channels: Steel, 1.5 inches (38 mm) wide with 7/8-inch (22-mm) continuous slot, gages and weights equal to Kindorf B-900 series.

D. Beam clamps: Equal to Kindorf E-160 or U-569 adjustable type, for connecting hanger rod to steel beam.

E. Hangers for conduit 1.0 inch (27 mm) and smaller, through or below bar joists: “Hang-on” hangers attached to joists with Minerallac scissor clips or two-piece stud clips.

F. Finish: All hangers, assemblies, plate washers, rods, locknuts, channels, bolts, and appurtenances shall be hot-dip galvanized.

2.7 FASTENERS

A. General: Select fasteners such that load applied does not exceed one-fourth of manufacturer’s load capacity in 3500 psi (24000 kPa) concrete.

B. Fasteners to concrete: Self-drilling type expansion anchors, or machine bolt drop in anchors for drilled holes. Fasteners to concrete ceilings shall be vibration- and shock-resistant.

C. Fasteners to drywall or cavity wall: Toggle bolts, hollow-wall drive anchors, or nylon anchors as required.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Provide complete, separate and independent raceway system for each of the various wiring systems including, but not limited to, the following:

1. Power
2. Emergency Lighting System
3. Fire Alarm System

4. Control Wiring

B. Wire raceway systems completely, except where otherwise indicated, as shown on drawings and as required for satisfactory operation of each system.

C. Where wiring troughs are required or used to facilitate the installation, amply size them to accommodate conductors, in accordance with NFPA 70.

D. Types and locations of conduits are scheduled at the end of the section.

E. Do not install conductors or pull rope during installation of conduit.

F. Where conduit is connected to a cabinet, junction box, pull box, or auxiliary gutter, protect the conductors with an insulating bushing. Provide locknuts both inside and outside the enclosure. Where conduit is stubbed up to above ceilings for future wiring, close ends with bushings.

G. Bituminous protective coating:

1. Coat exposed threads on steel conduits in concrete slabs at couplings and fittings, after joints are made up.
2. Coat metallic conduits below grade not in concrete, and where emerging from below grade or slabs, four inches above and below grade or slab.

H. Rust-inhibitive paint:

1. Exposed threads of exterior conduit.
2. All unfinished metal components.

I. Make turns in conduit runs with manufactured elbows or using machines or tools designed to bend conduit. Turns shall be not less than the various radii permitted by NFPA 70.

J. Sizes:

1. Do not use conduit smaller than 0.75 inch (21 mm), except where otherwise indicated.
2. Feeder conduits shall be as large as indicated, or as required by NFPA 70 (whichever is larger). Do not install more than one feeder in a single conduit.
3. Conduit sizes shown on drawings are based on Type THW wire.

K. Make vertical runs plumb and horizontal runs level and parallel with building walls and partitions.

L. Ground conduits as required by NFPA 70.

M. Where conduits pass through building expansion joints, and wherever relative movement could occur between adjacent slabs, equip with weatherproof expansion fittings and bonding jumpers.

N. Immediately after each run of conduit is completed, test it for clearance, smooth the joints, and close at each end with caps or plugs to prevent entrance of moisture or debris.

O. Conduit installed outdoors or at indoor locations exposed to continuous or intermittent moisture shall provide a liquidtight seal. Use steel or malleable iron hub fittings. Coat exposed threads with bituminous protective coating.

3.2 INSTALLING PULL BOXES, JUNCTION BOXES, OUTLET BOXES

A. Install as specified in Section 26 0534, Boxes.

B. Install pull or junction boxes in long runs of conduits or where necessary to reduce the number of bends in a run.

1. Select inconspicuous locations. Do not install until locations have been approved by the Engineer.
2. Install boxes flush with wall or ceiling surfaces, with flat covers. Where removable ceiling units are used, locate boxes above ceilings.

3.3 INSTALLING FLEXIBLE CONDUIT

A. Installation shall comply with NFPA 70.

1. Minimum length: Two feet (610 mm).
2. Maximum length: Six feet (1830 mm).

B. Make immediate connections to motors and transformers with liquidtight flexible conduit. Include sufficient slack to reduce the effects of vibration.

C. In wet locations, install liquidtight type, in such a manner that liquid tends to run off the surface and not drain toward the fittings.

D. Where fittings are brought into an enclosure with a knockout, install a gasket assembly consisting of an O ring and retainer on the outside.

3.4 INSTALLING PULL ROPE AND CONDUCTORS

A. After conduit is installed, fish pull rope. After completion of the work of this project, pull rope shall remain in conduits identified as to be left empty.

B. Do not use a pull rope that has a tensile strength of more than one of the conductors of a two-wire circuit, more than two of the conductors of a three-wire circuit, or more than three of the conductors of a four-wire circuit.

C. Do not pull conductors into the conduits until the system is entirely completed and wet building materials are dry.

D. Use only a lubricant approved for use with conductor materials and pull rope materials.

3.5 INSTALLING SLEEVES

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07.

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. 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.

D. Cut sleeves to length for mounting flush with both surfaces of walls.

E. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

F. Size pipe sleeves to provide 0.25-inch (6.4-mm) annular clear space between sleeve and raceway unless sleeve seal is to be installed.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

H. 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.

I. 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 07.

J. Exterior-wall penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal 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 INSTALLING CONDUIT HANGERS

A. Single runs of overhead conduits 1.25-inch (35-mm) size and larger shall be supported by adjustable hangers, using 0.375-inch (10-mm) rods for conduits up to 2.0 inch (53-mm) size and 0.5-inch (13-mm) rods for conduits larger than 2.0 inches (53 mm).

B. Support groups of conduits run in parallel on trapeze hangers suspended from 0.5-inch (13-mm) hanger rods.

C. Space hangers not over 10 feet (3 m) apart for metal conduits. Support conduits within 3 feet of each outlet, junction or pull box.

D. Below bar joist construction, support hangers from a length of structural channel, welded to the top chords of at least two joists.

E. Where large numbers of conduits are grouped together, stagger individual hangers so as not to concentrate the load on a few joists.

F. Where hanger rods are attached to structural beams, use adjustable beam clamps.

G. Below precast plank construction, hanger rods shall pass through the precast planks and be secured on top side with nut, locknut and plate washer. Plate washers shall be at least 4 inches (102 mm) square and 0.125 inch (3.2 mm) thick. Top of hanger assembly shall be concealed in the concrete fill which will be placed over the planks.

H. Attach hanger rods to concrete with expansion bolts and anchors.

3.8 CONDUIT IN EXISTING BUILDING

A. Remove superfluous electrical equipment and cap outlets not being used, as specified in Section 26 0504, Electrical Demolition.

B. In existing areas that are being renovated it is the intent to show on the drawings what the finished areas will contain when completed. Except as specified otherwise, existing conduit, and outlet boxes may be reused where they meet specifications and code requirements. Replace existing products or materials which are not suitable for reuse as determined by the Engineer.

C. Suitably cap superfluous concealed outlets, and remove unused wire. Remove superfluous raceways exposed in finished areas, and abandon superfluous raceways concealed in walls.

D. Install wiring in existing building concealed wherever possible above ceilings. In secondary rooms, such as storerooms, install in EMT.

3.9 INSTALLING UNDERGROUND CONDUIT, GENERAL

A. Depth:

1. Buried under building slabs: Top of conduit no less than 12 inches below the vapor barrier. Seal around conduits where they penetrate the vapor barrier.
2. Outside building: Top of conduit no less than 24 inches below finish grade.

B. Slope: At least 3 inches in 100 feet away from buildings and toward manholes or other drainage points.

C. Cleaning: At the completion of each run, in each conduit, first run a testing mandrel not less than 12 inches (305 mm) long with diameter 0.25 inch (6.35 mm) less than the inside diameter of the conduit; then draw through a stiff-bristled brush until all particles are removed. Immediately install conduit plugs.

D. Except at conduit risers, make changes in direction of runs, either vertical or horizontal, by long sweep bends. Bend may be made up of one or more curved or straight sections or combinations. Use manufactured bends with a minimum radius of 36 inches.

E. Where underground nonmetallic conduit runs penetrate floor slabs, penetrations shall be made with metallic elbows. Coat metallic elbows with bituminous protective coating.

3.10 INSTALLING UNDERGROUND CONDUIT WITHOUT CONCRETE ENCASEMENT

A. Run conduit in straight lines except as necessary.

B. Trenches: At least three inches (80 mm) clearance on each side of the conduit.

C. Warning tape: Install in backfill approximately 12 inches (300 mm) below grade.

D. Under existing roads and paved areas not to be disturbed, jack rigid steel conduit into place.

3.11 SCHEDULE OF LOCATIONS

A. IMC with screw joint couplings:

1. Conduits 3.0 inch size and larger.
2. Wiring to exterior equipment.

B. EMT:

1. Sizes 2.5 inches and smaller except as noted above.

C. Plastic with solvent cement joints:

1. For exterior circuits, directly buried, except first five feet from building.
2. Where noted under concrete slab, concrete encased.
3. Where noted under concrete slab, direct buried.
4. Where noted in concrete slabs.
5. For concrete encased duct banks.

END OF SECTION

SECTION 26 0534

BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Boxes with covers.

1.2 RELATED SECTIONS

A. Conduits: Section 26 0533.

B. Wiring devices: Section 26 2726.

C. Outlet boxes where required for special systems: Provided by the equipment manufacturers of the various systems.

1.3 SUBMITTALS

A. Product data: Each type of box included in the project.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

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

B. Boxes:

1. Appleton/EGS Electrical Group
2. RACO/Hubbell Electrical Products
3. Steel City/Thomas & Betts

2.2 MATERIALS

A. Outlet, switch, and junction boxes:

1. Sheet metal: NEMA OS 1, sherardized or galvanized stamped.
2. Cast-metal, where required for weather-exposed or exposed locations: NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

2.3 BOXES FOR WALLS AND PARTITIONS

A. Outlet boxes in concrete construction: Octagonal, two-piece type, of sufficient depth to keep conduits not closer than 1 inch (25 mm) to surface.

B. Switch and receptacle boxes in masonry partitions and walls: Square cornered tile wall boxes 3.5 inches (90 mm) deep, or four-inch (100-mm) square boxes with raised tile wall device covers. The device covers shall be of extra depths required to suit the block or brick construction in which they are placed.

2.4 JUNCTION AND PULL BOXES

A. Junction and pull boxes in feeder conduit runs: Galvanized, of size required for conduit arrangement and not less than the size required by NFPA 70, and furnished with screwed covers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide box at each outlet, switch, and appurtenance. Each box shall be of a type suitable for the duty intended and shall be installed in accordance with the manufacturer's instructions.

1. Where conduit is weather-exposed or exposed, provide cast-steel or cast-aluminum boxes.

B. Coordinate locations of boxes with installation of conduit as specified in Section 26 0533.

C. Firmly secure the boxes in place, plumb, level, and with front of device cover even with finished wall surface.

D. Provide a single cover plate where two or more devices are grouped together in one box.

E. Outlet boxes in fire-rated assembly:

1. Clearance between boxes and wallboard shall not exceed 0.125 inch (3.2 mm).
2. Surface area of individual outlet box does not exceed 16 square inches (103 sq cm).
3. Entire surface area of boxes shall not exceed 100 square inches (645 sq cm) per 100 square feet (9.3 sq m) of wall surface.

3.2 IDENTIFICATION

A. Identification on outside covers of pull and junction boxes in ceiling space or exposed on walls: Paint with colored enamel or mark with permanent waterproof black marker, or both, as specified.

1. Power and lighting: Panelboard designation and circuit number(s).

B. Identification inside boxes for recess-mounted or concealed in walls and partitions: Plasticized card stock tags marked with permanent waterproof black markers.

1. Power and lighting: Panelboard designation and circuit number(s).

END OF SECTION

SECTION 26 2200

TRANSFORMERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Transformers for electric power 600 V and below.

B. General-purpose transformer.

1.2 REFERENCES

A. NEMA ST 20: Dry-Type Transformers for General Applications.

B. DOE 2016: Department of Energy federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment."

1.3 SUBMITTALS

A. Product data: Each transformer, includes the following:

1. Outline dimensions and weights.
2. kVA rating.
3. Primary and secondary voltage.
4. Taps.
5. Impedance.
6. Insulation class and temperature rise.
7. Sound level.

B. Certifications:

1. Specified sound levels.
2. Compliance with DOE 2016 for energy efficiency.

C. Test reports: Factory and field test reports specified in Parts 2 and 3 below.

D. Unit shown on drawings is based on the characteristics of the design basis unit specified in Part 2. If another acceptable manufacturer’s unit should be proposed, ascertain that it will meet the required standards and performance. Include, with shop drawings of the unit, scale drawings similar to the contract drawings, showing any changes in wiring, arrangement or access made necessary to accommodate the unit proposed.

E. Operation and Maintenance Data: For transformer to include in operation and maintenance manuals: In addition to items specified in Division 01 and Section 26 0101, include the following:

1. Final settings for transformer taps and measured voltage.

1.4 QUALITY ASSURANCE

A. UL label and local testing (if required): As specified in Section 26 0500, Common Work Results for Electrical.

B. UL Energy Verification Mark to confirm compliance with DOE 2016.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Siemens Industry, Inc. units are the basis for design of the project. The following listed manufacturers also provide units of acceptable quality. If units by any of these manufacturers should be proposed, verify that they meet requirements specified in the article “Product Options” in Section 01 6000, and submit shop drawings as specified in the article “Submittals” above.

1. Eaton Corporation
2. General Electric Company
3. Schneider Electric; Square D products
4. Siemens Industry, Inc.

2.2 TRANSFORMERS, GENERAL

A. Factory-assembled and -tested, air-cooled units of types specified, of size, phase, and voltage ratings indicated on the drawings, designed for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous copper windings without splices except for taps.

D. Enclosure: Heavy-gage steel enclosure and base, arranged for conduit entrance on the primary and secondary sides and provided with adequate louvered openings to allow suitable ventilation and cooling. NEMA 250 Type 1.

E. Enclosure Finish: Degreased, cleaned, phosphatized, primed and finished with baked enamel paint. Comply with NEMA 250; color manufacturer's standard gray.

F. Taps: Four, 2.5 percent rated kVA taps, two below and two above rated primary voltages, except transformers rated 15 kVA and smaller may have two 5-percent-rated kVA taps, one above and one below rated primary voltage.

G. Sound levels based on NEMA ST 20 test procedure:

1. Transformer 50 kVA and smaller: Not more than 45 dB.
2. Transformers 51 to 150 kVA: Not more than 50 dB.
3. Transformers 151 to 300 kVA: Not more than 55 dB.
4. Transformers 500 kVA: Not more than 60 dB.

2.3 GENERAL-PURPOSE TRANSFORMERS

A. Self-cooled, dry type of size, phase, and voltage rating indicated on the drawings, designed in accordance with NEMA ST-20. Dry-type, general-purpose transformers shall be Energy Efficient type in compliance with DOE 2016.

B. Insulation: The maximum hot spot temperature can be 30 degrees C higher than the specified average below.

1. Transformers below 15 kVA: Class 150 degrees C having a maximum temperature rise under full load conditions not exceeding 115 degrees C when the transformer is operating in 40 degrees C ambient temperature.

2. Transformers 15 kVA and higher: Class 220 degrees C having a maximum temperature rise under full load conditions not exceeding 150 degrees C when the transformer is operating in 40 degrees C ambient temperature.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Mount on wall as shown on the drawings. Transformers shall be level and plumb. Transformers shall not be mounted in corrosive areas.

1. Wall mount: Use manufacturer's wall-mounted bracket in accordance with manufacturers' instructions.

B. Ground neutrals of dry type transformers as specified in Section 26 0526, Grounding and Bonding and as required by NEC (NFPA 70).

3.2 INSTALLING TRANSFORMER

A. Protect against overload on the primary side by circuit breakers in the panelboards as indicated.

B. Make immediate connections to and from transformers through flexible metal conduit.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's field service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.4 ADJUSTING AND CLEANING

A. Refinish painted surfaces damaged during construction to match the rest of the equipment.

B. Measure voltage on the secondary side of transformer during a typical occupancy period and adjust taps to achieve nominal voltage output. Nominal voltage shall be plus three percent or minus two percent of nameplate secondary voltage.

C. Record final tap settings and measured voltage and include in Operation and Maintenance manuals.

3.5 PROTECTION

A. Apply temporary heat within indoor transformer enclosures, in accordance with manufacturer's recommendations, until the space temperature and humidity are under normal control.

END OF SECTION

SECTION 26 2416

PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Circuit breaker panelboards, lighting, and appliance branch-circuit types.

B. Fusible branch circuit panelboards.

1.2 RELATED SECTIONS

A. Fuses: Section 26 2813.

1.3 REFERENCES

A. ANSI/NECA 407: Recommended Practice for Installing and Maintaining Panelboards.

B. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).

C. NEMA PB 1: Panelboards.

D. NEMA PB 1.1: Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

E. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

F. UL 50: Enclosures for Electrical Equipment.

G. UL 67: Panelboards.

1.4 DEFINITIONS

A. Circuit-breaker panelboards in this section:

1. Lighting and appliance panelboard: Maximum branch breaker amperage 100 A.

1.5 SUBMITTALS

A. Product data: For each type of panelboard, overcurrent protective device, surge protective device, accessory, and component indicated.

B. Bill of materials: Provide detailed list of components.

C. Shop drawings: For each type of panelboard, include the following details:

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings in panel schedule format.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.

5. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

D. Operation and Maintenance Data: For panelboards and components to include in operation and maintenance manuals. In addition to items specified in Division 01 and Section 26 0101, include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Copy of each printed panelboard schedule representing final version following installation.

1.6 QUALITY ASSURANCE

A. Source limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

B. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency accepted by the authority having jurisdiction, and marked for intended location and application; listed as a complete assembly.

1. UL label and local testing (where required): As specified in Section 26 0500, Common Work Results for Electrical.

C. Comply with referenced standards and listings previously identified including NEMA PB 1, NFPA 70, and UL 67.

1.7 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.9 PROJECT CONDITIONS

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

1. Notify Owner no fewer than ten days in advance of proposed interruption of electrical service. Provide applicable details of proposed outage including sequence of work and methods of providing temporary electrical service.
2. Do not proceed with interruption of electrical service without written permission.

1.10 EXTRA MATERIALS

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

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Furnish spare breakers for panelboards as indicated in schedule on drawings.
3. Furnish spare fuses for fused switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Circuit breaker panelboards: Subject to compliance with requirements, provide circuit breaker panelboards manufactured by Siemens Industry, Inc. products or comparable product by one of the following:

1. Eaton Corporation.
2. General Electric Company.
3. Schneider Electric; Square D products.
4. Siemens Industry, Inc.

B. Fusible branch circuit panelboards: Subject to compliance with requirements, provide fusible branch circuit panelboards manufactured by Eaton Corporation; Bussmann products or comparable product by one of the following:

1. Eaton Corporation; Bussmann.
2. General Electric Company.
3. Littlefuse, Inc.
4. Mersen
5. Schneider Electric; Square D products.
6. Siemens Industry, Inc.

2.2 PANELBOARDS, GENERAL

A. UL listing: UL 67, listed and labeled.

B. Integrated equipment short-circuit rating: Each panelboard, as a complete unit, shall have a short-circuit rating equal to or greater than the integrated equipment rating shown or scheduled on the drawings.

1. Rating shall be established by testing in accordance with UL 67, with the overcurrent devices mounted in the panelboard. Make short-circuit tests on the overcurrent devices and on the panelboard structure simultaneously, by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. The source shall be capable of supplying specified panelboard short-circuit current or greater.
2. Testing of overcurrent devices only while individually mounted is not acceptable. Testing the bus structure by applying a fixed fault to the bus structure alone is not acceptable.
3. Mark each panelboard with its maximum short-circuit current rating at the supply voltage.
4. Series rating of panelboards with devices outside of the panelboard enclosure are not permitted.

C. Enclosures: Flush- or surface-mounted as indicated, NEMA PB 1, Type 1, UL 50, galvanized steel.

1. Size: Where multiple-width or multiple-section panelboards are indicated or required, each cabinet shall be the same width and height.
2. Provide enclosure type as indicated below:

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

D. Directory card: Inside panelboard door, mounted in metal frame with transparent protective cover with information as indicated in Part 3, Identification.

E. Provisions for future devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Furnish each unit with a master nameplate, listing standard manufacturer information including voltage, ampacity, frequency, and short-circuit ratings; manufacturer's model and project designations.

2.3 CIRCUIT-BREAKER PANELBOARDS

A. Factory-assembled complete with breakers.

B. Cabinets and fronts: Minimum 20 inches wide, wiring gutter space in accordance with UL 67, with minimum four-inch width on every side.

1. Cabinet front: Hinged trim with entire front hinged to cabinet box with piano hinge and screw fasteners for surface mounted cabinets. Door-in-door construction, one or more latches as required for size, with outer door covering the gutter.
2. Door: Required for sizes up to and including 600 amps.

a. Lock: Flush, cylinder tumbler type, with catch and spring-loaded stainless steel door pull. All panelboards shall be keyed alike. Provide two keys per lock. Provide extra keys as required in "Extra Materials" in Part 1 above.
b. Hinges: Steel, completely concealed.

C. Circuit breakers: UL 489; voltage, continuous-current rating, and interrupting rating as indicated on the drawings.

1. Breakers shall be 1-, 2- or 3-pole, with an integral crossbar to ensure simultaneous opening of all poles in multipole circuit breakers.
2. Operating mechanism: Over center, trip-free, toggle-type with quick-make, quick-break action. Handles shall have on, off, and tripped positions.
3. Circuit breakers shall be able to be installed in the panelboard without requiring additional mounting hardware or disturbing adjacent units, bars, or branch circuit connections.
4. Where indicated on the drawings, provide shunt-trip main breakers, standard main breakers, or lugs.
5. Main and branch circuit breakers shall have device ampacity rating engraved on the front or side of each breaker handle. The breaker rating shall be clearly visible without removing panelboard cover.
6. Circuit breakers shall be rated for use with 75 deg C wire (conductor temperature rating).
7. Thermal-magnetic circuit breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 amps and larger.
8. Ground-fault circuit interrupter (GFCI) type circuit breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
9. Tandem breakers are not permitted.

D. Bussing assembly and temperature rise: Panelboard bus structure and main lugs or main circuit breaker shall have current ratings as shown on the panelboard schedule, established by heat rise tests conducted in accordance with UL 67.

1. Conductor dimensions shall not be accepted in lieu of actual heat tests.
2. Current-carrying parts of the bus structure shall be hard-drawn copper, 98 percent conductivity.
3. Provide a separate copper ground bus with screw terminals for branch wiring and feed-through lugs.

E. Branch circuit panelboards: Panelboard shall be capable of accepting up to 100-amp branch breakers.

1. Single-pole, 15 and 20 A circuit breakers intended to switch fluorescent lighting loads on a regular basis shall carry the SWD marking.
2. Branch breakers serving exit lights, fire alarm, emergency lighting, and telephone equipment shall be provided with handle-blocking devices which shall prevent accidental operation but not prevent tripping.

2.4 FUSIBLE BRANCH CIRCUIT PANELBOARDS

A. Factory-assembled complete with branch fuse disconnect:

1. Emergency (life-safety) panelboard(s) shall be fusible branch circuit panelboards.
2. Main lug only, main fused switch, or main non-fused switch as indicated on the drawings, with main fused switch selectively coordinated with fusible branch switches.
3. Six spare single-pole 20-ampere fuses, unless otherwise noted.
4. UL Listed minimum interrupting rating of 200,000 rms symmetrical amperes at 600 volts AC.

B. Cabinets and fronts: Minimum 20 inches wide, wiring gutter space in accordance with UL 67.

1. Cabinet front: Door-in-door construction, one or more latches as required for size, with outer door covering the gutter.
2. Door: Lock, two keys per lock, steel hinges, and circuit directory card on inside of door.

C. Branch fuse disconnects: UL 248, UL 98, and NEMA FU 1; voltage, continuous-current rating, and interrupting rating as indicated on the drawings.

1. Incorporating overcurrent protection fuse and disconnecting means into a single integrated finger-safe component (1-pole, 2-pole or 3-pole) mechanically interlocked to prevent removal of the fuse while fuse terminals are energized.
2. Interchangeable from 15 amperes to 100 amperes without requiring additional space.
3. Time-delay UL Listed Class CF power fuses (equivalent to Class J).
4. Visible circuit ON/OFF indication positions and open fuse indication.
5. Permanently installed lockout means in the OFF position.

D. Bussing assembly and temperature rise: Panelboard bus structure and mains shall have current ratings as shown on the drawings:

1. Sufficient cross section to meet UL 67 temperature rise requirements.
2. Current-carrying parts of the bus structure shall be hard-drawn copper, 98 percent conductivity.
3. Provide a separate copper equipment ground bar and neutral bus bar.

2.5 SOURCE QUALITY CONTROL

A. With branch circuit breakers installed, short-circuit test panelboards as complete units, in accordance with requirements of UL 67.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Securely attach panelboards to the wall where indicated on the drawings. Install in accordance with NEMA PB 1.1 and manufacturer's written installation instructions.

1. Mounting height:

a. 72 inches (1829 mm) to top of panelboard.
b. Panelboards taller than 72 inches (1829 mm): Bottom edge no more than 4-inches (102 mm) above floor.
c. Top breaker maximum height: No more than 6-feet, 7-inches (2.0 m) above the floor or working platform.

B. Comply with applicable portions of NECA 407.

C. Frame and mount printed circuit directory indicating type and location of equipment on each circuit.

D. Wiring in gutters: Arrange conductors into groups, and bundle and wrap with wire ties.

E. Install filler plates in unused spaces.

3.2 CONNECTIONS

A. Connect panelboards and components to wiring and to ground as indicated.

B. Shared neutral conductors shall not be permitted, except where indicated.

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

3.3 IDENTIFICATION

A. Nameplates: Provide identification nameplate for each panelboard and associated components located on front of assembly.

B. Provide printed directory for each panelboard. Handwritten directories are not acceptable. Copying of panel schedules and descriptions on drawings is not acceptable. Circuit directory shall reflect final circuit installation. Include the following information:

1. Panelboard designation and room location.
2. Circuit breakers, size and number of poles.
3. Circuit or feeder description including destination room name(s) and number(s).
4. Clear description of type of load circuit serves.
5. Panelboard ratings: Main bus ampacity, main circuit breaker or main lug ampacity, AIC rating.
6. Incoming primary feeder size and source panelboard circuit designation.

C. Room names and numbers on the panelboard circuit directories shall match names and numbers used by the Owner. Note that room names and numbers on the drawings may not match the Owner's final room name and numbering scheme.

3.4 FIELD QUALITY CONTROL

A. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuit.

B. Make continuity tests of each circuit.

C. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

D. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.5 CLEANING

A. Clean interior and exterior of panelboards.

B. Refinish painted surfaces damaged during construction to match the rest of the panelboard.

END OF SECTION

SECTION 26 2550

GENERATOR DOCKING STATION

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

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. UL (Underwriters Laboratories, Inc.) Standards

C. cUL (Underwriters Laboratories of Canada) Standards

D. Comply with NFPA 70.

1.2 GUARANTEE/WARRANTY

A. The equipment installed under this contract shall be left in proper working order. Replace, without additional charge, new work or material which develops defects from ordinary use within one year.

B. New materials and equipment shall be guaranteed against defects in composition, design or workmanship. Guarantee certificates shall be furnished.

PART 2 - PRODUCTS

2.1 GENERATOR DOCKING STATION

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

1. TRYSTAR: Dual-Purpose Generator Docking Station.

2.2 GENERAL REQUIREMENTS

A. Enclosures:

1. Pad mounted cabinet.
2. Side and back accessible.
3. Built for environmental conditions at installed location: Outdoor Locations: NEMA 250, Type 4X.
4. Enclosure material: 304 stainless steel.
5. Front Door:

a. Hinged.
b. Gasketed.
c. Pad-lockable latch.

6. Finishes:

a. Paint after fabrication. Powder coated ANSI 61 light gray.
b. Custom colors available, consult factory.

B. Phase, neutral, and ground buses:

1. Material: Silver-plated, hard-drawn copper.

2. Equipment ground bus: bonded to box.
3. Isolated ground bus: insulated from box.
4. Ground bus: 25%, 50% or 100% of phase size.
5. Neutral bus: Neutral bus rated 100 percent of phase bus.
6. Round edges on bus.

C. Inputs connectors (from roll-up device):

1. E1016 Series male camlock panel mounts with flip covers.
2. Termination lugs for cable connections.

D. Voltage and phase: 277/480 volts, 3-phase, 4-wire.

E. Amperage: 60A input.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive Generator Docking Station for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Surface, flush or base mounted: Specified with order.

1. Install anchor bolts to elevations required for proper attachment to Generator Docking Station.

B. Temporary lifting provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 FIELD QUALITY CONTROL

A. Suggested tests and inspections to include the following:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

B. Generator docking station will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports, including a certified report that identifies Generator Docking Station and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Optional manufacturer's field start-up: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections prior to turn-over to Owner.

END OF SECTION

SECTION 26 2726

WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Receptacles.

1.2 SUBMITTALS

A. Product data: Each type of device used in the project.

PART 2 - PRODUCTS

2.1 RECEPTACLES

A. Acceptable manufacturers:

1. Pass & Seymour, Inc.
2. Leviton Manufacturing Co.
3. Hubbell/Bryant Electric
4. Cooper Industries/Cooper Wiring Devices.

B. Provide devices conforming to UL 498 for receptacles, equal to the following Pass & Seymour catalog numbers or NEMA WD 1 and WD 6 configuration numbers:

1. Duplex convenience receptacles: PS5362, NEMA 5-20R, brass mounting strap.

a. Tamper resistant: TR5362, NEMA 5-20R.

2. GFCI receptacles: 2097, NEMA 5-20R.

a. Weatherproof cover: 4512 vertical, 4511 horizontal.
b. Exterior and wet locations: 2097TRWR, 20 amps, weather-resistant, tamper-resistant.
c. Interior cover: WP26 vertical, WPH26 horizontal.

C. Device color:

1. General-purpose receptacles: Brown.
2. Emergency power receptacles: Red.

D. Device plates: Equal to P&S: Type 302 stainless steel, SS Series.

2.2 RELAYS

A. Relays: Equal to Square D Company, Class 8501 Type C in NEMA 250 type 1 enclosure.

B. Contacts: Double-break, fine silver, convertible from normally open to normally closed contacts. Provide contact status indication.

C. Coils: Molded construction, terminals provided with pressure wire connectors.

D. Coil voltage and number of contacts shall be as indicated on the drawings.

2.3 TERMINAL BLOCKS

A. Terminal blocks: Equal to Square D, screw-terminal type, size as required by NFPA 70, NEMA 250 Type 1 enclosure with hinged cover.

2.4 CONTACTORS

A. Emergency power-off contactors: Equal to Square D Class 8903 contactor type LXG with accessory control relay for "on-off" (maintained contact) push button control, UL 508 listed, in NEMA 250 Type 1 enclosure, mechanically held, double-break, continuous-duty contacts rated 30 amps at 600 Vac, 60 Hz; number of poles indicated on drawings; HOA selector switch on cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices in complete compliance with the manufacturer’s recommendations.

B. Receptacles orientation:

1. Install ground pin of vertically mounted receptacles up and on horizontally mounted receptacles to the right.

C. Device plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

D. Arrangement of devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent devices under single multi-gang wall plates.

3.2 IDENTIFICATION

A. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

B. Attach nameplates securely to receptacle cover plates. Provide nameplates for all devices except 120-volt receptacles, identifying equipment and use.

END OF SECTION

SECTION 26 2800

ENCLOSED CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Enclosed switches (disconnects/safety switches).

1.2 RELATED SECTIONS

A. Fuses: Section 26 2813.

1.3 REFERENCES

A. NEMA KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. UL 98: Enclosed and Dead-Front Switches.

1.4 SUBMITTALS

A. Product data: Each type of enclosed switch.

1.5 QUALITY ASSURANCE

A. Comply with the following standards:

1. NEMA KS 1 for enclosed switches.
2. UL 98.
3. UL 198E.

B. UL label and local testing (if required): As specified in Section 26 0500, Common Work Results for Electrical.

PART 2 - PRODUCTS

2.1 ENCLOSED SWITCHES (DISCONNECTS/SAFETY SWITCHES)

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

1. Eaton Corporation.
2. General Electric Company.
3. Schneider Electric; Square D products.
4. Siemens Industry, Inc.

B. Properly size switches for number of poles and provide fused or non-fused as required for project conditions and to meet NFPA 70 requirements.

1. Neutral kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
2. Auxiliary contact kit: One NO/NC (Form “C”) auxiliary contact(s), arranged to activate before switch blades open.

C. Fuse contacts and quick-make/quick-break jaws shall insure positive contacts with reinforcing spring clips or other approved means.

D. Switches shall be front-operated.

E. Current-carrying parts: Plated copper.

F. Hinges: Noncurrent-carrying.

G. Switches shall be lockable in either open or closed position.

H. Type:

1. Nonfused switches: General-duty type on 120/208 V or 120/240 V systems, and heavy-duty type on 277/480 V or 240/480 V systems.
2. Fused switches: Heavy-duty type on all voltages.

I. Enclosures: Indoors NEMA 250 Type 1; outdoors 4X stainless steel with raintight hubs.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install enclosed switches where indicated and as required for motor outlets, transformers, and other equipment.

B. Securely attach and properly connect enclosed switches.

C. Provide an enclosed switch for each motor, as required by NFPA 70, except where it is provided in a panelboard within sight and easy reach of the motor, and provide wiring and connections from source. Enclosed switches shall be fused where protection is required or indicated on drawings and unfused elsewhere.

D. Enclosed switches:

1. Provide neutral kit where required for four-wire application.
2. Provide auxiliary contact kit where indicated on drawings.

END OF SECTION

SECTION 26 2813

FUSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fuses.

1.2 RELATED SECTIONS

A. Enclosed switches: Section 26 2800.

1.3 REFERENCES

A. UL 198E: Class R fuses.

B. UL 198C: High-Interrupting-Capacity Fuses, Current Limiting Types.

1.4 SUBMITTALS

A. Product data: Each type of fuse.

B. Published data on fuses shall include time/current curves, peak-let-through curves and I^2t melting and clearing curves.

1.5 QUALITY ASSURANCE

A. Comply with UL 198C, Class L fuses, also Classes G and J.

B. UL label and local testing (if required): As specified in Section 26 0500, Common Work Results for Electrical.

1.6 EXTRA MATERIALS

A. Provide three spare fuses for each type and size of fuse in the work.

PART 2 - PRODUCTS

2.1 FUSES

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

1. Eaton Corporation; Bussmann
2. Littelfuse, Inc.
3. Mersen

B. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

C. Fuses 0-600 amps for 600 V or 250 V, UL labeled Class RK1 with time delay, with a minimum short-circuit interrupting capacity of 200,000 rms symmetrical amperes, and shall carry 500 percent of rating for a minimum of 10 seconds.

1. Fuses for disconnecting switches for packaged HVAC equipment: Size and type recommended by the equipment manufacturer and as required for equipment to meet UL rating.

D. Fuses 601 amps and larger shall be UL labeled Class L with time delay, 600 V, with minimum short circuit interrupting capacity of 200,000 rms symmetrical amperes and dimensions to properly mount in switchboard or disconnecting switches.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fuses where indicated and as required for motor outlets or other equipment.

END OF SECTION

SECTION 26 2923

VARIABLE FREQUENCY DRIVES

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Variable frequency drives, rated less than 600V, for speed control of three-phase, induction motors.

1.2 REFERENCES

A. ANSI/IEEE 399: Standard Practice for Industrial and Commercial Power Systems Analysis

B. NEMA: Application Guide for AC Adjustable Speed Drive Systems

C. NEMA ICS 61800-2: Adjustable Speed Electrical Power Drive Systems

D. NEMA ICS 7.0: Industrial Controls & Systems for Adjustable Speed Drives

E. NEMA ICS 7.1: Standard Standards for Construction and Guide Selection, Installation, and Operation of Adjustable Speed Drive Systems

F. NEMA MG 1: Motors and Generators

G. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

H. NFPA 70: National Electrical Code

I. UL 508: Standard for Industrial Control Equipment

J. UL 508C: Standard for Safety for Power Conversion Equipment

1.3 SUBMITTALS

A. Product data: For each type and rating of equipment, include electrical ratings, operating characteristics, manufacturers' technical data on features and functions, enclosures, and furnished accessories. Include product data for each of the following:

1. Variable frequency drive (VFD).

a. List rated capacities and relationship to motor values including voltage, horsepower, rated current, and short-circuit ratings.

B. Bill of materials: Provide detailed list of components.

C. Shop drawings: For each type of unit, indicate the following:

1. Dimensioned plans, elevations, and sections; weights; loads; required clearances; mounting arrangements; components; and location of each field connection.
2. List of installed device and related equipment ratings and features including:

a. Unit type and standard details

b. Enclosure type
c. Nameplate and identification labels
d. Factory settings of installed devices

3. Wiring diagrams: Power, signal, and control wiring.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Enhanced VFD setup parameter settings report.

G. Operation and maintenance data: For each type of variable frequency drive and associated components, include in operation and maintenance manuals. In addition to items specified in Division 01, include the following:

1. Detailed operating and programming instructions.
2. Troubleshooting procedures.
3. Detailed spare parts list.
4. Warranty, executed and signed at the time of putting the unit in service.

1.4 QUALITY ASSURANCE

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; listed as a complete assembly.

1. UL label and local testing (where required): As specified in Section 26 0500, Common Work Results for Electrical.

B. Variable frequency drives shall be fully assembled, inspected, and tested at the factory prior to shipment.

C. Installer qualifications:

1. Staff is authorized and factory-trained by manufacturer. Includes training in electrical safety as required by NFPA 70E and qualified as defined in NEMA PB 2.
2. Maintains a service center location with staff factory-trained by manufacturer in the Baltimore/Washington, DC, metropolitan area.
3. Service available 24 hours a day, seven days a week, 365 days a year.
4. Maintains an adequate stock of manufacturer’s genuine or approved parts to service this equipment.
5. Service and maintenance contracts available.

D. Testing agency qualifications: Member company of NETA or a nationally recognized testing laboratory (NRTL).

1. Testing agency's field supervisor: Currently certified by NETA to supervise on-site testing.

E. Comply with referenced standards and listings previously identified including NEMA MG 1, UL 508C, and NFPA 70.

F. Verify motor, drive, and load compatibility. Motors shall be inverter duty rated, per NEMA MG1.

1.5 COORDINATION

A. Ratings and functions of each variable frequency drive unit shall be coordinated with associated motor and connected load including the following:

1. Load requirements such as torque, speed, and horsepower.
2. Motor and power supply characteristics.
3. Control and operational sequences.
4. Ambient, environmental, and physical conditions of installation location.

B. Coordinate layout and installation of drive and associated components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access.

C. Coordinate method and location for mounting equipment including size and location of housekeeping pads and structural channel supports.

D. Coordinate location of underslab and overhead conduit.

E. Coordinate with ATC/BAS/DDC for proper control and communications functions.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.7 PROJECT CONDITIONS

A. Environmental conditions: Variable frequency drive assembly and associated components shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient temperature: Minus 15 to plus 40 deg C.
2. Relative humidity: 5 to 95 percent, non-condensing.
3. Altitude: Sea level to 3300 feet (1000 m).

1.8 WARRANTY

A. Special warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of drive unit and associated auxiliary components that fail in materials or workmanship within specified warranty period:

1. Warranty period: Two years from date of substantial completion.
2. Warranty shall include all parts and labor.

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. Control power fuses: Six of each type and rating used.
2. Indicating lights: Six of each type installed.
3. Touchup paint: Three containers of paint matching enclosure finish, each 0.5 pint (250mL).

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-design product: Subject to compliance with requirements, provide products manufactured by ABB, Inc. (Model ACH550), or comparable product by one of the following:

1. ABB, Inc.
2. Toshiba International Corporation; Industrial Division
3. Trane/Danfoss

2.2 VARIABLE FREQUENCY DRIVES

A. Description: Enclosed variable frequency, alternating-current (AC) motor controller assembly suitable for operation of inverter-duty, Design A and Design B, induction motors as defined by NEMA MG1. The drive shall be designed for variable torque applications.

1. Unit shall be a packaged assembly including power conversion components, disconnecting means, overcurrent and overload protection, and control components.

B. Equipment ratings and design:

1. Ratings: VFD shall be sized to match the motor load type served. The motor current, voltage, and/or horsepower ratings are scheduled on the drawings. The following drive ratings shall also apply:

a. Input power characteristics: Unit shall be capable of continuous operation under the following conditions.

(1) Voltage variation: Plus 10 percent or minus 15 percent, nominal 208 VAC or 480 VAC.
(2) Frequency variation: Plus or minus 5 percent, 60 Hz.
(3) Power factor (input-primary side): 0.95 minimum.

b. Output power characteristics: 0 to Rated Input Voltage, 3-phase, 0 to 120 Hz.

(1) Current: Drive shall be capable of continuous operation at rated full load motor current.
(2) Power factor (output-secondary side): 0.90 minimum.

c. Minimum efficiency: 95 percent at half speed; 97 percent at rated full speed.
d. Overload capability: 110 percent of the normal duty current rating for 60 seconds, and 130 percent for 2 seconds.
e. Short-circuit current (withstand) rating: Minimum 65 kA, without additional input fuses.
f. Audible noise: Motor and VFD combination noise level shall not be increased more than 2 dBA at 3 feet (1m), compared to motor operation from across-the-line motor control.
g. Output carrier frequency: Unit shall have adjustable frequency switching settings up to 4 kHz without derating the drive output characteristics. Drive selection size may be increased to comply.

2. Design: Unit shall consist of the following components and characteristics:

a. Power conversion components: Microprocessor based control.

(1) Rectifier: Solid state, full-wave, diode-bridge rectifier used to convert AC input power to DC power, with metal-oxide-varistor (MOV) surge protection.

(a) Provide 6-pulse drives.

(2) DC bus: DC-bus reactor and capacitor components to minimize reflected harmonics and manage DC power to inverter. Bus shall interface with VFD programmable logic controller, for continuous monitoring and protection of system components, and include short circuit protection and filtering.
(3) Inverter: Insulated-gate-bipolar-transistor (IGBT) type employing pulse-width-modulated (PWM) technology power supplies for sine-code, AC output waveform.

b. Standard power conditioning components: Provide the following power conditioning and filter devices.

(1) Integral, DC link reactor.
(2) Integral, 3-phase, EMI/RFI filter capable of filtering out radio frequency interference (RFI) in the range of 10 kHz to 30 MHz.
(3) Output reactor filters on load side of drive for motor protection where motor length is greater than 100 feet (30.5 m).

C. Construction:

1. Enclosure: UL (NEMA 250) Type 12 according to UL 508; as scheduled on the drawings.
2. Completely assembled and tested by the manufacturer. Listed and labeled as a complete assembly under UL 508C.
3. Furnish each unit with a master nameplate, listing standard manufacturer information including voltage, ampacity, frequency, and short-circuit ratings; manufacturer's model and project designations.

D. Drive features:

1. System interface:

a. Digital display and keypad operator station sealed and located on front of assembly.

(1) Operator interface shall provide complete programming, program copying, operating, monitoring, and diagnostic capabilities.
(2) Operator interface shall include menus and selections to display system characteristics such as metering, program parameters, settings, and messages. Standard displays shall include:

(a) Output frequency (hertz).
(b) Set-point frequency (hertz).
(c) Motor current (amperes).
(d) DC-link voltage (volts-dc).
(e) Motor torque (percent).
(f) Motor speed (rpm).
(g) Motor output voltage (volts).
(h) Historical Information: Displays indicating current time and date, total run time, total power versus time log, and fault log.

(3) Keypad shall include Hand-Off-Auto selections in addition to programming and control keys.
(4) Security access: Capable of preventing access by unauthorized personnel and protecting data and system parameters.

b. System input characteristics capable of accepting remote signals from the Building Automation System (BAS) shall include the following:

(1) Minimum of six programmable, multifunction digital inputs.

(2) Minimum of two programmable analog inputs accepting current or voltage signals for speed reference.
(3) Minimum of one external fault input, programmable for normally open or normally closed contact, used for connection of freeze, fire, smoke contacts, or high pressure limits.

c. System output characteristics including the following:

(1) Minimum of three programmable, multifunction, digital, Form-C type, relay outputs.
(2) Minimum of two programmable analog outputs.
(3) Programmable loss-of-load, Form-C type, relay output dedicated to drive protection under motor failure condition.

2. Building automation system (BAS) interface: Factory-installed or optional card hardware and software package to enable the BAS to monitor, control, and display VFD status, alarms, and energy usage.

a. Network communications: Ethernet based with RS-422/RS-485 communication port.
b. Integral or removable communications card embedded with standard BAS protocols including Johnson Controls, Modbus, Siemens Building Technologies, and BACnet. Additional protocols such as LonWorks, DeviceNet, Ethernet TCP/IP, and Profibus shall be available with the addition of an optional card.

3. Provide separate terminal strip and four auxiliary contacts for connection to remote device providing remote start/stop signals. All interlocks and start/stop contacts shall remain functional whether the drive is in Hand or Auto.
4. Local Communication Port: RS-232 or USB 2.0 for connection of portable computer or peripheral device.
5. Cooling fans: VFD shall incorporate cooling fan system to dissipate heat from assembly to maintain drive temperature control.
6. Control power for drive controls as well as digital inputs and outputs shall be derived from internal power supply or control system power source.

E. Drive functions: The VFD shall include the following functions, either pre-programmed or field-programmed according to project requirements.

1. Minimum of three programmable preset speeds.
2. The ability to automatically reset and restart after an overcurrent, overvoltage, undervoltage, or over-temperature condition; overload fault; loss of phase, or loss of input signal.
3. Capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to programmed set point without drive tripping or component damage.
4. Capable of adjusting acceleration and deceleration ramp control time from 1 to 360 seconds.
5. Equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be 12 cycles (200 milliseconds), based on full load and no inertia. Control logic shall incorporate programmable ride-through with minimum one-second (60 cycles).
6. Stop modes shall be field-selectable allowing the VFD to ramp or coast to a stop.

F. Drive and motor protection: Include the following electrical protection and safety features, factory mounted and wired within the VFD enclosure.

1. Input disconnecting means and overcurrent protective device: Integral, NEMA AB1, thermal magnetic, molded-case circuit breaker, with door interlocked, padlockable handle mechanism connected to input line side of drive.

a. Circuit breaker shall be selected to provide trip-free operation. Breaker trip size and thermal curve shall be selected to allow VFD to operate the motor under continuous running and starting conditions as recommended by the motor manufacturer.

2. Transient voltage surge suppression (TVSS): Integral, system to provide three-phase protection against damage from supply voltage surges.
3. Motor and VFD overload and overtemperature protection: NEMA ICS 2, solid-state, overload relay protection monitoring both motor and VFD characteristics. Relay shall be interconnected with motor thermal couple.
4. Protective relays or functions for the following conditions:

   a. Overvoltage
   b. Undervoltage
   c. Phase loss
   d. Phase reversal
   e. Ground fault

5. Programmable, critical frequency lock-out: Multi-range selection, preventing VFD from operating load continuously at an unstable speed.
6. Control fuses utilized within the drive enclosure shall be 100,000 A current limiting type. Input AC power fusing is not acceptable.

G. Comply with requirements of NEMA ICS 7, NEMA ICS 61800-2, and UL 580C.

2.3 DRIVE CONTROL AND OPERATION

A. VFD shall operate according to the following scenarios:

1. “Hand”: VFD shall start and speed controlled manually through user interface.
2. “Off”: VFD shall stop or disregard start signal.
3. “Auto”: VFD shall start via external contact closure or control signal reference.

B. VFD shall run at programmable preset speed if input reference signal is lost.

2.4 SOURCE QUALITY CONTROL

A. Test and inspect variable frequency drive units and associated controls according to requirements in NEMA ICS 61800-2 and UL 508C.

1. Perform tests at rated full load to ensure proper operation.
2. Provide three certified copies of factory test reports.

B. Each drive shall undergo a burn-in test at 100 percent inductive or motor load prior to final testing.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine project submittals for compliance with electrical distribution system requirements outlined on the drawings and in electrical specification sections.

3.2 INSTALLATION

A. Install drive units in locations shown on drawings. Equipment shall not be located further from the equipment it serves than the maximum distance recommended by the drive manufacturer.

B. Install wiring between drive and motor in ferrous metallic conduit, with separate conduits for power input, power output, and control wiring.

1. Maintain minimum separation between conduits of 3 inches.

C. Service engineers trained and authorized by the variable-frequency drive manufacturer at the service center shall provide start-up service, including physical inspection of drive and connected wiring and final adjustments to meet specified performance requirements.

3.3 IDENTIFICATION

A. Materials: Identify units, devices, fuse blocks, relays, controls, and wiring. Identify equipment ratings.

B. Nameplates: Provide nameplate for each drive unit and associated components located on front of assembly.

C. Control components mounted within the assembly shall be identified corresponding to designations on manufacturer's drawings using tags and other identification materials.

D. Operating instructions: Provide fabricated frame on side of each unit to house operating instruction manuals.

3.4 FIELD QUALITY CONTROL

A. Test variable frequency drives by operating them in all modes with associated components and motors. Perform tests recommended by manufacturer under supervision of manufacturer's factory-authorized representative. Tests shall include simulation of various building conditions through the ATC/BAS/DDC control system.

B. Coordinate tests with system balancing of fan and pump equipment.

C. Perform mechanical and visual inspection of equipment installation including verification of wiring and components, connections, enclosures, and auxiliary devices and components.

D. Perform testing in compliance with NETA ATS. Perform manufacturer standard tests including the following:

1. Test insulation resistance and circuit continuity for power and control wiring.
2. Verify voltage values follow nameplate ratings at drive input and output terminals.

E. Correct deficiencies and retest equipment until equipment is operational. Report results and identify corrections in writing. Where necessary, replace damaged and malfunctioning equipment.

F. Record field adjustable settings.

3.5 ADJUSTING

A. Program variable frequency drives for required operations as outlined by the mechanical control sequences.

B. Set field-adjustable elements such as switches, relays, timers, and trip devices as required for proper system operation and coordination with related power and control systems.

3.6 CLEANING

A. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Clean components internally using methods and materials recommended by the manufacturer.

3.7 SYSTEM STARTUP

A. Provide factory-authorized service representative to perform startup service.

B. Perform enhanced VFD setup to individually and manually adjust and document VFD parameter settings as appropriate in order to maximize motor operation and serviceable life. Settings shall include, but not be limited to, the following:

1. Phase protection settings (missing phase, one of the motor phases is lost).
2. Motor protection settings (drive response to motor overheating, motor thermal time constant, operating load of the motor, current at zero speed, break point frequency).
3. Wiring protection settings (wiring fault, control board temperature fault, ground fault).

C. Minimum frequency (Hz) shall be set at the lowest frequency allowable without shortening the motor's serviceable life, based on the motor manufacturers' recommendation and the type of use / application of the motor.

D. Settings shall be backed up and turned over to the Owner on a comparable storage and connection device.

E. Submit report listing of parameter settings by factory-authorized service representative after setup is complete

3.8 OPERATING INSTRUCTIONS

A. As specified in Sections 26 0500, provide operating instructions.

B. Provide at least two sessions of four consecutive hours of additional instruction time for each system specified in this section.

END OF SECTION

SECTION 26 3213

GENERATORS, WEATHER-PROTECTED

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Packaged engine generator set for standby, emergency power application including the following:

1. Natural gas engine with electronic generator set controls, governor, and voltage regulator.
2. Located in outdoor, weather-protected, sound-attenuated enclosure.
3. Complete with remote annunciator and generator accessories.

1.2 RELATED SECTIONS

A. Natural gas piping: Section 23 1123.

B. Grounding and bonding: Section 26 0526.

C. Equipment foundations: Section 26 0528.

D. Transfer switches: Section 26 3600.

1.3 REFERENCES

A. ANSI/NECA/EGSA 404: Standard for Installing Generator Sets.

B. CFR Title 40, Protection of Environment.

C. IEEE 115: Test Procedures for Synchronous Machines.

D. IEEE 446: Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

E. NECA/EGSA 404: Standard for Installing Generator Sets.

F. NEMA MG 1: Motors and Generators.

G. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

H. NFPA 30: Flammable and Combustible Liquids Code.

I. NFPA 37: Installation and Use of Stationary Combustion Engines and Gas Turbines.

J. NFPA 70: National Electrical Code.

K. NFPA 110: Emergency and Standby Power Systems.

L. UL 1236: Battery Chargers for Charging Engine Starter Batteries.

M. UL 2200: Stationary Engine Generator Assemblies.

1.4 DEFINITIONS

A. CFR: Code of Federal Regulations.

B. EPA: Environmental Protection Agency.

C. NIST: National Institute of Standards and Technology

D. NSPS: New Source Performance Standards.

1.5 SUBMITTALS

A. Product data: For each type of packaged generator set indicated. Include rated capacities, operating characteristics, manufacturers' technical data on features and functions, finishes, and furnished accessories. Include product data for each of the following:

1. Engine generator set.

a. Thermal damage curve for generator.
b. Time-current characteristic curves for generator protective device.
c. Documentation proving that generator(s) provided have sufficient starting kVA to start the loads under any load sequence.

2. Generator accessories including batteries and battery charger, silencer, and jacket heater.
3. Remote alarm annunciator panel.
4. Enclosure components and accessories.

B. Bill of materials: Provide detailed list of components.

C. Shop drawings: For each type of generator set and related equipment, detail assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design calculations: Calculate requirements for designing vibration isolation bases.
3. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring diagrams: Power, signal, and control wiring.
5. Piping schematics for fuel system, lubricating oil, jacket coolant, and cooling water.

D. Source quality-control test reports.

1. Certified summary of performance tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
2. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
3. Report of sound generation.
4. Report of exhaust emissions showing compliance with applicable regulations.

a. Factory certification of compliance with EPA emissions regulations.

E. Field quality-control test reports.

F. Operation and maintenance data: For packaged engine generator sets, accessories, and remote annunciator panel to include in operation and maintenance manuals. In addition to items specified in Division 01, include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
2. Detailed operating instructions for event conditions.
3. Fuel adjustment procedures and maximum tolerances of wear on bearings and other rubbing surfaces that will require corrective measures.

G. Warranty: Certificate of special warranty.

H. Air quality permits: Submit air quality construction and operational permits for Owner record.

1.6 QUALITY ASSURANCE

A. Generator accessories, appurtenances, and installation of the same, shall comply with referenced codes and standards listed in Part 1 and applicable federal, state, and local codes and regulations.

B. Emissions: Equipment shall be certified to U.S. EPA Stationary Emission Regulation, 40 CFR, Part 60.

C. Permits: Serve as the Owner's representative during the application process. Collect generator information, prepare and submit required applications for air quality construction and operational permits required by the State of Maryland Department of the Environment in compliance of state environmental regulations. Include payment for applicable permit costs. Approved permits and registration shall be issued to the Owner.

D. Equipment shall bear UL label, and shall be locally tested by an electrical testing specialist, acceptable to local authority having jurisdiction where required.

E. Source limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

F. Installer qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this project.

1. Installer has training in electrical safety as required by NFPA 70E and is qualified as defined in NEMA PB 2.

G. 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), 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.

H. Service and maintenance agency qualifications: Manufacturer's authorized service and maintenance representative characteristics shall include the following:

1. Located in the Baltimore/Washington, DC metropolitan area.
2. Staff is factory employed and trained.

3. Service available 24 hours a day, seven days a week, 365 days a year.
4. Maintains an adequate stock of manufacturer's genuine or approved parts to service this equipment.
5. Service and maintenance contracts available.

1.7 COORDINATION

A. Obtain interconnection diagrams, interface hardware, accessory components, and installation manual for generator, and other components of the system. Coordinate installation to provide a complete, integrated, operating generator system.

1. Coordinate installation and interface connections with other emergency power supply system equipment.

B. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate terminations of generator fuel piping outside of generator enclosure with locations indicated on drawings.

1.8 PROJECT CONDITIONS

A. Environmental conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient temperature: 5 to 40 deg C.
2. Relative humidity: 0 to 95 percent.
3. Altitude: Sea level to minimum 1000 feet (300 m).

1.9 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: Five years from date of substantial completion.
2. Warranty shall include all parts and labor with no deductible.

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. Fuses: One for every ten of each type and rating, but no less than one of each.
2. Indicator lamps: One for every five of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

1.11 MAINTENANCE SERVICE

A. Initial maintenance service: Beginning at Substantial Completion, provide 12 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. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-design product: Subject to compliance with requirements, provide products manufactured by Cummins Power Generation/Onan, or comparable product by one of the following:

1. Caterpillar; Power Generation
2. Cummins Power Generation/Onan
3. Kohler Power Systems Co.; Generator Division

2.2 GENERATOR SET

A. Generator set characteristics: The generator set system shall comprise a package of equipment including:

1. A natural gas engine and alternator assembly to provide emergency electric power.
2. Generator-mounted start-stop control system with remote control capability.
3. Mounted accessories as specified.
4. Factory-assembled and -tested, engine-generator set.

B. Generator set ratings:

1. Duty rating shall be based on emergency/standby service.
2. Operate at 1800 rpm and 480/277 volts AC, 3-phase, 4-wire, 60 hertz.
3. The generator set shall be rated at values indicated on the drawings at 0.8 pf based on the project conditions listed in Part 1.

C. Performance characteristics:

1. The engine-generator set shall be able to handle the starting step load effects of the connected equipment. Each automatic transfer switch shall be considered a step unless otherwise indicated.
2. Generator set characteristics shall not exceed the following:

a. Starting voltage dip: 30 percent.
b. Peak voltage dip: 15 percent.
c. Frequency dip: 15 percent.
d. Voltage regulation (random): Plus or minus 0.5 percent of rated output voltage.
e. Frequency regulation (steady-state): Isochronous.
f. Frequency regulation (random): Plus or minus 0.25 percent of rated frequency from no load to full load.

3. AC output waveform: Distortion at no load measured line-to-line or line-to-neutral.

a. Total harmonic distortion (THD): Less than 5 percent
b. Singe harmonic: Less than 3 percent.
c. Telephone influence factor (TIF): Less than 50, as determined by NEMA MG 1.
d. Telephone harmonic factor (THF): Less than 3, as determined by IEC 60034.

4. 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.
5. Sustained short-circuit current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
6. Start time: Comply with NFPA 110, Type 10, system requirements.
7. Excitation system: Performance shall be unaffected by voltage distortion caused by nonlinear load.

D. Engine:

1. Natural gas engine: Four-cycle, natural gas with fan and water pump. It shall have the number cylinders and minimum displacement to achieve required brake horsepower rating at 1800 rpm.

    a. Carburetor.
    b. Secondary gas regulators.
    c. Fuel-shutoff solenoid valves.
    d. Flexible fuel connectors.
    e. Natural gas source pressure shall be 7 to 11 inches H_2O for proper operation.

E. Generator: Three-phase, single bearing, synchronous type built to NEMA MG 1 standards.

1. Alternator: Brushless, 4-pole, 2/3 pitch windings, 125 degrees C standard temperature rise. Class H insulation shall be used on the stator and rotor, and both shall be further protected with 100 percent epoxy impregnation and an overcoat of resilient insulating material on end coils to protect against fungus or abrasion. The alternator shall incorporate a resettable thermal protector for exciter/regulator protection. The alternator shall be twelve lead, wye connected.
2. Regulator: Permanent magnet excitation for power source to voltage regulators, solid-state controlled, exciter/regulator, matching the characteristics of the alternator and engine. Voltage regulation with adjustable electronic isochronous governor. Readily accessible voltage droop, voltage level, and voltage gain controls shall be provided. The solid state regulator module shall be shock mounted and epoxy encapsulated for protection against vibration and atmospheric deterioration.
3. The subtransient reactance of the alternator shall not exceed 12 percent, based on the standby rating of the generator set.

F. Mounting:

1. Unit shall be capable of installation on rail system within enclosure base and include vibration isolation as required.

G. Cooling system: Closed loop, liquid-cooled system with engine mounted radiator and blower type fan, sized to maintain safe operation at 104 degrees F (40 degrees C) maximum ambient temperature. The radiator shall be equipped for a duct adapter flange connected to exterior cabinet with flexible connection.

1. Centrifugal jacket water pump: Built on the engine and driven from the engine crankshaft or camshaft, ample capacity to circulate the required flow of engine jacket water through the radiator to remove the total heat rejected from the engine to the jacket water and lubricating oil at 110 percent rated load in 104 degrees F (40 degrees C) ambient while maintaining the

optimum jacket water temperature leaving and entering the engine recommended by the engine manufacturer.

2. Thermostatic control valve: Shall maintain constant water temperature to the engine. Provide modulating type thermostatic valves using self-contained thermostats without external bulbs. Provide valves with one or more interchangeable thermostatic elements. Provide nonadjustable type thermostat with operating temperature factory set at the temperature recommended by the engine manufacturer. Design valve so that in event of thermostatic element failure it will fail safe, permitting water flow through the engine.

H. Fuel system: Natural gas.

1. Fuel system shall consist of the following fuel supply:

a. Uninterrupted natural gas fuel supply specified in Section 23 1123.

I. Exhaust system:

1. Provide a silencer, including flexible exhaust fitting, properly sized and installed according to the manufacturer's recommendation. Mounting shall be provided by the installing contractor. The silencer shall be mounted so that its weight is not supported by the engine.

a. Muffler/silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

(1) Minimum sound attenuation of 25 dB at 500 Hz.
(2) Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 85 dBA or less.

2. Exhaust pipe size shall be sufficient to ensure that exhaust backpressure does not exceed the maximum limitations specified by the generator set manufacturer.

J. Automatic starting system:

1. Starting motor: DC electric starting system with positive engagement drive. The motor voltage shall be as recommended by the engine manufacturer.
2. Automatic controls: Fully automatic generator set start-stop controls in the generator control panel. Controls shall provide shutdown for low oil pressure, high water temperature, overspeed, and overcrank; and one auxiliary contact for activating accessory items. Controls shall include a multi-cycle, cranking limit with lockout contacts for starting by switch on remote panel.

K. System accessories:

1. Jacket water heater: Unit mounted thermal circulation type water heater incorporating a thermostatic switch, capable of maintaining engine jacket water to 90 degrees F in ambient temperature of minus 10 degrees F. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
2. Starting and station batteries: Lead-acid storage battery set of the heavy duty starting type. 24Vdc battery voltage shall be compatible with the starting system. The battery set shall be of sufficient capacity to provide for 1 1/2 minutes total cranking time without recharging. Include a battery rack and necessary cables and clamps.
3. Battery charger: UL 1236 listed. Engine starting, current limiting battery charger to automatically recharge batteries. The charger shall have adjustable float and equalize voltage. DC amperage output shall be no less than 10 amperes. Output voltage shall be

compatible with starting system. AC input voltage shall be 120V. Charger shall include fused overload protection; circuit breaker overcurrent protection; solid-state, silicon diode full wave rectifiers; voltage surge suppressors; DC voltmeter and AC ammeter; temperature voltage regulator; relays indicating AC power failure, low-, and high-battery voltage.

L. Generator control panel:

1. Type: Generator mounted NEMA 250 Type 1, vibration isolated, dead front, made of sheet metal gauge steel, with lockable hinged door.
2. Panel shall contain, but not be limited to, the following equipment:

    a. Voltmeter, 2 percent accuracy.
    b. Ammeter, 2 percent accuracy.
    c. Ammeter voltmeter, phase selector switch.
    d. Frequency meter, dial type. (45-65 Hz)
    e. Automatic starting controls.
    f. Voltage level adjustment rheostat.
    g. Dry contacts for remote alarms wired to terminal strips.
    h. Fault indicators for low oil pressure, high water temperature, overspeed, and overcrank.
    i. Three position selector switch with the following functions: auto, manual, off/reset.
    j. Emergency stop switch.
    k. Panel light.
    l. Running time meter
    m. Oil pressure and water temperature gauges

3. Remote outputs for monitoring.

M. Generator output circuit breaker(s):

1. Type: Molded-case circuit breaker and molded-case electronic trip type, and size as indicated on drawings. Circuit breaker shall conform to standards established by UL 489, and NFPA 70. Circuit breaker trip elements shall have inverse time delay for overload conditions and instantaneous magnetic tripping for short-circuit protection. Circuit breaker shall have long-time and short-time pick-up and delay, and instantaneous adjustable trip settings.
2. The circuit breaker trip curve shall be coordinated with alternator thermal damage curve as required by generator manufacturer data.

    a. Generator/exciter field circuit breakers do not meet the specified electrical standards and are unacceptable for line protection.

3. Shunt trip device: The shunt trip shall open the generator circuit breaker in the event of an engine shutdown signal, and shall operate from the cranking battery voltage.
4. Circuit breakers shall be lockable in the open position.

2.3 GENERATOR ENCLOSURE

A. Manufacturer’s standard enclosure: Prefabricated weather-resistant, sound attenuated enclosure sized to house the generator, battery charger, batteries, and required accessories. Enclosure shall be factory-assembled by the generator manufacturer.

B. Sheet metal steel enclosure primed with corrosion protection and painted with electrostatically-applied powder coat finish of manufacturer’s standard color. Enclosure shall include roof, side walls, and end walls. Hardware shall be stainless steel.

1. Lifting provisions: Capacity to support total assembly weight during rigging.

2. Access doors: Provide sufficient access for maintenance and operation from outside the enclosure.

    a. Handles key lockable, all doors keyed alike.

3. Air intake and sound attenuation louver openings shall be screened to limit entry of rodents.
4. Roof shall be designed to prevent collection of rainwater.
5. Provide factory-mounted exhaust silencer inside the enclosure. Exhaust shall exit the enclosure through a rain collar and terminate at a rain cap. Exhaust connections to the generator set shall be made with seamless flexible connections.

C. Sound attenuation: Enclosure shall be constructed to mitigate noise level to 85 dBA maximum at 23 feet (7 m) from enclosure at rated generator output.

D. Accessories:

1. Enclosure manufacturer shall provide the hardware required to mount the exhaust silencers while maintaining the enclosure's weather resistance.

2.4 EXTERNAL VIBRATION ISOLATION DEVICES

A. Elastomeric isolator pads: Oil- and water-resistant elastomer, arranged in single or multiple layers, molded with a non-slip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Double layer, standard neoprene.

2.5 REMOTE ALARM ANNUNCIATOR PANEL

A. Surface-mounted panel, complying with the requirements of NFPA 110, Level 1 equipment, providing visible and audible alarm signals powered by the storage battery of the generator. Unit enclosure: Fabricated of sheet steel, with removable front panel. The front panel shall contain LED type indicating lamps (visible signals) as listed below. The enclosure shall contain the required printed circuits, internal wiring, terminal block and battery voltage sensors. Provide knockouts for external wiring through bottom of box.

B. Provide on face of panel the following switches:

1. Lamp test pushbutton.
2. Audible alarm: Silence switch.

(See schedule, next page)

LAMP LEGEND	GENERATING SET CONDITION INDICATED	DERANGEMENT SIGNALS	
		Audible	Visible
EXERCISING	Generator exercising	No	Yes
GENERATING	Generating Power to Load	Yes	Yes
OVERCRANK	Failed to Start	Yes	Yes
LOW ENG TEMP	Low Lube Oil Pressure	Yes	Yes
HI ENG TEMP PRE	Excessive Engine Temperature Pre-Alarm	Yes	Yes
HI ENG TEMP	Excessive Engine Temperature	Yes	Yes
LOW OIL PRESS PRE	Low Lube Oil Pressure Pre-Alarm	Yes	Yes
LOW OIL PRESS	Low Lube Oil Pressure	Yes	Yes
OVERSPEED	Engine Overspeed	Yes	Yes
LOW FUEL	Low Fuel Supply	Yes	Yes
LOW COOLANT	Low Engine Coolant Level	Yes	Yes
AUTO SWITCH	Control Switch Not in Automatic Position	Yes	Yes
LOW CRANK VOLT	Low Engine Cranking Voltage	Yes	Yes
LOW BATT VOLT	Low Battery Voltage	Yes	Yes
HI BATT VOLT	High Battery Voltage	Yes	Yes
ALARM CONTACT	Contacts for Common Alarm	Yes	Yes

2.6 MONITORING SYSTEM

A. Monitoring system: Provide contacts from generator for monitoring by the power monitoring system for the following functions:

1. Generator off.
2. Generator running.
3. Generator exercising.
4. Generator alarms: Overcrank, low oil pressure, high or low engine temperature, overspeed, batteries.

B. Provide control interface for monitoring the generator status through the building fire alarm system.

2.7 SYSTEM OPERATION

A. Loss of normal power:

1. System is given signal to start by one of the automatic transfer switches or a remote device. Loss of power can occur at any automatic transfer switch, which can cause the generator to start. On receipt of this signal, generator shall automatically start, accelerate to rated frequency and build up to rated voltage.
2. Priority shall be set to actuate the automatic transfer switch designated in the following order:

a. ATS-1: Life-Safety.
b. ATS-2: Standby.

3. After the first transfer switch closes to the bus, subsequent transfer switches shall close to the bus after pre-determined time delays.

B. Failure of generator to start:

1. If a unit fails to start, after the overcrank time delay (in the generator set control) has expired, the unit will be shut down, and an alarm will sound.

C. Return of normal power:

1. When normal power has been restored to the normal power system bus and sensed at each transfer switch, the loads shall be transferred back to normal source.
2. The generator shall operate until all transfer switches have returned to normal power switch position and operate at no load for a cool-down period. When the cool-down period has been completed, the generator shall shut down.
3. If a system start signal is received during the cool-down period, generator shall remain online and operate as described in “Loss of Normal Power” above.

2.8 SOURCE QUALITY CONTROL

A. Prototype testing: Perform factory performance tests using prototype generator of same engine model and alternative configuration, and assembled with like components and accessories. Provide three certified copies of the successful test reports.

1. Tests: Comply with NFPA 110, Level 1, energy converters in Paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2.
2. Alternator tests: Comply with IEEE 115.
3. Equivalent components and accessories: Submit evidence that items furnished with the unit, but that are not identical to those on the prototype, are reliable and compatible with the application.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine rough-in requirements for connecting piping and wiring for generator and verify conditions. Verify actual sizes and locations of connections are correct before packaged engine-generator installation.

3.2 PREPARATION

A. Battery equalization: Equalize charging of battery cells according to manufacturer’s written instructions.

3.3 INSTALLATION - GENERATORS

A. Install generators, complete with controls, accessories, and enclosure, as indicated on the drawings and in accordance with manufacturer’s recommendations.

B. Comply with generator manufacturer’s written installation and alignment instructions and with NFPA 37 and 110.

C. Install the remote alarm annunciator panel where indicated on drawings.

D. Set generators plumb and level on concrete base. Secure to anchor bolts installed in the concrete base.

E. Install generators so as to provide access for maintenance and service, including removal of drivers and accessories.

F. Install piping, wiring, accessories, and appurtenances in accordance with the applicable specifications and manufacturers' recommendations. Ground equipment.

G. Comply with applicable portions of NECA 404.

H. Generator and enclosure accessories shall be connected to the building electrical distribution system via branch circuits and feeders as indicated on drawings.

I. Verify proper fuel pressure for natural gas engines.

3.4 IDENTIFICATION

A. Materials: Identify units, devices, fuse blocks, relays, controls, and wiring. Identify equipment ratings.

B. Nameplates: Provide nameplate for each unit and associated components located on front of assembly.

C. Control components mounted within the assembly shall be identified with tags and other identification materials, and correspond to designations on manufacturer's drawings.

D. Operating instructions: Provide fabricated frame on side of unit to house operating instruction manuals.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's field service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections; and to assist the Contractor in testing.

B. Tests and inspections:

1. Perform tests recommended by manufacturer. Perform electrical tests and visual and mechanical inspection (except those indicated to be optional) for "AC Generators and or Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. NFPA 110 acceptance tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
3. Battery tests: Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

4. Battery-charger tests: Verify specified rates of charge for both equalizing and float charging conditions.
5. System integrity tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks. Retain subparagraph below for long, restricted exhaust systems.
6. 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.
7. 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.
8. 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, and compare measured levels with required values.

C. Coordinate generator testing with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

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

H. Remove and replace malfunctioning units; retest and reinspect as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. The unit shall operate without undue noise or vibration, or excessive heating. Correct defects and retest until unit is operating satisfactorily.

K. Demonstrate satisfactory operation of each feature required of the generator set and accessories.

L. Test emergency power system: After completion and acceptance of the generator tests, perform an operational test of the emergency power system. Perform a power failure test on the emergency electrical system. This shall be performed by interrupting the normal power source and verifying proper generator start and transfer switch operation.

M. Report results of tests and inspections in writing. Record adjustable device 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.

3.6 ACCEPTANCE TESTING

A. In addition to the factory and field tests required in Part 2, perform a scheduled on-site test and demonstration of the completely installed generator before making final electrical connections.

B. Test shall be witnessed by the Engineer, and Owner's representative, and manufacturer's representative. Manufacturer's representative shall conduct demonstrations.

C. Provide and utilize load bank for testing. Load banks shall be capable of providing full load at 0.8 power factor.

D. Test procedures: Test the generator in accordance with NFPA 110 and as follows:

1. Test the generator for at least four hours under full load, starting and stopping at least five times.

a. The unit shall operate without undue noise or vibration, or excessive heating. Correct defects and retest until unit is operating satisfactorily.
b. Demonstrate satisfactory operation of each feature required of the generator set and accessories.

3.7 CLEANING

A. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Clean components internally using methods and materials recommended by the manufacturer.

3.8 OPERATING INSTRUCTIONS

A. As specified in Section 26 0500, provide operating instructions.

B. Provide at least one session of four consecutive hours of additional instruction time for each system specified in this section.

END OF SECTION

SECTION 26 3600

TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Automatic transfer switches rated 600 V and less, including:

1. Automatic transfer switch with open transition operation and microprocessor-based controls.

1.2 RELATED SECTIONS

A. Generators: Section 26 3213.

1.3 REFERENCES

A. NFPA 110: Emergency and Standby Power Systems.

B. UL 1008: Transfer Switch Equipment.

1.4 SUBMITTALS

A. Product data: Include assembly ratings and dimensioned plans, sections, and elevations showing minimum clearances, cable termination sizes, conductor entry, gutter space, installed features and devices, and material lists for each switch.

B. Bill of Materials: Provide detailed list of components.

C. Shop drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each transfer switch specified. Wiring diagrams showing detail wiring for transfer switch, differentiating between manufacturer-installed and field-installed wiring, and including power and control wiring.

1. Single-Line Diagram: Show connections between transfer switch, power sources and load.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Certifications:

1. Product certificate signed by manufacturer certifying that products furnished comply with requirements and that switches have been tested for applicable load ratings and short-circuit closing and withstand ratings.
2. Manufacturer's test reports showing that controllers meet the specified requirements.
3. Evidence that manufacturer, installer, and equipment meet the requirements specified in "Quality Assurance" below.

G. Operation and Maintenance Data: For transfer switches and associated components, provide product data, shop drawings, and test reports in operation and maintenance manual. In addition to items specified in Division 01, include the following:

1. Features and operating sequences, both automatic and manual

1.5 QUALITY ASSURANCE

A. Transfer switches shall comply with UL 1008. Where specified requirements exceed requirements of UL 1008, switch shall meet the stricter requirements.

B. Qualifications of manufacturer: Maintain a factory-authorized service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

C. Qualifications of supplier/installer:

1. Staff factory-trained and -authorized in the installation, testing, and operation of the specified equipment.
2. Provides emergency service on call 24 hours a day, seven days a week.
3. Maintains an adequate stock of manufacturer's genuine or approved parts to service this equipment.
4. Has service contracts available which can meet requirements specified for the equipment of this project.

1.6 COORDINATION

A. Coordinate layout and installation of switches 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.

C. Coordinate location of underslab conduit.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store switches indoors in clean dry space with uniform temperature to prevent condensation. Protect switches from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.8 PROJECT CONDITIONS

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

1. Notify Owner no fewer than ten days in advance of proposed interruption of electrical service. Provide applicable details of proposed outage including sequence of work and methods of providing temporary electrical service.
2. Do not proceed with interruption of electrical service without written permission.

1.9 WARRANTY

A. Special warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of 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.
2. Warranty shall include all parts and labor.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis-of-design product: Subject to compliance with requirements, provide products manufactured by Onan/Cummins Power Generation, or comparable product by one of the following:

1. General Electric / Zenith Controls, Inc.
2. Kohler Power Systems Co.; Generator Division
3. Onan/Cummins Power Generation

2.2 GENERAL TRANSFER SWITCH REQUIREMENTS

A. Equipment shall be based on the following: 480/277 volts, 3-phase, 4-pole; Level 1 equipment according to NFPA 110; rated in accordance with UL 1008 for continuous loading and total system transfer; suitable for motor, resistance heating, electric-discharge lighting, and tungsten filament lamp loads.

B. Tested Fault-Current Closing and Withstand Ratings (3 cycles): Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Provide transfer switches with withstand ratings as indicated on one-line diagram.

C. Neutral Switching. Provide neutral pole switched simultaneously with phase poles on four-pole transfer switches.

D. Enclosure: NEMA 250, Type 4X; NEMA ICS 6; and UL 508.

E. Terminal block: Termination of all auxiliary contacts, switches, pilot lights, and appurtenances mounted in transfer switch enclosure.

F. Clearly label and identify each indicating light and switch as to its purpose or function.

G. Heater: Provide switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

2.3 AUTOMATIC TRANSFER SWITCH

A. Ratings: Unit ratings involving ampacity, number of poles, and withstand close rating are indicated on drawings.

B. Switching arrangement:

1. Delayed, Open Transition Transfer Operation: Double-throw design, with break-before-make capability. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in both the normal and emergency positions without the use of hooks, latches, magnets, or springs.

a. ATS-1: Life safety.
b. ATS 2: Standby.

2. Switch Characteristics:

a. Designed for continuous-duty, repetitive transfer of full-rated current between active power sources.

b. The contact driving system shall be mechanically held and electrically operated by a single motor operator.
c. Contacts: Silver alloy, capable of making or breaking any load within the rating of the switch.

(1) Contacts that close to start the engine generator: Include a time delay of transfer switch and engine starting signals, factory set at 5.0 seconds (adjustable from 0-5 minutes).

d. Interlocked, molded case circuit breakers or contactors are not acceptable.

C. Controls: Microprocessor-based controller integrally mounted in the transfer switch with all components and wiring accessible from the front.

1. Tested and rated as follows:

a. For storage at temperatures from minus 25 to plus 85 degrees C.
b. For operation:

(1) At minus 20 to plus 70 degrees C.
(2) At 0 to 99 percent humidity, non-condensing.
(3) Withstands infinite power interruptions.
(4) Withstands surges when tested in accordance with ANSI/IEEE C37.90.1.

2. Include a real-time clock with nickel-cadmium battery backup.
3. Monitoring: On both normal and emergency sources, include three-phase over or under voltage, over or under frequency, and phase sequence detection, and phase differential monitoring.
4. Communications: Industry standard open-architecture communication protocol for high-speed serial communications via multidrop connection to other controllers and to a master terminal with up to 4000 feet of cable, or farther with the addition of a communication repeater.

a. Serial communication port: RS422/485 compatible

5. Self-diagnostics: Shall perform periodic checks of the memory I/O and communications circuits, with a power failure circuit.
6. Password protection shall limit access to designated personnel.
7. Operation: Keypad with multi-character liquid crystal display.
8. Memory / Flash-backup: Accessible both locally and from remote controller, including:

a. Number of hours transfer switch has been in the emergency position (total since reset).
b. Number of transfers in either direction (total since reset).
c. Date, time, and description of the last 4 source failures.
d. Date of the last exercise period.
e. Date the record was reset.

D. Provide close differential voltage sensing of all phases of both the normal and alternate sources of power. Factory settings preset for:

1. Dropout at 87 percent of nominal voltage (adjustable 75-98 percent)
2. Pickup at 95 percent of nominal voltage (adjustable 85-100 percent).

E. The transfer of the load shall occur only if the alternate source has attained factory setting of 95 percent of nominal voltage (adjustable 85-100 percent) and 95 percent of nominal frequency (adjustable 90-100 percent) and the transfer to alternate time delay has expired. The time delay

shall be factory set for 5 seconds and adjusted in the field to comply with system priority requirements outlined in Part 2 below. (Field adjustable range of 0 to 2 minutes.)

1. Upon return of the normal source to within the limits of the voltage sensor, the switch shall retransfer to the normal source after a retransfer to normal time delay. The time delay shall be factory preset for 15 minutes. (Field-adjustable range of 0.5 to 30 minutes.) Retransfer shall be a closed-transition operation. A synch-check function shall confirm synchronization prior to retransfer.

F. Time delay for engine generator cooldown: Unloaded, running, factory-set at 5 minutes (adjustable 0-5 minutes).

G. Indicating lights: LED type. Green, indicating that the normal source is connected to the load, and red, indicating that the alternate source is connected to the load.

H. Test switch: Simulates a normal source outage.

I. Reset switch: To manually retransfer the automatic transfer switch to the normal source, except that retransfer shall occur automatically if alternate source fails.

J. In-phase monitor control for transfer and retransfer of motor loads.

K. Automatic exerciser with load for 0.5 hour monthly. The automatic exerciser function shall be enabled in one transfer switch selected by the Owner.

L. Relay protection:

1. Full-phase voltage on normal side.
2. Three-phase voltage frequency on generator side.

M. Auxiliary contacts: Provide number of sets of auxiliary contacts necessary to initiate generator starting and interface with Owner monitoring system.

N. The transfer switch shall have the following programming functions available:

1. Block transfer to emergency source.
2. Load shedding.
3. Peak-shaving.

O. The transfer switch shall control the load functions.

2.4 TRANSFER SWITCH OPERATION AND EMERGENCY SYSTEM PRIORITY

A. Priority Status: Transfer switch priority shall apply as follows:

1. ATS-1.
2. ATS-2.

B. Transfer to Generator Source: Switches shall transfer to emergency power source in order of priority status listed above. In the event that the emergency source cannot generate enough capacity to carry the total emergency system load, switches shall transfer in decreasing order of priority until system capacity is reached. Switches can later be transferred to the emergency source if additional capacity is available. Field adjust the time delay settings to achieve system transfer of loads as follows:

1. ATS-1: Use factory setting or 5 seconds, whichever is less. Total system transfer time shall

not exceed 10 seconds per NFPA 110.
2. ATS-2: Time delay: 30 seconds.

C. Generator Failure: In the event generator system power is not sufficient to carry the loads of each emergency branch, transfer switches shall open and shed load in reverse priority order.

D. Transfer Back to Normal Source: Switches shall transfer back to normal source in reverse priority order as follows:

1. Delayed, Open Transition Operation – When the normal source has been restored and is within the pre-selected ranges for voltage and frequency, and after an adjustable time delay to ensure the integrity of the normal power source, the load shall be transferred back to normal source in a break-before-make transfer scheme. The generator set will continue to run for a user adjustable time to allow the generator set to run unloaded for cool down, after which the engine will be shut down. Upon completion, the system will then be ready for automatic operation.

2.5 REMOTE ANNUNCIATOR SYSTEM

A. Remote annunciator panel:

1. Functional Description: Annunciate conditions at each transfer switch including the following indications:

a. Source availability, both Normal and Emergency sources, as defined by actual pickup and dropout settings of transfer-switch controls.
b. Switch position.
c. Switch in test mode.
d. Failure of communication link.

2. Features: LED-lamp indicators with audible signal and silencing switch.

a. Indicating Lights: Grouped for each transfer switch monitored.
b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
c. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
d. Lamp Test: Push-to-test or lamp-test switch on front panel.

B. Malfunction of annunciator or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.

2.6 SOURCE QUALITY CONTROL

A. Factory-test 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 in accordance with NEMA ICS 1.

B. As a condition of approval, the manufacturer of the automatic transfer switches shall verify that their switches are listed by Underwriters Laboratories, Inc., Standard UL-1008 with 3-cycle short circuit closing and withstand as follows:

Amperes	Closing and Withstand	Current Limiting Fuse Rating
100-400	42,000	200,000
600-800	65,000	200,000
1000-1200	85,000	200,000
1600-4000	100,000	200,000

Where available fault current levels exceed closing and withstand ratings listed above, provide integrally mounted current-limiting fuses to meet this rating.

C. During the 3-cycle closing and withstand tests, there shall be no contact welding or damage. The 3-cycle tests shall be performed without the use of current limiting fuses. The test shall verify that contacts separation has not occurred, and there is contact continuity across all phases. Test procedures shall be in accordance with UL-1008, and testing shall be certified by Underwriters' Laboratories, Inc.

D. When conducting temperature rise tests to UL-1008, the manufacturer shall include post-endurance temperature rise tests to verify the ability of the combination transfer bypass/isolation switch to carry full rated current after completing the overload and endurance tests.

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.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install transfer switches on concrete equipment foundations (housekeeping pad).

1. Anchor equipment to concrete housekeeping pad according to manufacturer’s written instructions and requirements in other sections of Division 26.
2. Install each unit level and plumb.

B. Maintain minimum clearances and workspace at equipment according to manufacturer’s written instructions and NFPA 70.

C. Install in accordance with national, state, and local codes, and manufacturer's instructions.

D. Include items not specifically mentioned but necessary for proper operation.

E. Connect wiring as indicated on the drawings and in accordance with manufacturer's recommendations.

F. Identify components.

3.2 CONNECTIONS

A. Ground equipment according to Division 26 Section “Grounding and Bonding.”

B. Wiring to Remote Components: Provide type and number of cables and conductors in raceway as recommended by manufacturer between emergency distribution system components for control and communication requirements.

3.3 IDENTIFICATION

A. Materials: Identify units, devices, fuse blocks, relays, controls, and wiring. Identify equipment ratings.

B. Nameplates: Provide nameplate for each switch and major control or display component located on front of assembly.

1. Furnish master nameplate, stamped metal, listing standard manufacturer information including voltage, ampere, frequency, and short-circuit ratings; manufacturer’s model and project designations.

C. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be identified corresponding to designations on manufacturer’s drawings using tags and other identification materials.

3.4 FIELD QUALITY CONTROL

A. Test transfer switches and components by operating them in all modes. Perform tests recommended by manufacturer under supervision of manufacturer's factory-authorized representative. Tests shall include simulation of building power outages to verify coordination of transfer timing sequences with switchgear.

B. Correct deficiencies and report results in writing. Record adjustable relay settings.

C. Coordinate tests with tests of generator plant and run them concurrently.

3.5 CLEANING

A. Inspect and clean surfaces and repair damaged finishes to match original finish.

B. Clean interior of equipment according to manufacturer's instructions.

3.6 OPERATING INSTRUCTIONS

A. As specified in Section 26 0500, provide operating instructions.

B. Provide a period of 4 hours for equipment instruction to operating personnel.

C. Coordinate this instructional training with that for generator equipment.

END OF SECTION

SECTION 26 5600

EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fixtures.

1.2 RELATED SECTIONS

A. Conduits: Section 26 0533.

B. Wires and cables: Section 26 0519.

1.3 DEFINITIONS

A. Bracket: An attachment to a standard, on which a luminaire is carried.

B. Luminaire: A lighting device consisting of a light source together with its direct appurtenances, including globe, reflector, refractor, housing, and such support as is integral with the housing. The standard and the bracket are not part of the luminaire.

1.4 SUBMITTALS

A. Product data: Submit for each type of fixture, pole and standard.

1. Type
2. Wattage
3. Voltage
4. Efficiency
5. Suspension
6. Glassware
7. Finished diameters
8. Mounting heights
9. LED drivers
10. Appurtenances

B. Shop drawings shall show complete dimensions of complete assembled unit with accessories. Include wiring diagrams, showing clearly manufacturer-installed and field-installed wiring.

1.5 QUALITY ASSURANCE

A. UL label and local testing (if required): As specified in Section 26 0500, Common Work Results for Electrical.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-design products: Fixtures indicated in the Fixture Schedule on the drawings are the basis of design of the project.

1. Subject to compliance with requirements, provide the scheduled products. Unnamed products will only be considered and approved according to bidding and Contracting requirements and Division 01 requirements for substitutions.

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

1. LED drivers:

a. EldoLED
b. Lutron
c. Osram Sylvania
d. Philips/Advance
e. Universal Lighting Technologies

2.2 EXTERIOR LIGHTING FIXTURES

A. Provide lighting fixtures of sizes, types, and ratings scheduled, complete with, but not limited to, housings, drivers, starters, and wiring.

2.3 LED DRIVERS

A. Driver shall operate from a 120-volt or 277-volt, 60-Hz input power source and be suitable for outputting power to 12-volt or 24-volt LED lamp sources, as required.

B. Drivers, where specified, shall be capable of being dimmed. Dimmable drivers shall be controlled by a Class 2 low-voltage 0-10VDC controller.

C. Performance criteria:

1. Driver shall have a Class A sound rating.
2. Driver shall have a power factor (PF) greater than 0.90.
3. Driver shall have Total Harmonic Distortion (THD) of input current equal to or less than 20 percent.

D. Driver shall meet FCC and Title 47 CFR regulations for EMI/RFI.

E. Driver shall comply with ANSI C62.41 Class A requirements for transient protection.

2.4 LAMPS

A. Lamps, LED:

1. The LED manufacturer shall provide the quantity and wattage of LEDs required to achieve the defined lighting output set forth by the lighting fixture manufacturer.
2. LED lamps shall be integrated into an engineered package for the specific lighting fixture application, including heat dissipation components.
3. Color temperature: As specified in lighting fixture schedule, with a tolerance of plus or minus 100K and within a range of three macadam ellipses. Noticeable color temperature variations between adjacent lighting fixtures shall be considered a failure to meet these specifications and shall be replaced at no cost to the Owner.
4. Minimum performance characteristics:

a. Life: Minimum lumen maintenance of L70 at 50,000 hours, as defined by IES LM-80.
b. Lumen output: Based on absolute photometry, lumens (total luminous flux exiting the physical luminaire), as specified on contract drawings and schedules.
c. Color rendering index: Rated at 85 or higher.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install accessories and fixtures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NFPA 70, NESC and NEMA standards, and with recognized industry practices.

3.2 ADJUSTING AND CLEANING

A. Clean lighting fixtures of dirt and debris upon completion of installation.

B. Protect installed fixtures from damage during construction period.

3.3 DEMONSTRATION

A. Upon completion of installation of exterior lighting fixtures, and associated electrical supply circuitry, apply electrical energy to circuitry to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION

SECTION 28 3100

FIRE DETECTION AND ALARM SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Provide modifications to existing fire detection and alarm system.

B. Costs of certification and testing, including tests required by NFPA 72, shall be included in the contract sum.

1.2 DEFINITIONS

A. FACP: Fire alarm control panel.

B. Definitions in NFPA 72 apply to fire alarm terms used in this section.

1.3 SUBMITTALS

A. General:

1. When approved, no variation will be permitted except with the approval of the Engineer.
2. Submit to the authority having jurisdiction and to the Engineer for review and approval.

B. Shop drawings:

1. System operation description: Detailed description for this project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
2. Wiring diagrams and riser diagrams.

C. Product data: Schedule and each type of system component, including dimensioned plans and elevations showing minimum clearances and installed features and devices. Include UL listings.

D. Certifications:

1. UL Certificate of Compliance of system supplier as specified in "Quality Assurance" below.
2. Fire and smoke detection system inspection and test report, completed by the factory representative, endorsed by the Owner and the factory representative, including test data, detector locations and serial numbers, a summary of maintenance performed, recommendations for relocation or addition of detectors and final action regarding these recommendations, and system certification.

1.4 QUALITY ASSURANCE

A. System and equipment shall be UL listed. Each major component shall bear the manufacturer's name and catalog number.

B. UL labels and local testing (if required).

C. Single-source responsibility: Obtain system components from a single source who assumes responsibility for their compatibility.

D. Qualifications of system supplier and installer:

1. Staff shall consist of at least one NICET Level IV Technician or a professional engineer registered in Maryland.
2. Has installed at least ten systems of the type specified which have performed satisfactorily for not less than two years.
3. Maintains a facility with a sufficient stock of spare parts.
4. Shall respond within 24 hours of notification to correct system failure or malfunction. During the project correction period defined in General Conditions, perform such corrections at no addition to the Contract Sum.

E. Factory-authorized service representative: Trained and certified by the manufacturer of the system, and experienced in the installation and operation of the type of system included in the work.

F. Comply with NFPA 72, applicable local codes, and regulations and requirements of the authorities having jurisdiction. Howard County is the local code authority.

1.5 SEQUENCING AND SCHEDULING

A. Existing fire alarm equipment: Maintain fully operational until new equipment has been tested and accepted.

1. Field verify existing system is fully operational before beginning work on the existing components. If existing system is not fully operational immediately notify the Owner and Engineer in writing, and do not perform any work on the existing system until directed by the Engineer.
2. As new equipment is installed, label it NOT IN SERVICE until new equipment is accepted. As equipment is put in service, remove label and label existing equipment NOT IN SERVICE until it is physically removed.

B. Disconnected equipment: Remove equipment and restore damaged surfaces.

1. Operational disconnected equipment: Package, label, and deliver to Owner.

1.6 INSPECTIONS AND SERVICE CONTRACT

A. During the general project correction period, every six months starting six months after Substantial Completion, the supplier shall inspect and test the system.

1. Submit written reports to the Owner and Engineer, describing test results, including defects found and how they have been corrected, and listing components replaced.

B. At the end of the correction period, offer the Owner a service contract for the complete system.

PART 2 - PRODUCTS

2.1 EXISTING SYSTEM

A. Existing FACP is by Edwards Systems Technology, (EST) Inc. Model EST-2. Provide devices compatible with existing fire detection and alarm system.

2.2 ADDRESSABLE INTERFACE DEVICE

A. Monitor module: Microelectronic monitor module listed for use in providing a system address for external alarm-initiating devices with normally open contacts.

1. Dual circuit, intelligent, signaling circuit interface module.

2.3 WIRE AND WIRING SYSTEM

A. Non-power-limited circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-voltage circuits: No. 16 AWG, minimum.
2. Line-voltage circuits: No. 12 AWG, minimum.

B. Power-limited circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.

C. Wiring system: Class B in accordance with NFPA 72.

D. Survivability: Circuits necessary for the operation of notification appliances shall be protected by a 2-hour fire-rated cable, a 2-hour fire-rated cable system, or a 2-hour fire-rated enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Factory-authorized service representative, as required in "Quality Assurance" in Part 1 above, shall supervise installation, software documentation, adjustment, preliminary testing, final testing, and certification of the system, and provide the operating instructions.

B. Provide wiring, conduit, and outlet boxes required for the complete system, in accordance with system manufacturer's instructions and with requirements specified in Division 26 for wiring, conduit, and boxes. Provide 12 inches of slack at each outlet.

1. Install wiring in conduit.
2. Identification: Paint fire alarm junction box covers red.

C. Wires, cables, conduits, and wiring connections are specified in Division 26, Electrical. Include in the work of this section, wiring, conduits, and equipment connections complying with the requirements of Division 26, so that the fire alarm system will function as specified and indicated on the drawings.

D. Wiring: Free from grounds or crosses between conductors.

1. Identification: Color code wiring, not duplicating building wiring colors. Tag each wire at each junction point.

E. Final connections between equipment and the wiring system shall be made under the direction and supervision of the qualified supplier.

3.2 INSPECTION, TEST, ADJUSTMENT AND REPORT

A. Furnish equipment and appliances for testing the complete system during progress of the work and after completion of the installation, including a megger test of wiring. The tests generally shall demonstrate the following:

1. Circuits are continuous and free from short circuits.

2. Circuits are free from unspecified grounds.
3. Resistance to ground of non-grounded circuits is not less than one megohm.
4. Circuits are properly connected in accordance with the applicable wiring diagrams.
5. Each detector operates correctly.
6. Detectors are correctly located and sufficient in number.

B. Defects or omissions observed during general and system tests shall be repaired as quickly as possible and the tests reconducted.

C. Submit report as required in Part 1 above.

END OF SECTION

SECTION 31 2300

EXCAVATION AND FILL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Trenching, backfilling, and compacting for electrical work underground inside the building and extending five feet beyond exterior building walls, and outside the building as shown on drawings.

1.2 RELATED SECTIONS

A. Cutting and patching: Section 01 7329.

B. Repairing pavements: Section 32 0129.

C. Underground electrical ductbanks: Section 33 7119.

D. Conduit: Section 26 0533.

1.3 REFERENCES

A. ASTM D 1557: Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbs/cu ft (2,700 kN-m/cu m).

1.4 SUBMITTALS

A. Product data: Warning tape.

B. Certifications: Test reports showing that compaction meets specified requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Backfill: Earth materials, free from perceptible amounts of wood, debris, or topsoil, free of frost at the time of placement, and not containing marl or other elements which tend to stay in a plastic state.

B. Underground warning tape: Polyethylene 0.004 inch (0.102 mm) thick for metallic lines, and for non-metallic lines polyethylene both sides with metallic lining, six inches (152 mm) wide.

1. Colors: In accordance with APWA and AASHTO standards.
2. Markings: Repeated continuously along the entire length, legend appropriate for line being identified.

2.2 EQUIPMENT

A. Mechanical tampers for compacting backfill: Capable of exerting a blow equal to 250 pounds per square foot (12 kPa) of area of the tamping face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Contact local utility company underground information service (BGE Miss Utility) before beginning excavation outside buildings.

B. The general locations of underground utilities are indicated on the drawings and are not to be assumed to be accurate or complete. Before beginning work, field check the area with the most accurate instruments available, such as Fisher Labs' Pipe and Cable Locators.

3.2 INSTALLATION

A. Perform all excavating, cutting of paved areas, trenching, sheeting, shoring, backfilling, and compacting required for the proper installation of the work. Repair of pavement is specified in Section 32 0129.

B. Where obstructions are encountered, obtain written approval and make necessary changes in line, grade or location.

C. Protect existing utilities from damage during excavation and backfilling. Repair damaged new or existing work at no addition to the contract sum. Bracing, shoring and other protection of existing utilities is part of this work.

D. Do not damage or remove existing shrubs or trees including their root systems, without prior notification to the Engineer.

E. Provide temporary roadways over trenches with railings and other safeguards, including amber blinker lamps or other warnings for night use.

F. Note the depths of footings. In cases where conduit is in close proximity to or below footings and where the natural earth under footings is disturbed, after the line is installed the voids shall be filled up to bottoms of such footings with solid concrete.

3.3 CUTTING

A. Cut concrete and asphalt concrete with masonry saw prior to breaking it into smaller pieces for removal.

B. Cut sidewalks perpendicular to the length at the closest existing joint that is a minimum of 24 inches back from either side of the top of the new trench.

3.4 TRENCHING

A. Excavations inside the building shall be carefully planned. Stockpile excavated earth so as not to interfere with other construction. Dig trenches to the proper depths, providing extra depressions where required for hubs of pipes.

B. Excavations outside the building shall generally follow the routes indicated on the drawings. Stockpile topsoil separately for later replacement. Excavations shall be of sufficient depths to provide, unless indicated otherwise on the drawings, a minimum cover as follows:

1. Electrical conduit: Depth required by NFPA 70 (NEC).

C. Trenches shall be of necessary depth and width for the proper laying of conduit with a minimum of 8 inches (205 mm) on each side of the joint.

1. The sides shall be as nearly vertical as practicable. Unless local regulations are more strict, trenches 4 ft. (1220 mm) and deeper shall have shored sides as required by OSHA trenching regulations.

2. The bottoms of trenches shall be accurately graded to provide uniform bearing and support for each section of conduit on undisturbed soil at every point along its entire length, except for bell holes and for the proper sealing of the pipe joints.
3. No greater length of trench shall be left open, in advance of the completed structure placed in it, than can be completed in that day's operation.
4. Except where rock is encountered, do not excavate below the depths required. Where rock excavation is required, excavate to a depth of at least 6 inches (150 mm) below the trench depth and fill the overdepth with compacted crusher run or bank run stone or sand. Unauthorized overdepths in excavation shall be backfilled with crushed stone, slag or gravel, thoroughly compacted.
5. Whenever wet or otherwise unstable soil is encountered, it shall be removed to the depth and extent directed, and the trench backfilled to the proper grade with crushed stone, slag or gravel.

D. Should springs be encountered within the work area, or soft soil conditions at the elevations required for load bearing, immediately notify the Engineer and do not place any portion of the work on such surfaces until instructions are received.

E. Furnish and maintain pumps, flumes, gutters, and appurtenances if required to keep the excavations free from water. Water shall be directed to a point remote from building operations, shown on the approved shop drawing.

3.5 BACKFILL

A. Place no backfill until the adjacent construction or the utility to be covered has been inspected, tested, and approved.

B. Installing underground warning tape: Install in backfill above exterior buried lines not encased in concrete. Select legend and color appropriate for type of line. Install metallic lined tape for non-metallic lines. Install approximately 12 inches (305 mm) below grade.

C. Electrical systems backfill:

1. Backfill and compact in eight-inch (200-mm) layers, to level finished grade with the excavated materials approved for backfilling.
2. Surplus earth shall be mounded up on excavation and left to settle. When directed by the Engineer, surplus earth shall be removed and excavations leveled off to proper grade. Where direct burial cables are placed in trenches, first cover the cables with clean earth.

D. Structure backfill:

1. Do not backfill against structures with cement mortar joints until the mortar is at least twelve hours old.

3.6 COMPACTION

A. Test in accordance with the requirements of ASTM D 1557.

B. Compact under slabs, roads, and sidewalks to a 95 percent density.

C. Compact unpaved areas to a 90 percent density.

D. Backfill and compact trench in unpaved areas to within 4 inches (102 mm) of existing grade. Furnish and install compacted select topsoil for the final layer to finish even with existing grade. Remove surplus earth and rake unpaved areas for final planting.

E. Take particular care in compaction of earth under joints of mechanical piping.

3.7 RESURFACING

A. Resurface sidewalks, roads, streets, and other paved areas as work of this section, matching the construction and finish of adjacent paving. Paving shall meet the requirements of Section 32 0129.

END OF SECTION

SECTION 32 0129

PAVEMENT REPAIR

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Repairing asphalt and parking lots.

1.2 RELATED SECTIONS

A. Cutting and patching: Section 01 7329.

1.3 SUBMITTALS

A. Product data:

1. Proposed mix design for each type of paving material.
2. Material certificates for paving materials.
3. Joint fillers and sealers.

1.4 QUALITY ASSURANCE

A. Use locally available materials and gradations with a satisfactory record of previous installations.

B. Engage a testing laboratory acceptable to Engineer to perform material evaluation tests and to design mixes.

1.5 PROJECT CONDITIONS

A. Weather limitations:

1. Apply asphalt prime and tack coats when ambient temperature is above 50 degrees F. (10 degrees C) and when temperature has not been below 35 degrees F. (1 degree C) for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.
2. Construct hot-mixed asphalt surface course when atmospheric temperature is above 40 degrees F. (4 degrees C) and when base is dry. Base course may be placed when air temperature is above 30 degrees F. (minus 1 degree C) and rising.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforcing bars: ASTM A 615, Grade 60 (Grade 420), deformed.

B. Bonding compound: Polyvinyl acetate or acrylic base, rewettable.

C. Coarse aggregate for asphalt: Sound, angular, crushed stone or crushed gravel complying with ASTM D 692.

D. Fine aggregate for asphalt: Sharp-edged natural sand or sand prepared from stone, gravel, or combinations thereof, complying with ASTM D 1073.

E. Asphalt cement: ASTM D 3381 for viscosity-graded material; ASTM D 946 for penetration-graded material.

F. Prime coat: Medium-curing cutback asphalt type, ASTM D 2027; MC-30, MC-70 or MC-250.

G. Tack coat: Emulsified asphalt; ASTM D 977.

H. Portland cement: ASTM C 150, Type I or Type II.

I. Moisture-retaining cover: Polyethylene film or polyethylene-coated burlap.

J. Antispalling compound: Boiled linseed oil and mineral spirits, complying with AASHTO M-233.

K. Hot-poured elastomeric sealant: Manufacturer's standard sealant for concrete and asphalt pavement joints, complying with ASTM D 3405.

L. Joint filler: Preformed strips, complying with ASTM D 1751, asphalt impregnated fiberboard, or other as compatible with sealants.

2.2 ASPHALT-AGGREGATE MIXTURE

A. Provide plant-mixed, hot-laid asphalt-aggregate mixture complying with ASTM D 3515 and as recommended by local paving authorities to suit project conditions.

B. Base course: CR-6 aggregate meeting requirements of MSHA Article 32.08.

C. Bituminous surface course: MSHA Specification B.

PART 3 - EXECUTION

3.1 PREPARATION

A. General: Do not proceed until subgrade is firm, hard and unyielding, and at the elevation to result in correct finish grades.

B. Asphalt prime coat: Apply at rate of 0.20 to 0.50 gallon per square yard, over compacted subgrade. Apply material to penetrate and seal, but not flood, surface. Cure and dry as long as necessary to attain penetration and evaporation of volatile.

C. Asphalt tack coat: Apply to contact surfaces of previously constructed asphalt or Portland cement concrete and surfaces abutting or projecting into hot-mixed asphalt pavement. Distribute at rate of 0.05 to 0.15 gallon per square yard of surface.

1. Allow to dry until at proper condition to receive paving.

D. In applying bituminous materials, do not smear adjoining concrete surfaces. Remove and clean damaged surfaces.

3.2 PLACING ASPHALT PAVEMENT

A. Place hot-mixed asphalt mixture on prepared surface, spread, and strike off. Spread mixture at minimum temperature of 225 degrees F. (107 degrees C). Place areas inaccessible to equipment by hand. Place each course to required grade, cross-section, and compacted thickness.

B. Joints: Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density, and smoothness as other sections of hot-mixed asphalt course. Clean contact surfaces and apply tack coat.

C. Curbs: Construct curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust.

1. Place curb materials to cross-section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms as soon as material has cooled.

3.3 ROLLING ASPHALT PAVEMENT

A. General: Begin rolling when mixture will bear roller weight without excessive displacement.

B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.

C. Breakdown rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling and repair displaced areas by loosening and filling if required, with hot material.

D. Second rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been evenly compacted.

E. Finish rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained 95 percent laboratory density.

F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot-mixed asphalt. Compact by rolling to specified surface density and smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.4 REPAIRS AND PROTECTIONS

A. Repair or replace broken or defective pavement.

B. Protect pavement from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement.

END OF SECTION

SECTION 32 3113

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Galvanized steel chain link fences and gates.

1.2 RELATED SECTIONS

A. Portland Cement Concrete: Division 03.

1.3 SUBMITTALS

A. Product Data:

1. Ports
2. Wire
3. Mesh
4. Manufacturer's standard details of fence and gate installation

B. Shop Drawings:

1. Details of site-specific fence and gate installation

1.4 STORAGE AND PROTECTION

A. Store fencing materials and manufactured items supported off ground and protected from weather.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Anchor Fence, Inc.

B. Security Fence Manufacturing and Supply, Inc.

C. Sonco Fence Manufacturing Company

2.2 MATERIALS

A. Wire: Zinc-coated steel, standard industrial weight, nominal diameter of coated wire 0.148 inch.

B. Fabric: FS RR-F-191 Type I - zinc-coated steel, one piece for the full height shown on the drawings.

2.3 GATES

A. Frames: Round members of galvanized steel, assembled with corner fittings and 3.8-inch steel truss rods.

B. Hinges: Size to accommodate gate frame and post, standard type.

C. Latches: Drop bar type, operable from either side of gate, with integral padlock hasp.

2.4 FENCE FRAMING

A. Galvanized steel.

B. Posts: FS RR-F-191, line posts, Class 1, steel pipe.

C. Top Rails and Braces: Class 1, steel pipe. Provide continuous top rail.

D. Equip each gate post, end post, pull post, and both sides of corner posts with brace rails and adjustable 3/8-inch diameter truss rods.

E. Accessories: Caps, rail ends, rail sleeves, wire ties and clips, brace bands, and miscellaneous fasteners as required for a complete installation.

2.5 MISCELLANEOUS MATERIALS

A. Concrete: 3,000 psi when tested at 28 days.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that final grading in fence location is without irregularities which would interfere with the fence installation. Do not commence work until unsatisfactory conditions have been corrected.

3.2 ERECTION

A. Locate line posts at equal distance spacing, not exceeding ten foot centers.

B. Locate corner posts at positions where fence changes direction more than 10 degrees.

C. Posts: Minimum post hole diameter three times outside post diameter. Minimum post hole depth 3 inches below post bottom. Place concrete in hold to depth of post bottom, set post plumb to 0.25 inch in ten feet, fill hole with concrete to two inches above grade, and crown surface of concrete to slope away from post.

3.3 INSTALLATION

A. Fence Fabric: Stretch fabric tight from post to post. Position bottom of fabric approximately 1 to 2 inches above ground level at each post. Cut fabric to form one continuous piece between terminal posts.

1. Attach fabric to terminal posts using tension bars and tension band. Thread tension bars through fabric. Tension band spacing shall not exceed 15 inches on centers.
2. Attach fabric to line posts using wire ties or clips, spacing not to exceed 15 inches on centers.

3. Attach top edge of fabric to top rail using wire ties or clips, spacing not to exceed 24 inches on centers.
4. Attach bottom edge of fabric to bottom tension wire using wire ties or clips, spacing not to exceed 24 inches on centers.

B. Gates: Install plumb and level to a tolerance of 0.25 inch in 10 feet. Install ground-set items in concrete. Adjust hardware to provide smooth operation.

3.4 ADJUSTING

A. Adjust brace rails and tension rods until installation is rigid. Tighten hardware, fasteners and accessories.

END OF SECTION

SECTION 33 7119

ELECTRICAL UNDERGROUND DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Ducts in directly buried duct banks.

1.2 SUBMITTALS

A. Product data: For the following:

1. Conduit and ducts, including elbows, bell ends, bends, fittings, and solvent cement.
2. Ductbank materials, including spacers and miscellaneous components.

B. Shop drawings: Show fabrication and installation details for underground ducts.

1.3 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 ANSI C2.

C. Comply with NFPA 70.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

1.5 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 Engineer and Owner at least ten days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner’s written permission.

1.6 COORDINATION

A. Coordinate layout and installation of ducts, with final arrangement of other utilities and site grading, as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances with final profiles of conduits as determined by coordination with other utilities and underground obstructions.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Available manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Nonmetallic ducts and accessories:

a. ARNCO Corp.
b. Beck Manufacturing Inc.
c. Cantex, Inc.
d. CertainTeed Corp.; Pipe & Plastics Group.
e. ElecSys, Inc.
f. Electri-Flex Co.
g. IPEX, Inc.
h. Lamson & Sessions; Carlon Electrical Products.
i. Manhattan/CDT
j. Spiraduct/AFC Cable Systems, Inc.

2.2 CONDUIT

A. Conduit and fittings are specified in Section 26 0533.

2.3 DUCTS

A. Rigid nonmetallic conduit: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

B. Rigid nonmetallic conduit: NEMA TC 2, Type EPC-80-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

C. Plastic utilities duct: NEMA TC 6, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 9.

2.4 ACCESSORIES

A. Duct spacers: Rigid, nonmetallic, horizontally and vertically interlocking spacers, selected to provide minimum duct spacings and cover depths indicated while supporting ducts during concreting and backfilling.

B. Duct-sealing compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and of adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

C. Warning tape: Underground-line warning tape specified in Section 31 2300, Excavation and Fill.

2.5 CONSTRUCTION MATERIALS

A. Concrete: Use 3000-psi- (20.7-MPa-) minimum, 28-day compressive strength and 0.375-inch (10-mm) maximum aggregate size. Concrete and reinforcement are specified in Division 03 Section “Cast-in-Place Concrete.”

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Underground ducts for electrical cables higher than 600 V: Type EPC-40-PVC concrete-encased duct bank.

B. Underground ducts for electrical feeders 600 V and below: Type EPC-40-PVC, concrete-encased duct bank.

C. Underground ducts for electrical branch circuits 600 V and below: Type EPC-40-PVC, directly buried duct bank.

3.2 EARTHWORK

A. Excavation and backfill: Comply with Section 31 2300, Excavation and Fill, but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work.

D. Restore disturbed pavement. Refer to Section 01 7329, Cutting and Patching.

3.3 CONDUIT AND DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 and away from buildings and equipment.

B. Curves and bends: Use manufactured rigid steel elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet (7.5 m), both horizontally and vertically, at other locations.

C. Use solvent-cement 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 the same plane.

1. Concrete-encased ducts: Install reinforcement in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.

D. Concrete-encased, nonmetallic ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator installation: Space separators close enough to prevent sagging and deforming of ducts and secure separators to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Pour each run of envelope between manholes or other terminations in one continuous operation. If more than one pour is necessary, terminate each pour in a

vertical plane and install 0.75-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
3. Reinforcement: Reinforce duct banks where they cross disturbed earth and where indicated.
4. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
5. Minimum clearances between ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
6. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in nontraffic areas and at least 30 inches (750 mm) below finished grade in vehicular traffic areas, unless otherwise indicated.

E. Directly buried ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator installation: Space separators close enough to prevent sagging and deforming of ducts.
2. Install expansion fittings as shown on shop drawings.
3. Trench bottom: Continuous, firm, and uniform support for duct bank. Prepare trench bottoms as specified in Section 31 2300, Excavation and Fill.
4. Backfill: Install backfill as specified in Section 31 2300, Excavation and Fill. After installing first tier of ducts, backfill and compact. Repeat backfilling after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, complete backfilling normally.
5. Minimum clearances between ducts: 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.
6. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade, unless otherwise indicated.

F. Warning tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank.

G. Stub-ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete bases, extend steel conduit a minimum of 5 feet (1.5 m) from edge of base. Install insulated grounding bushings on terminations. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete.

H. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

I. Pulling cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.

3.4 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts.

B. Duct integrity: 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 the duct. If obstructions are indicated, remove obstructions and retest.

C. Correct installations if possible and retest to demonstrate compliance. Remove and replace defective products and retest.

3.5 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