ST. TAMMANY PARISH

MICHAEL B. COOPER
PARISH PRESIDENT

August 29, 2024

Please find the following addendum to the below-mentioned BID.

Addendum No.:3

Bid#: 24-31-2

Project Name: West St. Tammany Regional Sewer Treatment Facility

Bid Due Date: September 4, 2024

Receipt of this addendum shall be acknowledged by inserting its number in the space provide on the Bid Form.

GENERAL INFORMATION:

1. A request for prior approval was submitted for an alternate generator vendor (Gillette). There was insufficient information provided to adequately determine "or equal" status of the alternate product. Therefore, the alternate vendor is NOT pre-approved. This does not mean the alternate products will not be approved for use on this project. Products submitted for approval during construction that meet the specifications will be considered at that time.
2. A request for prior approval was submitted for alternate lighting fixtures. There was insufficient information provided to adequately determine "or equal" status of the alternate products. Therefore, the alternate products are NOT pre-approved. This does not mean the alternate products will not be approved for use on this project. Products submitted for approval during construction that meet the specifications will be considered at that time.
3. Specification Section 01590 – Field Offices: This section is hereby added to the Bid Proposal documents.
4. Specification Section 02800 – Sewers and Appurtenances: remove the section included in Addendum #1 in its entirety and replace with the revised section included herein.
5. Specification Section 03300 – Cast-in-Place Concrete: remove the section included in Addendum #1 in its entirety and replace with the revised section included herein.
6. Specification Section 16060 – Grounding and Bonding for Electrical Systems: remove this section in its entirety and replace with the revised section included herein.
7. Specification Section 16230 – Engine Generators: remove this section in its entirety and replace with the revised section included herein.

8. Drawing Sheet S-1 – Add the following to the General Sheet Notes:
   7. No structural concrete components shall be poured until dimensions have been confirmed with approved equipment vendor shop drawings.
9. Drawing Sheet S-4 – Add the following to the General Sheet Notes:
   7. Gable ends shall be sheathed with Hardie Panel siding.
   8. Soffits shall be sheathed with vented Hardie Soffit.
10. Drawing Sheet E-10 – Add the following to the General Notes:
    D. Maintain minimum 3'-6" clearance in front of MCC.

QUESTIONS & ANSWERS:

QUESTION 1: Will concrete resistivity testing be required on this project?
ANSWER 1: No. Concrete resistivity testing is not required.

QUESTION 2: Spec section 16230 2.08 calls for a docking station for connection to a portable load bank. This is not shown on the electrical plans or one-line. Please advise if this is needed for this project.
ANSWER 2: A load bank docking station is not required.

QUESTION 3: Please confirm if lightning protection is needed. Detail 5 on sheet E-16 is a detail for an air terminal, however, there is no mention of lightning protection on any other drawings and there is not a spec section for lightning protection.
ANSWER 3: Lighting protection is required for the pump building and the generator. Contractor shall secure the services of a certified lighting protection contractor/consultant to provide a certified lighting protection system for same. Include in bid cost.

QUESTION 4: Section 03300 of the specs calls for epoxy coated rebar, is this correct or an error?
ANSWER 4: Epoxy coated rebar is not required.

QUESTION 5: Spec section 02800, 2.02, C calls for piping to have cement lining & fusion bonded epoxy lining, but manufacturers are not able to install epoxy lining on top of cement lining. The fitting manufacturer also informed us that they can do P-401 lining with N69 prime coat, but cannot do FBE ID with N69 prime coat. If FBE is needed on fittings the ID & OD would have to be coated & they are telling us that they aren't able to supply prime coat on top of FBE. Will you accept cement lining for the discharge/station piping & fittings? If cement lining is not acceptable, will you allow P-401 or PL-90 lining in lieu of FBE?
ANSWER 5: P 401 lining is preferred. Section 02800 has been revised accordingly.

QUESTION 6: The specifications call out for all the piping located within the wet well to be ductile iron flanged piping. The plans call out for this material to be stainless steel. Please clarify which is correct?
ANSWER 6: The suction pipe material is stainless steel. See revised Section 02800.

QUESTION 7: Plan sheet M-2 specifies stainless steel suction pipe, but doesn't specify what material the suction bells need to be. Will you allow ductile iron flanged x flare fittings with coating specified in spec section 09960, 2.02, B, or is the intent for the suction bells to be stainless steel as well?
ANSWER 7: The suction bell can be ductile iron coated per 09960.

QUESTION 8: Spec section 09960, 2.02 B, 3 calls for Series 435 Perma-Glaze primer & finish coat, but some manufacturers are unable to supply Series 435 Perma-Glaze primer. They are proposing Tnemec N69 primer as alternate, which is compatible with Series 435 Perma-Glaze finish coat. Will you allow Tnemec series N69 primer as alternate to Series 435 Perma-Glaze for the ductile iron spools & fittings?
ANSWER 8: Series 435 is self-priming. The same coating material is used for primer and finish coat.

QUESTION 9: Section 2.02 on page 16230-4 of the specs calls for exhaust emissions to comply with EPA Tier 3. Section 2.03 of the same page calls for emissions to comply with EPA Tier 4. Which one applies?
ANSWER 9: The emission requirement is for Tier 4.

QUESTION 10: Section 2.04 on page 16230-6 of the specs calls for the fuel to be DF-2. Is there a reason this needs to be military grade fuel, can this run off of regular diesel, DF-1?
ANSWER 10: DF-2 is standard diesel fuel. That is the intended fuel requirement.

QUESTION 11: What type of finish is required at the gable and soffits? Plans show CMU to about 14', but does not indicate the material above that point. Does the CMU go all the way up the gable, or will it stop at 14' and then hardiboard (or some type of different finish) go up the gable end? What type of Insulation is required?
ANSWER 11: Gable ends shall be sheathed with Hardie Panel siding and soffits shall be sheathed with vented Hardie Soffit. Insulation is not required.

QUESTION 12: Is there a ceiling in the pump room or are we doing exposed trusses?
ANSWER 12: Exposed trusses

QUESTION 13: Please provide a spec and size for louvers shown on Sheet S-1.
ANSWER 13: The louvers are specified in Section 15700.

QUESTION 14: There have been several requests for prior approval for alternate vendors that were not pre-approved with follow up questions requesting what information is required for prior approval.
ANSWER: 14: It is incumbent on the vendor requesting prior approval to prove definitively that their item meets the specification. In order to do this, the vendor must supply an exhaustive list based on the specifications denoting how their proposed product or equipment meets or exceeds each requirement of the specification. None of the items submitted for prior approval on this project have met that standard. This does not mean the alternate products will not be approved for use on this project. Products submitted for approval during construction that meet the specifications will be considered at that time.

ATTACHMENTS:

1. **Specification Section 01590 – Field Offices**
2. **Revised Specification Section 02800 – Sewers and Appurtenances**
3. **Revised Specification Section 03300 – Cast-in-Place Concrete**
4. **Revised Specification Section 16060 – Grounding and Bonding for Electrical Systems**
5. **Revised Specification Section 16230 – Engine Generators**

End of Addendum #3

SECTION 01590 – FIELD OFFICES

PART 1 -- GENERAL

1.1 FIELD OFFICES

A. Field offices shall be established on the job site at location approved or directed by the ENGINEER, adequately furnished, and maintained in a clean, orderly condition by the CONTRACTOR. The CONTRACTOR or an authorized representative shall be present in the field office at all times while work is in progress. Instructions received there from the ENGINEER shall be considered as delivered to the CONTRACTOR.

B. CONTRACTOR shall provide a separate building of at least 100 sq ft of floor space for the exclusive use of the ENGINEER throughout the period of construction. The temporary office shall be weathertight, have a tight floor at least 8-in off the ground and shall be insulated all around with rigid insulation board not less than 1/2-in thick and suitably ventilated. The office shall have at least three screened windows capable of being opened, a screen door and a solid door provided with cylinder lock and three keys. The lock shall have a separate key from the CONTRACTOR's facilities. The office shall be provided with janitor service (at least once a week), sewage disposal, heating and air conditioning equipment, electrical wiring, outlets and fixtures suitable to light the tables and desk adequately as directed. Provide separate toilet facilities for the exclusive use of the ENGINEER.

C. CONTRACTOR shall furnish their separate field office as necessary for their day-to-day operations.

D. CONTRACTOR shall provide the following furniture and equipment in the ENGINEER's field office:

1. One plan table, 3-ft by 5-ft and one (1) stool
2. Desk about 3-ft by 5-ft with desk chair
3. Two (2) additional chairs
4. Coat rack and hooks
5. Air Conditioner (6,000 BTU/minimum)
6. Trash can and trash bags.
7. All paper products for use with the office equipment and sanitary facilities.
8. Supply all fuel for heating and pay all electrical bills.
9. An approved, suitably constructed and equipped trailer of proper size may be furnished for the ENGINEER's office.

1.2 TEMPORARY TELEPHONE AND INTERNET SERVICE

A. Provide high speed internet access in the ENGINEER's field office (minimum 3.0 MBPS bandwidth DSL, or equal).

B. Pay all cost for installation, maintenance and removal of the high-speed Internet and instruments.

1.3 TEMPORARY LIGHT AND POWER

A. Furnish temporary light and power, complete with wiring, lamps and similar equipment as required to adequately light all office areas. Make all necessary arrangements with the local electric company for temporary electric service and pay all expenses in connection therewith.

B. Provide properly configured NEMA polarized outlets to prevent insertion of 110-120 Volt plugs into higher voltage outlets.

C. Provide grounded extension cords. Use "hard-service" cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if more than one length is required.

D. Provide general service incandescent lamps as required for adequate illumination. Provide guard cages or tempered glass enclosures where exposed to breakage. Provide exterior fixtures where exposed to moisture.

1.4 FIRE EXTINGUISHERS

A. Provide portable UL-rated, Class A fire extinguishers for field offices.

1.5 LAYOUT OF FIELD OFFICES

A. Before starting the work, the CONTRACTOR shall submit to the ENGINEER his requirements for field offices. Where onsite space is limited, the allocation of the available space will be made by the ENGINEER. Should the CONTRACTOR require space in addition to that allocated, the CONTRACTOR shall make his own arrangements for storage of materials and equipment in locations off the construction site. For the allocated space, the CONTRACTOR shall submit to the ENGINEER for approval, his proposed plan and layout for all temporary offices.

1.6 REMOVAL OF FIELD OFFICES AND TEMPORARY UTILITIES

A. At such time or times any field offices are no longer required for the work, the CONTRACTOR shall notify the ENGINEER of his intent and schedule for removal of same, and obtain the Engineer's approval before removing the same. As approved, the CONTRACTOR shall disconnect and/or dismantle the field office and utilities and remove them from the site as his property. The CONTRACTOR shall leave the site in such condition as specified, as directed by the ENGINEER, and/or as shown on the Plans.

B. In unfinished areas, the condition of the site shall be left in a condition that will restore original drainage, evenly graded, seeded or planted as necessary, and left with an appearance equal to, or better than original.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01590

SECTION 02800

SEWERS AND APPURTENANCES

PART 1 - GENERAL

1.01. WORK INCLUDED

A. This section covers the construction of the buried piping, lift station piping, and appurtenances.

B. Included in this section are force mains, access hatches, and lift station piping. Sheeting, shoring and bracing of excavations is covered in Section 02160 – Sheeting, Shoring, and Bracing. Valves, couplings, and adapters are covered in Section 15100 – Valves and Appurtenances.

C. The Contractor shall furnish all materials, equipment, transportation, tools and labor necessary and complete the system in substantial conformance with the lines, grades, and locations shown on the Drawings.

1.02. REFERENCED SPECIFICATIONS

A. Those parts of the referenced specifications which are applicable hereto shall be considered as if written herein in full.

B. ASTM: American Society of Testing Materials.

C. AWWA: American Water Works Association.

D. ASA: American Standards Association.

PART 2 - PRODUCTS

2.01. FOUNDATION, EMBEDMENT, & BACKFILL

A. Embedment Material shall be a non-plastic, granular, siliceous material with 100% passing the ½ inch sieve, 75 – 100% passing the No. 10 sieve and 0 to 10% passing the No. 200 sieve, free of trash, roots and weeds and other deleterious materials.

B. Backfill material shall be as indicated on the Drawings.

2.02. FORCE MAIN AND LIFT STATION PIPING

A. Below Grade Piping

1. Below grade force main shall be PVC.

a. PVC pipe sizes 4”-12” shall conform with ANSI/AWWA C900 with a dimension ratio (DR) of 18 and rated working pressure of 150 psi. Fittings shall be ductile iron mechanical joint. Megalug Series 2000 PV Mechanical Joint Restraint shall be used at ductile iron fittings to PVC pipe joints. EBAA Series 1500 joint restraint shall be used at PVC to PVC joints. Where additional joints require restraint, the length of restrained joint pipe shall be as indicated on the drawings. Mechanical Joint fittings shall meet the requirements of ANSI A21.11 except as amended by ANSI A-21.51.

b. PVC pipe sizes >12” shall conform with ANSI/AWWA C900 with a dimension ratio (DR) of 21 and rated working pressure of 200 psi. Fittings shall be ductile iron mechanical joint. Megalug Series 2000 PV Mechanical Joint Restraint shall be used at ductile iron fittings to PVC pipe joints. EBAA Series 1500 joint restraint shall be used at PVC to

PVC joints. Where additional joints require restraint, the length of restrained joint pipe shall be as indicated on the drawings. Mechanical Joint fittings shall meet the requirements of ANSI A21.11 except as amended by ANSI A-21.51.

B. Lift Station Piping

1. All rigid station piping located above grade as well as vertical piping transitioning between above and below grade shall be ductile iron flanged piping. Ductile iron flanged pipe shall be in accordance with ANSI/AWWA C115/A21.15, Class 350. Pipe spools shall be shop fabricated with both flanges. Uni-flanges are not acceptable. Nuts and bolts shall be 304 stainless steel. Anti-seize compound shall be applied to all threads. Flange gaskets shall be full face type SBR per AWWA C111. Thickness shall be 1/8-inch unless indicated otherwise.

2. Pump suction piping entering and within the wet well shall be Schedule 10 Stainless Steel with ANSI B16.5 Class 150 flanges compatible with AWWA C115. Each suction pipe shall be furnished in one-piece spools with shop welded flanges.

C. Ductile Iron Piping Lining Requirements

1. Discharge/Station Piping shall be factory coated with P 401 ceramic epoxy coating per manufacturer's standard (minimum 40 mil DFT).

D. Ductile Iron Piping Coating Requirements

1. For buried service applications, the Contractor shall use bituminous coating in accordance with AWWA C151 and C110.

2. For above grade applications, the Contractor shall use primer and final coating in accordance with Section 09960 – Coatings.

PART 3 - EXECUTION

3.01. EXCAVATION

A. Excavations shall be open cuts with vertical sides. Excavated material shall be placed so as not to interfere with public movement or to endanger the trench.

B. No greater length of trench shall be opened in advance of the installed pipe or structure, nor left unfilled to the rear for more than 40 feet, or to such other shorter length as the Engineer shall direct. All open trenches shall be barricaded, fenced, and lighted during non-working hours or when operations are temporarily suspended.

C. If unauthorized excavation is made below the grade required by the plans, the Contractor shall backfill to required grade with embedment material at the Contractor's expense.

D. Excavation includes removal of stumps, roots and logs encountered within the trench, and to a depth of 12" below the bottom of the trench. Excavation below grade to remove an obstruction encountered in the trench section and which may extend below grade and the foundation materials used to fill the undercut shall be paid under the Allowance Item in accordance with Section 01025.

E. The trench width shall be at the dimensions shown on the Drawings.

F. Base slabs for wet wells and manholes shall be constructed on dry, compacted excavation bottoms.

3.02. SHEETING & BRACING FOR PIPELINES

A. Protection of the excavation against caving or settling of the banks shall be the sole responsibility of the Contractor. He shall protect the sides of his excavation by sheeting and bracing as may be necessary to support the trench walls and any adjacent structures and sheeting and shoring shall be such as the nature of the ground and related construction and material storage may dictate.

B. The sheeting and bracing, where indicated on the drawings, is for the purpose of controlling the loading on the pipe only. The Contractor by his operations, the proximity of his equipment to the trench and the weight of this equipment, the location of backfill and construction material relative to the trench, etc. will increase or decrease the possibility of trench wall collapse and is solely responsible for installing the sheeting and bracing necessary to prevent this collapse.

C. All sheeting and bracing left in the trench shall be cut off a minimum of 3 feet below existing ground surface.

D. For sheeting and bracing of excavations for structures, see Section 02160 – Sheeting, Shoring, and Bracing.

3.03. FOUNDATION

A. The foundation shown on the drawings is a minimum design section; the use of additional material will be at the Contractor's expense.

3.04. BACKFILLING

A. Backfilling of piping trenches shall begin as soon as the joints have been made properly and the location of fittings properly recorded.

B. Embedment material shall be placed in the trench on top of the foundation on both sides and over the pipe in accordance with the Drawings.

C. Granular material or select excavated material, as noted on the Drawings, shall be placed over the embedment material in layers not to exceed 12" and each layer tamped and compacted prior to the placement of the next layer.

D. The requirement for embedment and backfilling varies with the relative location of the pipe line to the pavement as shown on the Drawings.

3.05. INSTALLATION OF PIPELINES

A. Contractor, prior to laying pipe, shall verify the location and elevation of tie-ins. Unless indicated otherwise, all pipes shall be installed with 3’-0” minimum cover.

B. Lay pipe to line and grades with bell upgrade. Force mains and waterlines shall be laid to avoid the gravity sewer system and gravity drainage. Unless indicated otherwise, pressure lines shall be installed to be under or over the gravity pipe with both pipes maintaining a minimum 3’-0” of cover and one foot (minimum) separation between the two pipes.

C. Each pipe length shall be clean and laid to form a close joint.

D. All material excavated and all construction material shall be placed so as to interfere as little as possible with public travel.

E. Give free access to fire engines, fire hydrants, water valves, fire alarm boxes, mail boxes and driveways.

F. Protect all poles, posts, gallery supports, signs, etc.

G. Should the location or position of any gas or water pipe, telephone conduit, sewer connection, etc. be such that it is in direct conflict with the work being constructed, then the conflict shall be remedied as follows:

1. For private utilities such as telephone or power lines and poles, the Contractor shall request in writing to the proper utility company that the conflicting item be removed.

2. For public utilities, the Contractor shall notify the utility as soon as the conflict is discovered to request assistance.

3. The Contractor, at the Contractor's expense, shall repair all surface and subsurface structures damaged by the Contractor's actions that cross or are in the trench in such a location as not to directly conflict with the sewer.

4. When a utility, such as a gas pipe line, is shown on the Drawings in proximity to the pipeline to be installed, the Contractor shall carefully find the exact location of this utility and protect it before beginning work on the pipeline.

3.06. CARE & RESTORATION OF STREETS, DRIVEWAYS, ETC.

A. All streets, driveways, parking areas, and sidewalks damaged by the Contractor shall be repaired at the Contractor's expense.

1. If not shown otherwise on the Drawings, concrete for repairs shall contain 6-1/2 sacks of cement per cubic yard, a water reducing admixture and have a maximum slump of 4".

2. If not shown otherwise on the Drawings, repairs of concrete shall be to the nearest joint, or, if approved by the Engineer to a saw cut joint.

3. Repairs shall be of the thickness of the concrete being repaired but not less than 4" for sidewalks, 6" for driveways and 8" for streets, unless otherwise shown on the Drawings.

B. Excavations through yards and grassy areas shall be sodded in accordance with the Specifications.

3.07. TESTING AND ACCEPTANCE

A. See Section 02660 – Testing of Pipelines.

B. All tie-ins to existing water or sewer lines shall be tested prior to back-filling.

END OF SECTION 02800

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to place all cast-in-place concrete, reinforcing steel, forms, waterstops, and miscellaneous related items including sleeves, anchor bolts, inserts and embedded items specified under other Sections.

B. All cast-in-place concrete work shall be performed in accordance with ACI 318 except as hereinafter specified.

1.02 REFERENCE SPECIFICATIONS

A. American Concrete Institute (ACI)

1. ACI 301 Specifications for Structural Concrete for Buildings.

2. ACI 304 Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete.

3. ACI 305 Hot Weather Concreting.

4. ACI 306 Cold Weather Concreting.

5. ACI 308 Standard Practice for Curing Concrete.

6. ACI 309 Standard Practice for Consolidation of Concrete.

7. ACI 318 Building Code Requirements for Reinforced Concrete.

8. ACI 347 Recommended Practice for Concrete Formwork.

9. ACI 350 Concrete Sanitary Engineering Structures.

B. American Society for Testing and Materials (ASTM)

1. ASTM C33 Specification for Concrete Aggregates.

2. ASTM C94 Specification for Ready-mix Concrete.

3. ASTM C150 Specification for Portland Cement.

4. ASTM C260 Specification for Air-Entraining Admixtures for Concrete.

5. ASTM C494 Specification for Chemical Admixtures for Concrete.

C. National Ready-Mixed Concrete Association

Truck Mixer and Agitator Standards

D. U.S. Army Corps of Engineers

CRD-C572 Polyvinyl Chloride Waterstops

1.03 SUBMITTALS

A. Submit to the Engineer for review in accordance with Section 01300 complete shop drawings, working drawings and product data showing placement of forms, form joints, locations of form ties in exposed exterior concrete, rustications, major inserts, and block outs.

B. Submit to the Engineer for review in accordance with Section 01300 the proposed methods of concrete placement, curing, and protection.

C. Submit to the Engineer for review in accordance with Section 01300 the proposed concrete mixes designed within the limits of these specifications, listing the brand and type of cement, source and results of tests of aggregates and admixtures, at least 45 days prior to the beginning of placing concrete.

D. Deliver to the Engineer concrete mix tickets as hereinafter specified.

1.04 QUALITY ASSURANCE

A. The actual acceptance of aggregates and development of mix proportions to produce concrete conforming to the specific requirements shall be determined prior to the placement of any concrete, by means of laboratory tests made with the constituents to be used on the work.

B. The limiting strengths, water-cement ratios and cement factors as shown on Table A shall apply. Maximum water-cement (#/#) for water retaining structures shall be 0.45.

TABLE A

Minimum Comp. Str. psi at 28 days	Maximum Net Water Content gals/100 lbs*	Minimum Cement Factor 100 lbs/cu. yd.**
4000	5.4	5.64
6000	4.5	6.58

* Maximum; decrease if possible. This represents total water in mix at time of mixing, including free water on aggregates, and water in admixture solution.

** Minimum; increase as necessary to meet other requirements. These cement factors apply to "controlled" concrete subject to specific inspection.

C. When high-early-strength Portland cement is permitted, the same strength requirements shall apply except that the indicated strengths shall be attained at seven (7) days instead of twenty-eight (28) days.

D. If, during the progress of the work, it is impossible to secure concrete of the required workability and strength with the materials being furnished, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the desired properties. All changes so ordered shall be made at the Contractor's expense.

E. If, during the progress of the work, the Contractor desires to use materials other than those originally approved, or if the materials from the sources originally approved change in characteristics, the Contractor shall, at his own expense, have made new acceptance tests of aggregates and establishment of new basic mixtures and submit them to the Engineer for approval.

F. Under special circumstances, the Engineer may allow minor deviations from the material requirements specified, provided the resulting concrete quality is not adversely affected or provided a suitable adjustment in cement content is made to compensate for such deviations

without cost to the Owner.

G. Consistency of the concrete as measured by the ASTM Designation C143 shall be as shown in Table B.

TABLE B

	Slump (inches)	
Portion of Structure	Max.	Min.
Pavement and slabs at grade	4	2
Slabs below grade	4	2

H. Concrete shall be of such consistency and mix composition that it can be readily worked into the corners and angles of the forms and around the reinforcement, inserts, and wall castings without permitting materials to segregate or free water to collect on the surface, due consideration being given to the methods of placing and compacting.

I. No excessively wet concrete will be permitted, and if at any time concrete of such consistency beyond the limits of Table B is delivered to the job, the Engineer may direct the Contractor to reject same. No additional water shall be added by drivers of transit-mix trucks except that established for the design. Failure to comply with this requirement shall be justification for rejecting the concrete.

J. The concrete supplier shall submit a certified copy of the mill test certificate showing that the Portland cement used in the batching of all concrete delivered to the project is in conformance with the requirements of these specifications. The mill test certificate shall show point of origin of the Portland cement, type, and shall state that the material is in conformance with these specifications and standard mill practice established by the Portland Cement Association. A mill test certificate shall be supplied for each lot of cement that is used in the manufacture of concrete for this project. Cements not included on the LADOTD approved products list will not be acceptable.

1.05 ACCEPTANCE TESTS

A. Conformity of aggregates to these Specifications, and the actual proportions of cement, aggregates, and water necessary to produce concrete conforming to the requirements set forth in Table A, shall be determined by tests made with representative samples of the materials to be used on the work. Tests will be made by an accredited testing laboratory from the Owner's pre-qualified vendors list in accordance with Section 01410.

B. Cement may be subject to testing to determine that it conforms to the requirements of this Specification. Methods of testing shall conform to the appropriate specification, but the place, time, frequency, and method of sampling will be determined by the Engineer in accordance with the particular need.

C. Samples of fine and coarse aggregates shall be delivered to the laboratory for examination and testing at least three (3) weeks before the Contractor proposes to use them in the work.

D. Water content of the concrete shall be based on a curve showing the relation between water content and seven (7) and twenty-eight (28) day compressive strengths of concrete made using the proposed materials. The curves shall be determined by four (4) or more points, each representing an average value of at least three (3) test specimens at each age, and shall have a range of values sufficient to yield the desired data, including all the compressive strengths called for on the Drawings, without extrapolation. The water content of the concrete to be used, as determined from the curve, shall correspond to the test strengths of the laboratory trial mixtures as shown on Table C.

TABLE C

Design Strength	Minimum Lab Strength 7 Day	28 Days
4000	3500	4600
6000	4000	6000

E. In no case, however, shall the resulting mix conflict with the limiting values for maximum water-cement ratios and minimum cement contents as specified in Table A.

PART 2: PRODUCTS

2.01 MATERIALS

A. Concrete shall be of Portland cement, fine aggregate, coarse aggregate, water and admixtures as specified and shall be ready-mixed, or transit-mixed concrete produced by a plant acceptable to the Engineers. All constituents, including admixture, shall be batched at the central batch plant in accordance with ASTM C-94. Materials shall conform to these Specifications and any State or local specification requirements. Mixtures containing fly ash shall not be acceptable.

B. Cement:

1. Cement for all cast in place concrete shall be a domestic Portland cement (ASTM C150, Type I) or high early strength Portland cement (ASTM C150, Type III) free from injurious water soluble salts or alkalis.

2. High early strength cement may only be used with written approval of the Engineer.

3. Air entraining cements shall not be used.

4. Cement brands shall be subject to approval of the Engineer.

5. Fly ash and slag cements shall not be used.

C. Aggregates:

1. Fine aggregate shall consist of washed inert sand conforming to the requirements of ASTM C33, and the following detailed requirements:

Fineness Modulus	2.30-3.10
Organics	Organic Plate 2, per ASTM 40
Silt	2.0% maximum
Mortar	95% minimum as per ASTM C87 Section10
Soundness	8% maximum loss, using magnesium sulfate, subjected to 5 cycles

2. Coarse aggregate shall consist of well-graded crushed rock or washed gravel conforming to the requirements of ASTM C33 and the following detailed requirements:

Organics	Organic Plate 1, per ASTM C40
Silt	1.0% maximum
Soundness	8% maximum loss, using magnesium sulfate, subjected to 5 cycles

3. The following designated sizes* of aggregate shall be the maximum employed in concrete:

2-inch for plain concrete
1-inch for reinforced sections 10-in and over in thickness
3/4-inch for reinforced sections less than 10-in thickness

D. Water:

1. Water shall be clean and free from injurious amounts of oils, acid, alkali, organic matter, or other deleterious substances.

2. When subjected to the mortar strength test described in ASTM C87, the twenty-eight (28) day strength of mortar specimens made with the water under examination and normal Portland cement shall be at least one hundred percent (100%) of the strength of similar specimens made with distilled water.

3. Potable tap water will normally fulfill the above requirements.

E. Admixtures:

1. A water reducing agent such as Pozzolith, WRDA or equal may be used in all concrete. The admixture shall conform to ASTM C494. Proportioning and mixing shall be as recommended by the manufacturer.

2. Admixtures causing accelerated setting of cement in concrete shall not be used.

3. Air Entrainment admixtures shall not be used.

4. Anti-microbial/Waterproofing admixtures: Incorporate Xypex Bio-San C500, or equal admixture into the concrete to be used in the wet well and influent screen channels at a rate of 1% by weight of cementitious material, and in accordance with manufacturer's instructions.

F. Grout:

1. Grout for setting bearing plates for structural steel, machinery, and other equipment shall be mixed as recommended by the manufacturer to give the necessary consistency for placing and to give a minimum compressive strength of 3,000 lbs. per square inch in three (3) days, and 6,800 lbs. per square inch in twenty-eight (28) days.

2. Non-shrink grout shall be Masterflow 713 as manufactured by the Master Builders Company, Euco N-S by Euclid Chemical Co., Five Star Grout by U.S. Grout Corp., or equal.

G. Reinforcing Steel:

1. Reinforcing bars shall be ASTM A 615, Grade 60 ASTM A 706, deformed bars. Steel reinforcement shall be fabricated according to CRSI's "Manual of Standard Practice.

2. Bar supports, including bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place, shall be manufactured from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice.

PART 3: EXECUTION

3.01 MEASURING MATERIALS

A. Materials shall be measured by weighing except as otherwise specified or where other methods are specifically authorized by the Engineer. The apparatus provided for weighing the aggregates and cement shall be suitably designed and constructed for this purpose. Scales shall have been certified by the local Sealer of Weights and Measures within one (1) year of use. Each size of aggregate and the cement shall be weighed separately. The accuracy of all weighing devices shall be such that successive quantities can be measured to within one percent of the desired amount. Cement in standard packages (sacks) need not be weighed, but bulk cement and fractional packages shall be weighed.

B. Water shall be measured by volume or by weight. The water-measuring device shall be capable of control to ½-percent accuracy. All measuring devices shall be subject to approval. Admixtures shall be dispensed either manually with use of calibrated containers or measuring tanks, or by means of an approved automatic dispenser designed by the manufacturer of the specific admixture.

3.02 MIXING

A. Concrete shall be ready-mixed, or transit-mixed, as produced by equipment acceptable to the Engineer. No hand-mixing will be permitted. Adding water in controlled amounts during the mixing cycle shall be done only with the express approval of, and under the direction of, the Engineer.

B. Ready-mix or transit-mixed concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of rated capacities for the respective conditions as stated on the name plate. Discharge at the site shall be within 1½ hours and within one (1) hour when ambient temperature is above 85°F after cement was first introduced into the mix. Central mixed concrete shall be plant-mixed a minimum of 1½ minutes per batch and then shall be truck-mixed or agitated a minimum of eight (8) minutes. Agitation shall begin immediately after the pre-mixed concrete is placed in the truck and shall continue without interruption until discharge. Transit-mixed concrete shall be mixed at mixing speed for at least ten (10) minutes immediately after charging the truck, followed by agitation without interruption until discharged.

C. All central plant and rolling stock equipment and methods shall conform to ACI 304, ASTM C94, and the latest Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers' Bureau of the National Ready-Mixed Concrete Association.

D. The retempering of concrete or mortar which has partially hardened, that is, mixing with or without additional cement, aggregate, or water, will not be permitted.

E. Attention is called to the importance of dispatching trucks from the batching plant so that they shall arrive at the site of the work just before the concrete is required, thus avoiding excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms.

F. Deliver to the Engineer at the time of each truckload transported to the site a mix ticket, showing at least the following: concrete plant identification, date, quantity of ingredients (including water) added at the batch plant, time of charge, and truck number.

3.03 INSPECTION AND CONTROL

A. The preparation of forms, placing of reinforcing steel, conduits, pipes, and sleeves, batching, mixing, transportation, placing, curing, and testing of concrete shall be at all times under the inspection of the Engineer.

B. The Contractor shall engage the services of an accredited testing laboratory in accordance

with Section 01300 to review the basic mixtures of concrete as required by the specifications, to test field control cylinder specimens, and to conduct other tests as specified herein or as deemed required by the Engineer to ensure the quality of concrete as specified. All tests shall be performed in accordance with the applicable ASTM standard methods.

3.04 FIELD TESTS

A. Sets of four (4) field control cylinder specimens shall be taken for every one-hundred (100) cubic yards of concrete placed. During cold weather concreting, one additional test cylinder shall be taken and cured on the job site under the same conditions as the concrete it represents. Not less than one set of specimens shall be taken on any one day when concrete is being placed. At least one slump test shall be performed for each set of test cylinders taken and for each concrete mixer truck load delivery. All specimens shall be taken in conformance with ASTM C31. When average ultimate twenty-eight (28) day strength of control cylinders in any set falls below the required ultimate strength or below proportional minimum seven (7) day strengths where proper relation between seven (7) and twenty-eight (28) day strengths have been established by tests, proportions, water content, or temperature conditions shall be changed to secure the required strength.

B. The Contractor shall cooperate in the making of such tests to the extent of allowing free access to the work for the selection of samples, providing heated (when required) moist storage facilities for specimens, affording protection to the specimens against injury or loss through his operations, and furnishing material and labor required for the purpose of taking concrete cylinder samples, curing boxes, and shipping boxes.

3.05 CONCRETE APPEARANCE

A. Concrete for every part of the work shall be of homogeneous structure which, when hardened, will have the required strength, durability and appearance.

B. Formwork, mixtures and concrete placement workmanship shall be such that concrete surfaces, when exposed, will require only minimal finishing with no excess honeycombing, voids or irregular color lines.

3.06 FORMS

A. Forms shall be used for all concrete masonry, including footings. Forms shall be so constructed and placed that the resulting concrete will be of the shape, lines, dimensions, appearance, and to the elevations indicated on the Drawings.

B. Forms for all exposed exterior and interior concrete walls shall be plywood with "A" veneer exterior on casting side. Rustications shall be at the location and to the details shown on the Drawings. Moldings for chamfers and rustications shall be milled and planed smooth.

C. Forms shall be made of wood, metal, or other approved material. Wood forms shall be constructed of sound lumber or plywood of suitable dimensions, free from knotholes and loose knots; where used for exposed surfaces, boards shall be dressed and matched. Plywood shall be sanded smooth and fitted with tight joints between panels. Metal forms shall be of an approved type for the class of work involved and of the thickness and design required for rigid construction.

D. Edges of all form panels in contact with concrete shall be flush within 1/32-inch and forms for plane surfaces shall be such that the concrete will be plane within 1/16-inch in four feet (4'). Forms shall be tight to prevent the passage of mortar and water and grout.

E. Forms for walls shall have removable panels at the bottom for cleaning, inspection, and scrubbing-in of bonding paste. Forms for walls of considerable height shall be arranged with tremies and hoppers for placing concrete in a manner that will prevent segregation and

accumulation of hardened concrete on the forms or reinforcements above the fresh concrete.

F. Molding or bevels shall be placed to produce a 3/4-inch chamfer on all exposed projecting corners, unless otherwise shown on the Drawings. Similar chamfer strips shall be provided at horizontal and vertical extremities of all wall placements to produce "clean" separation between successive placements as called for on the Plans.

G. Forms shall be sufficiently rigid to withstand vibration, to prevent displacement or sagging between supports, and constructed so the concrete will not be damaged by their removal. The Contractor shall be entirely responsible for their adequacy.

H. Forms, including new pre-oiled forms, shall be oiled before reinforcement is placed, with an approved nonstaining oil or liquid form coating having a non-paraffin base.

I. Before form material is reused, all surfaces in contact with concrete shall be thoroughly cleaned, all damaged places repaired, all projecting nails withdrawn, all protrusions smoothed and in the case of wood forms pre-oiled.

J. Form ties encased in concrete shall be designed so that after removal of the projecting part, no metal shall be within 1½-inch of the face of the concrete. That part of the tie to be removed shall be at least one-inch (1") diameter, or be provided with a wood, metal, or plastic cone at least one-inch (1") in diameter and one-inch (1") long. Form ties in concrete exposed to view shall be the cone-washer type equal to the Richmond "Tyscru". Through bolts or common wire shall not be used for form ties. Ties for water-holding structures shall have an integral waterstop that is tightly fitted to the tie at minor point.

3.07 PLACING AND COMPACTING

A. Unless otherwise permitted, the work begun on any day shall be completed in daylight of the same day.

B. Concrete is not to be placed until reinforcing steel, pipes, conduits, sleeves, hangers, anchors, and other work required to be built into concrete have been inspected and approved by the Engineer. Remove water and foreign matter from forms and excavation. Place no concrete on frozen soil, and provide adequate protection against frost action during freezing weather. All soil bottom for slabs and footings shall be approved by the Engineer before placing concrete.

C. Transport concrete from mixer to place of final deposit as rapidly as practicable by methods which prevent separation of ingredients and displacement of reinforcement, and which avoid rehandling. Partially hardened concrete is not to be used.

D. "Cold joints" are to be avoided, but if they occur, are to be treated as bonded construction joints.

E. At construction joints the surfaces of the concrete already placed, including vertical and inclined surfaces, shall be thoroughly cleaned of foreign materials and laitance, and weak concrete and roughened with suitable tools to expose a fresh face. At least two hours before and again shortly before the new concrete is deposited, the joints shall be saturated with water. After glistening water disappears, the joints shall be given a thorough coating of neat cement slurry mixed to the consistency of very heavy paste. The surfaces shall receive a coating at least 1/8-inch thick, well scrubbed-in by means of stiff bristle brushes whenever possible. New concrete shall be deposited before the neat cement dries.

F. Deposit concrete to maintain, until the completion of the unit, a horizontal plastic surface. Vertical lifts shall not exceed twenty-four inches (24") and preferably eighteen-inches (18").

G. Chutes for conveying concrete shall be of U-shaped design and sized to insure a continuous

flow of concrete. Flat (coal) chutes shall not be employed. Chutes shall be metal or metal-lined and each section shall have approximately the same slope. The slope shall not be less than 25 nor more than 45° from the horizontal, and shall be such as to prevent the segregation of the ingredients. The discharge end of the chute shall be provided with a baffle plate or spout to prevent segregation. If the discharge end of the chute is more than five feet (5') above the surface of the concrete in the forms, a spout shall be used, and the lower end maintained as near the surface of deposit as practicable. When the operation is intermittent, the chute shall discharge into a hopper. Chutes shall be thoroughly cleaned before and after each run, and the debris and any water shall be discharged outside the forms. Concrete shall not be allowed to flow horizontally over distances exceeding five feet (5').

H. The pumping of concrete is an acceptable method. The proposed equipment and concrete mix shall be submitted to the Engineer for review prior to usage. The Contractor shall submit his entire plan of operation from time of discharge of concrete from the mixer to final placement in the forms, and the steps to be taken to prevent the formation of cold joints in case the transporting of concrete by chute, conveyor, or pumps is disrupted.

1. Aluminum alloy pipelines shall not be used for delivery of concrete.

2. The trial mixes intended for pumping shall be prepared and tested in laboratory in accordance with all applicable ASTM Standards, and comply to all above mentioned requirements.

3. The selected trial mixes shall be tested for pumpability. The pumpability test(s) involves a duplication of anticipated job conditions from beginning to end. The batching and truck mixing shall be the same as will be used, the same pump and operator shall be present and the pipe and/or hose layouts shall reflect the maximum height and distance contemplated.

4. If a go-devil device pushed by water is used to clean out the pipe, additional measures to prevent water spillage into the placement area shall be taken.

5. Sampling as indicated by the Engineer at both the truck discharge and points of final placement shall be employed to determine if any changes in the slump, air content and other significant mix characteristic occur. However, only the quality of the concrete at the placement end of the line will be considered.

6. No water will be permitted to be added in order to increase workability.

7. Pumps shall be operated and maintained so that a continuous stream of concrete is delivered into the forms without air pockets, segregation, or change in slump. When pumping is completed, concrete to be used remaining in the pipeline shall be ejected without contamination of concrete or segregation of ingredients. After each operation, equipment shall be thoroughly cleaned, and the flushing water shall be wasted outside the forms. Standby equipment shall be provided to assure continuity of operation when clogging or breakdown occur.

I. In thin sections of considerable height, concrete shall be placed using suitable hoppers, spouts with restricted outlets, or otherwise, as required or approved.

J. Concrete during and immediately after depositing shall be thoroughly compacted by means of suitable tools. Internal type mechanical vibrators shall be employed to produce required quality of finish. Vibration shall be done by experienced operators under close supervision and shall be carried on long enough to produce homogeneity and optimum consolidation without permitting segregation of the solid constituents or "pumping" or migration of air. All vibrators shall be supplemented by proper wooden spade puddling adjacent to forms to remove included bubbles and honeycomb. This is essential for the top lifts of walls. All vibrators shall travel at least 10,000 rpm and be of adequate capacity. At least one vibrator shall be used for every

ten (10) cubic yards of concrete placed per hour. In addition, one spare vibrator in operating condition shall be on the site.

K. Concrete slabs on the ground shall be well-tamped into place and foundation material shall be wet, tamped, and rolled until thoroughly compacted prior to placing concrete.

L. Concrete shall be deposited continuously in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams and planes of weakness within the section. If a section cannot be placed continuously, construction joints may be located at points as provided for in the Drawings or approved by the Engineer.

3.08 CURING AND PROTECTION

A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations. Special curing procedures shall be implemented as described herein to minimize the cracking of concrete in water retaining structures.

B. Concrete placed at air temperature below 40°F shall have a minimum temperature of 60°F. When the air temperature is below 40°F or near 40°F and falling, the water and aggregates shall be heated before mixing. Accelerating chemicals shall not be used to prevent freezing. All concrete shall be so protected that the temperature at the surface will not fall below 50°F for at least seven (7) days after placing. The Contractor shall submit for approval by the Engineer the methods he proposes to use against low temperatures. No salt, manure, or other chemicals shall be used for protection.

C. All concrete, particularly exposed surfaces, shall be treated immediately after concreting or cement finishing is completed to provide continuous moist curing above 50°F for at least seven (7) days, regardless of the ambient air temperature. Walls and vertical surfaces may be covered with continuously saturated burlap, or other approved means; horizontal surfaces, slabs, etc. shall be pounded to a depth of ½-inch or kept continuously wet by use of sprinklers.

1. Slabs of water retaining structures shall be wet cured continuously with approved means for a minimum of fourteen (14) days if Type I cement is used, or for three (3) days if Type III cement is used.

2. Walls of water retaining structures shall have all their exposed surfaces covered from direct sunlight and forms left in place for a minimum of three (3) days. Curing shall commence within four (4) hours after concrete placement.

3. A LDOTD approved white pigmented curing compound shall be applied to all street pavement slabs. Application of the curing compound shall be in strict accordance with the manufacturer's recommendation including application rates.

D. In cold weather supplementary continuous warm curing (above 50°F) shall provide a total of 350-day degrees (i.e., five (5) days, 70°F, etc.) of heat.

E. In hot weather, concrete when deposited shall have a placing temperature which will not cause difficulty from loss of slump, flash set or formation of cold joints. In no case shall the temperature of concrete being placed exceed 90°F.

F. Finished surface and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

3.09 REMOVAL OF FORMS

A. Except as otherwise specifically authorized by the Engineer, forms shall not be removed before the concrete has cured as specified above in Subparagraph 3.08C and the concrete has attained a strength of at least thirty percent (30%) of the ultimate strength prescribed by the

design, and not before reaching the following number of day-degrees (whichever is the longer):

Forms for	Day-degree*
Beams and slabs	500
Walls and vertical surfaces (non-water retaining)	100
Walls and vertical surfaces (water retaining)	150

* Day-degree: Total number of days times average daily air temperature at surface of concrete. For example, five (5) days at a daily weighted average temperature of 60°F equal 300 day-degrees. (Days with temperatures below 50°F not to be included).

B. Shores shall not be removed until the concrete has attained at least 75% of the specified strength and also sufficient strength to support safely its own weight and the construction live loads upon it, but concrete shall be minimum age of fourteen (14) days before such removal.

3.10 FAILURE TO MEET REQUIREMENTS

A. Should the strengths shown by the test specimens made and tested in accordance with the above provisions fall below the values given in Table A, the Engineer shall have the right to require changes in proportions as outlined above to apply to the remainder of the work. Furthermore, the Engineer shall have the right to require additional curing on those portions of the structure represented by the test specimens which failed, the cost of such additional curing to be at the Contractor's expense. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer shall have the right to require strengthening or replacement of those portions of the structure which fail to develop the required strength. The cost of all such core borings and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be entirely at the expense of the Contractor. In such cases of failure to meet strength requirements the Contractor and Engineer shall confer to determine what adjustment, if any, can be made in conformity with Sections 16 and 17 of ASTM C94.

B. When the tests on control specimens of concrete fall below the required strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in accordance with ASTM C42 and C39. In case of failure of the latter, the Engineer, in addition to other recourses, may require, at the Contractor's expense, load tests on any one of the slabs, beams, piles, caps, and columns in which such concrete was used. Test need not be made until concrete has aged sixty (60) days.

C. Slabs or beams, under load test, shall be loaded with their own weights plus a super-imposed load of two (2) times design live load. The load shall be applied uniformly over portion being tested in approved manner, and left in position for 24 hours. The structure shall be considered satisfactory if deflection "D" in feet, at the end of a 24-hour period, does not exceed value:

$$D = 0.001(L \times L)/t$$

in which "L" is span in feet, "t" is depth of slab or beam in inches.

D. If deflection exceeds "D" in the above formula, the concrete shall be considered faulty unless within 24 hours after removal of the load, slab or beam under test recovers at least seventy-five percent (75%) of observed deflection.

3.11 PATCHING AND REPAIRS

A. It is the intent of these Specification to require that forms, mixture of concrete and workmanship shall be such that concrete surfaces, when exposed, will require minimal finishing as specified in Paragraph 3.05 above.

B. As soon as the forms have been stripped and the concrete surfaces exposed, fins and other projections shall be removed, recesses left by the removal of form ties (except where ties are left in place during sandblasting) shall be filled, and surface defects which do not impair structural strength shall be repaired. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete, to approval of the Engineer.

C. Immediately after removal of forms remove plugs and break off metal ties as required by Paragraph 3.06. Holes are then to be promptly filled upon stripping as follows: Moisten the hole with water, followed by a 1/16-inch brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1-1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.

When patching or repairing exposed surfaces the same source of cement and sand as used in the parent concrete shall be employed. Adjust color, if necessary, by addition of proper amounts of white cement.

D. Rub lightly with a fine Carborundum stone at an age of one (1) to five (5) days if necessary to bring the surface down with the parent concrete. Exercise care to avoid damaging or staining the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.

E. Defective concrete and honeycombed areas shall be chipped down reasonably square and at least one-inch (1") deep to sound concrete by means of hand chisels or pneumatic chipping hammers. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded in the parent concrete, subject to Engineer's final inspection. If honeycomb exists around reinforcement, chip to provide a clear space at least 3/8-inch wide all around the steel. For areas less than 1½-inch deep, the patch may be made in the same manner as described above for filling form tie holes, care being exercised to use adequately dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs will require build-up in successive 1½-inch layers on successive days, each layer being applied (with slurry, etc.) as described above. The Contractor shall use non-shrink, non-metallic grout for these repairs.

3.12 INSTALLATION SCHEDULE

A. Concrete for structures shall have minimum compressive strength at twenty-eight (28) days of 4000 psi unless otherwise shown on the Drawings.

3.13 FIELD CONTROL

A. The Contractor shall advise the Engineer of his readiness to proceed at least 24 hours prior to each concrete placement. The Engineer will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing and the alignment and tightness of formwork. No placement shall be made without the prior approval of the Engineer.

B. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection or determining the continuation of concrete work.

C. The Contractor shall cooperate in the obtaining of cores by allowing free access to the work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. The Contractor shall repair all core holes to the satisfaction of the Engineer. The work of cutting and testing the cores will be at the expense of the Owner if cores test satisfactorily and will be at the expense of the Contractor if cores test unsatisfactorily.

3.14 MISCELLANEOUS WORK

A. All bolts, anchors, miscellaneous metals or other sleeves and steel work required to be set in the concrete forms for attachment of masonry, structural, and mechanical equipment shall be set or installed under this Section. The Contractor shall be fully responsible for the setting of such materials in the forms and shall correct all such not installed in a proper location or manner at his own expense.

B. Electric conduits shall be installed in the concrete as required by the Drawings and specified herein. Outlet boxes and fixtures shall be located in reference to the final floor, wall or ceiling finish and shall be as secured that they will not be displaced by concrete placing.

C. Pipes or conduits for embedment, other than those merely passing through shall not be larger in outside diameter than one-third (1/3) the thickness of the slab, wall, or beam in which they are embedded, unless indicated on the Drawings, nor shall they be spaced closer than three (3) diameters on center, nor so located as to unduly impair the strength of the construction. All conduits and fixtures shall be located as approved by the Engineer.

D. Concrete foundations, supports and bases for all equipment and machinery shall be built to the equipment manufacturer's requirements, as approved by the Engineer, with anchor bolts installed.

E. All motor control centers and power control centers shall be installed on four-inch (4") minimum depth concrete bases as specified above.

3.15 PLACING REINFORCING STEEL

A. The Contractor shall comply with CRSI's "Manual of Standard Practice" for placing reinforcement. There shall be no field bending or straightening of reinforcement partially embedded in concrete.

END OF SECTION

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SECTION 16060

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART - 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.
3. Foundation steel electrodes.

1.03 ACTION SUBMITTALS

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

1.04 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Instructions for periodic testing and inspection of grounding features at test wells, ground rings and grounding connections for separately derived systems based on NETA MTS.

i. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
ii. Include recommended testing intervals.

1.06 QUALITY ASSURANCE

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

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

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

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART - 2 PRODUCTS

2.01 MANUFACTURERS

A. Burndy

B. Erico

C. OZ Gedney

D. or equal

2.02 SYSTEM DESCRIPTION

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

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.03 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.04 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.05 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad; 3/4 inch by 10 feet (19 mm by 3 m).

PART - 3 EXECUTION

3.01 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.02 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.03 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.04 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned- copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.05 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

C. Metallic Fences: Comply with requirements of IEEE C2.

1. Grounding Conductor: Bare copper, not less than No. 8 AWG.
2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.06 LIGHTNING PROTECTION

A. Provide lightning protection system designed by a certified lightning protection contractor/consultant for the following:

1. Pump building
2. Generator

3.07 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.

1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

G. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, electrical equipment items, extending around the perimeter of area indicated.

1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches (600 mm) from building's foundation.

H. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet (6.0 m) long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

3.08 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their

depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

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

END OF SECTION

SECTION 16230

ENGINE GENERATORS

PART - 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes packaged engine-generator sets for standby power supply with the following features:

1. Diesel engine.
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Performance requirements for sensitive loads.
5. Fuel system.
6. Parallel generator sets.
7. Load banks.
8. Outdoor enclosure.

1.03 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. LP: Liquid petroleum.

C. EPS: Emergency power supply.

D. EPSS: Emergency power supply system.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.
4. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
5. Include generator efficiency at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
6. Include air flow requirements for cooling and combustion air in cfm at 0.8 power factor, with air supply temperature of 95, 80, 70, and 50 deg F. Provide drawings showing requirements and limitations for location of air intake and exhausts.
7. Include generator characteristics, including, but not limited to kw rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Include plans and elevations for engine-generator set and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer and testing agency.

B. Seismic Qualification Certificates: For engine-generator set, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails identify center of gravity and total weight, supplied enclosure, subbase-mounted fuel tank and each piece of equipment not integral to the engine-generator set, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control reports, including, but not limited to the following:

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control reports.

E. Warranty: For special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

b. Operating instructions laminated and mounted adjacent to generator location.
c. Training plan.

1.07 MAINTENANCE MATERIAL SUBMITTALS

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

1. Fuses: One for every 10 of each type and rating but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.08 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved by manufacturer.

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

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

1.09 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period5 years from date of Substantial Completion.

PART - 2 PRODUCTS

2.01 MANUFACTURERS

A. Cummins

B. Caterpillar

C. Kohler

D. Mitsubishi

E. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

A. ASME Compliance: Comply with ASME B15.1.

B. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 99.
4. Comply with NFPA 110 requirements for Level 2 emergency power supply system.

C. UL Compliance: Comply with UL 2200.

D. Engine Exhaust Emissions: Comply with EPA Tier 4 requirements and applicable state and local government requirements.

E. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

F. 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: Zero to 95 percent.
3. Altitude: Sea level to 1000 feet (300 m).

2.03 ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

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

C. EPSS Class: Engine-generator set shall be classified as a Class 96 in accordance with NFPA 110.

D. Induction Method: Naturally aspirated.

E. Governor: Adjustable isochronous, with speed sensing.

F. Emissions: Comply with EPA Tier 4 requirements.

G. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

H. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries, with capacity as required to operate as a unit as evidenced by records of prototype testing.
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

I. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.

2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
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. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

J. Generator-Set Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

    a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

    a. Provide permanent magnet excitation for power source to voltage regulator.

10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.04 ENGINE

A. Fuel: Fuel oil, Grade DF-2.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

F. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator- set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

    a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and non-collapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

G. Cooling System: Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump. Comply with requirements in Section 232113 "Hydronic Piping" for coolant piping.

1. Configuration: Horizontal air discharge.
2. Radiator Core Tubes: manufacturer’s standard.
3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
5. Fan: Driven by multiple belts from engine shaft.
6. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

H. Muffler/Silencer: Commercial 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 12 dB at 500 Hz.
2. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be 90 dBA or less.

I. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

J. Starting System: 24-V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35 A minimum continuous rating.
9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F (minus 40 deg C) to 140 deg F (plus 60 deg C) to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

K. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:

1. Tank level indicator.
2. Fuel-Tank Capacity: Minimum 133 percent of total fuel required for periodic maintenance operations between fuel refills, plus fuel for the hours of continuous operation for indicated EPSS class.
3. Leak detection in interstitial space.
4. Vandal-resistant fill cap.
5. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.05 CONTROL AND MONITORING

A. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

B. Provide minimum run time control set for 30 minutes with override only by operation of a remote emergency-stop switch.

C. Comply with UL 508A.

D. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration. Panel shall be powered from the engine-generator set battery.

E. Indicating Devices: As required by NFPA 110 for Level 2 system, including the following:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. EPS supplying load indicator.
5. Ammeter and voltmeter phase-selector switches.
6. DC voltmeter (alternator battery charging).
7. Engine-coolant temperature gage.
8. Engine lubricating-oil pressure gage.
9. Running-time meter.
10. Current and Potential Transformers: Instrument accuracy class.

F. Protective Devices and Controls in Local Control Panel: Shutdown devices and common visual alarm indication as required by NFPA 110 for Level 2 system, including the following:

1. Start-stop switch.
2. Overcrank shutdown device.
3. Overspeed shutdown device.
4. Coolant high-temperature shutdown device.
5. Coolant low-level shutdown device.
6. Low lube oil pressure shutdown device.
7. Air shutdown damper shutdown device when used.
8. Overcrank alarm.
9. Overspeed alarm.
10. Coolant high-temperature alarm.
11. Coolant low-temperature alarm.
12. Coolant low-level alarm.
13. Low lube oil pressure alarm.
14. Air shutdown damper alarm when used.
15. Lamp test.
16. Contacts for local and remote common alarm.

17. Coolant high-temperature prealarm.
18. Generator-voltage adjusting rheostat.
19. Main fuel tank low-level alarm.

    a. Low fuel level alarm shall be initiated when the level falls below that required for operation for the duration required in "Fuel Tank Capacity" Paragraph in "Diesel Fuel-Oil System" Article.

20. Run-Off-Auto switch.
21. Control switch not in automatic position alarm.
22. Low-starting air pressure alarm.
23. Low-starting hydraulic pressure alarm.
24. Low cranking voltage alarm.
25. Battery-charger malfunction alarm.
26. Battery low-voltage alarm.
27. Battery high-voltage alarm.
28. Generator overcurrent protective device not closed alarm.

G. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

H. Common Remote Panel with Common Audible Alarm: Comply with NFPA 110 requirements for Level 2 systems. Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine-generator set battery.

I. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush- mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Coolant low-temperature alarm.
3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Lamp test.
18. Low cranking voltage alarm.
19. Generator overcurrent protective device not closed.

J. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

K. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation. Locate per owner's preference.

2.06 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.

1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms. Contacts shall be available for load shed functions.
2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.

1. Indicate ground fault with other generator-set alarm indications.
2. Trip generator protective device on ground fault.

2.07 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide 12 lead alternator.

E. Range: Provide extended range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
2. Maintain voltage within 15 percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within 5 percent and stabilize at rated frequency within 5 seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.

2.08 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Prefabricated or pre-engineered galvanized-steel-clad, integral structural-steel-framed skin tight enclosure, erected on concrete foundation.

1. Structural Design and Anchorage: Comply with ASCE 7 for wind loads up to 150 mph (240 km/h).
2. Hinged Doors: With padlocking provisions.
3. Space Heater: Thermostatically controlled and sized to prevent condensation.
4. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
5. Muffler Location: External to enclosure.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

C. Interior Lights with Switch: Factory-wired, vapor-proof fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

D. Provide stairs and access platform.

E. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.09 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Standard neoprene separated by steel shims.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Test generator, exciter, and voltage regulator as a unit.
3. Full load run.
4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.
7. Single-step load pickup.
8. Safety shutdown.
9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

C. Report factory test results within 10 days of completion of test.

PART - 3 EXECUTION

3.01 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

3.02 PREPARATION

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

1. Notify Construction Manager and Owner no fewer than seven working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager's and Owner's written permission.

3.03 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases.
2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

C. Install packaged engine-generator to provide access, without removing connections or accessories, for periodic maintenance.

D. Install engine-generator in skin tight enclosure. on 4-inch- (100-mm-) high concrete base. Secure enclosure to anchor bolts installed in concrete bases.

E. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints.

F. Installation requirements for piping materials and flexible connectors are specified in Section 232116 "Hydronic Piping Specialties." Copper and galvanized steel shall not be used in the fuel-oil piping system.

G. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.04 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the generator set from a stationary element.

3.05 IDENTIFICATION

A. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs as specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.

    a. Visual and Mechanical Inspection

        i. Compare equipment nameplate data with drawings and specifications.
        ii. Inspect physical and mechanical condition.
        iii. Inspect anchorage, alignment, and grounding.
        iv. Verify the unit is clean.

    b. Electrical and Mechanical Tests

        i. Perform insulation-resistance tests in accordance with IEEE 43.
            (a) Machines larger than 200 horsepower (150 kilowatts). Test duration shall be 10 minutes. Calculate polarization index.
            (b) Machines 200 horsepower (150 kilowatts) or less. Test duration shall be one minute. Calculate the dielectric-absorption ratio.
        ii. Test protective relay devices.
        iii. Verify phase rotation, phasing, and synchronized operation as required by the application.
        iv. Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
        v. Conduct performance test in accordance with NFPA 110.
        vi. Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.

8. 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.
9. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
10. 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 25 feet (7.6 m) from edge of the generator enclosure on the property line, and compare measured levels with required values.

C. Test instruments shall have been calibrated within the last 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

D. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

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

G. Remove and replace malfunctioning units and retest and reinspect as specified above.

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

J. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.07 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.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION